Asian Development Review

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Special Issue on the People's Republic of China

Understanding the Slowing Growth Rate of the People's Republic of China
Dwight H. Perkins

Sustaining Growth of the People's Republic of China
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Trilemma Challenges for the People's Republic of China
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Export Destination and Export Market Penetration of the People's Republic of China—Past and Future
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Special Issue on the People's Republic of China

This special issue of the *Asian Development Review* contains a selection of papers on the People's Republic of China's (PRC's) economic growth and on policies that influence its pattern. It is generally accepted that the PRC can no longer sustain the double-digit growth rates it experienced in the last three decades as it undergoes economic transformation. The papers focus on recent patterns of growth and on some of the policy issues that confront the PRC as it moves towards a lower but more sustainable and inclusive growth path.

The paper by Dwight Perkins examines factors that have contributed to the deceleration of the PRC's growth. He notes that, on the supply side, total factor productivity growth has been slowing down instead of increasing as the PRC's labor force growth has reached its demographic limit. On the demand side, the largely investment-led growth experienced in the past is expected to substantially decelerate as the PRC rationalizes its infrastructure build-out program. Justin Lin and Fan Zhang take a contrarian perspective, and their paper considers the possibility of a sustained high-growth environment in the PRC, arguing that its large technological gap with more advanced economies could still represent a substantial bonus in terms of "advantage of backwardness." They, however, note that for the PRC to sustain its growth rates, it needs to satisfy a number of preconditions, such as to develop well-functioning markets, to undertake successful structural reforms, and to implement effective governance systems.

Two papers discuss macro policy challenges confronting the PRC. Masahiro Kawai and Li-Gang Liu's paper outlines monetary and exchange rate policy challenges, specifically the decline in the effectiveness of capital controls and monetary policy autonomy. Using both Taylor- and McCallum-like rules, they cannot reject the hypothesis of diminished monetary policy autonomy. Ran Li and Yiping Huang examine the impact of greater financial openness by analyzing the effects of foreign bank entry on industrial efficiency in the PRC. Their findings suggest that while there is positive impact as a whole, effects vary across groups. Specifically, the impact is negative for state and collective sectors, positive for the private sector, and insignificant for foreign-invested firms.

Although domestic aggregate demand is expected to play a greater role in the future, the PRC's export markets will continue to be an important source of economic growth. Rui Mao and Bin Zhang's paper analyzes the growth of the PRC's aggregate export market penetration. They find that export competitiveness weakened during 2002–2014 due to increases in production and trade costs. They argue that for exports to stabilize, the PRC must facilitate the structural transformation of its export basket.

The continuing development of the local financial sector and the growing importance of private sector finance is highlighted by Di Guo, Kun Jiang, and

Xiaoting Mai's paper on venture capital investments and the performance of entrepreneurial firms in the PRC. Using firm-level panel data, they examine the performance of entrepreneurial firms after tapping into the local equities market through an initial public offering. They find a positive and significant relationship between corporate governance and the incidence of investments from venture capitalists.

The last two papers in this issue of the ADR are on the dispensation of health care expenditures and education, two areas known to promote inclusive growth under certain conditions. Jin Feng, Pingyi Lou, and Yangyang Yu use survey data spanning two decades to examine the age profiles of health expenditures for rural and urban residents from the PRC. They find that the estimated age-expenditure profiles in both rural and urban areas were steeper in 2004–2011 than in 1991–2000. Dandan Zhang, Xin Li, and Jinjun Xue also use survey data to examine education inequality between rural and urban areas in the PRC and assess potential bottlenecks for human capital accumulation. They find that the education levels of rural children and children of rural-to-urban migrants are significantly lower than those of their urban counterparts, after accounting for individual attributes such as nutrition and style of parenting.

The *Asian Development Review* thanks its contributors, especially Dwight Perkins, Professor Emeritus, Harvard University, for his role as guest editor.

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Understanding the Slowing Growth Rate of the People's Republic of China

Dwight H. Perkins*

It is increasingly accepted that the gross domestic product (GDP) growth rate of the People's Republic of China (PRC) is slowing down, but the reasons for the slowdown are not yet well understood. Part of the reason is that growth in all countries that reach high-income status slows down when they reach a global research income level that is still far below the level of the highest income countries. In the PRC, on the supply side, this is happening because total factor productivity (TFP) is slowing down whereas, because of slowing labor force growth, it would have to increase in order to maintain near double-digit GDP growth. On the demand side, a low share of household income in GDP has required the PRC to maintain an unusually high rate of investment in transport infrastructure and housing, but the rapid growth in both of these areas is coming to an end. Environmental investment could take up the slack and keep aggregate demand at a level that would fully employ resources. Finally, the PRC has reached the point where the manufacturing share of GDP has peaked and will begin to decline as the economy becomes increasingly service based, but services seldom grow at the double-digit rates that manufacturing is sometimes capable of.

Keywords: TFP, GDP growth rate, housing construction, transport investment, environmental investment, service-based economy
JEL codes: E6, O43, O47, P42

I. Introduction

It has become increasingly accepted within the People's Republic of China (PRC) and outside that the PRC's slowing growth rate is a long-term phenomenon, not a temporary or cyclical downturn. The future rate of growth can fluctuate from year to year depending on world economic conditions and on the PRC's domestic policies—notably whether the government calls for a fiscal and monetary stimulus or not—but there are compelling reasons for believing that the long-term trend in the growth rate is sloping downward. The PRC's gross domestic product (GDP) may well grow at 5% or 6% for the next 1 to 2 decades and possibly a point or two faster than that for the next few years. If there is a fiscal stimulus comparable to what occurred during 2009–2010, the rate could be even higher but with likely long-term effects that would be negative.

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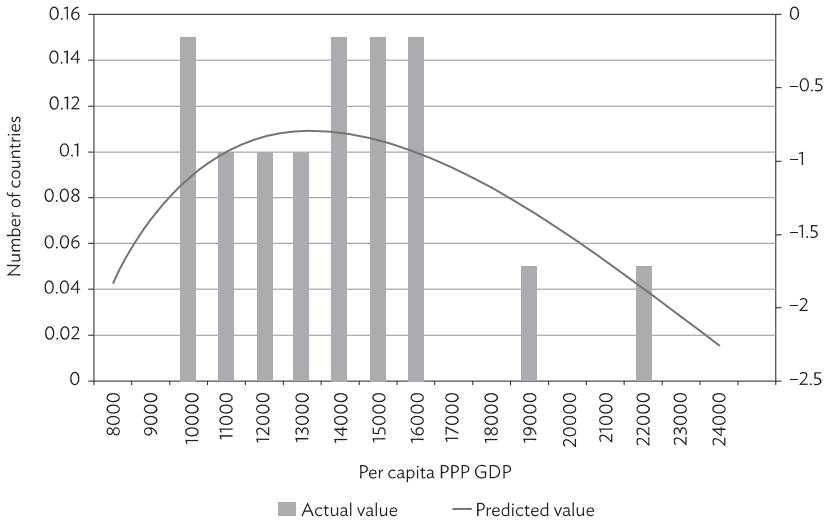
Figure 1. **Per Capita Income at which Growth Decelerated**
(Y = Number of countries; X = Per capita PPP GDP)

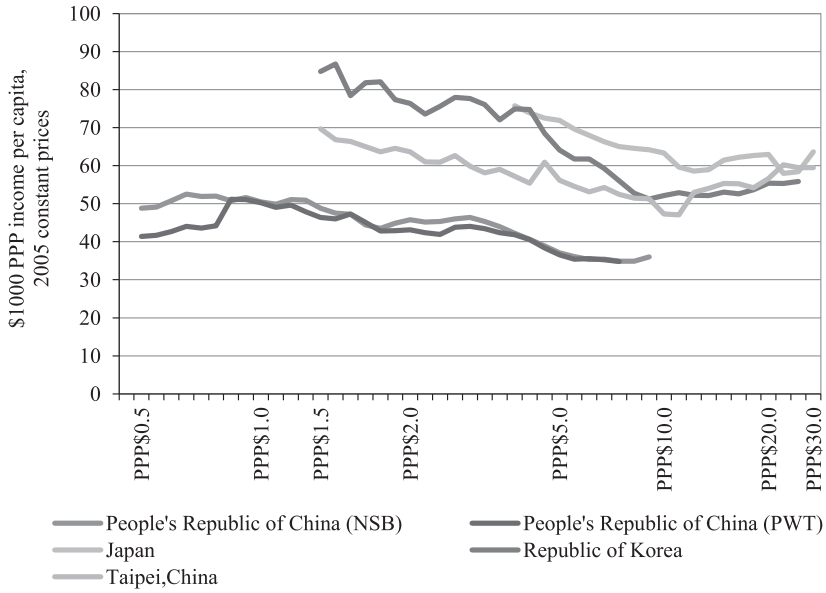


GDP = gross domestic product, PPP = purchasing power parity.
Note: This figure is based on countries that achieved high-income status except for those whose high income was mainly the result of petroleum exports.
Source: Eichengreen, Barry, Dwight Perkins, and Kwanho Shin. 2012. *From Miracle to Maturity: The Growth of the Korean Economy*, p. 33. Cambridge: Harvard Asia Center, distributed by Harvard University Press.

The slowdown in growth at purchasing power parity (PPP) per capita GDP of between $10,000 and $16,000 is normal and most high-income countries existing today experienced such a decline when per capita GDP reached this level (Figure 1). The causes of this decline involve structural changes such as the end of a rural labor surplus, that can be readily shifted to higher productivity urban occupations, and the gradual shift away from manufacturing to services. To some degree, it is also the case that middle-income countries can no longer simply copy what the high-income countries did when they were at the middle-income level and must depend increasingly on their own innovative capacity with its inevitable mistakes and dead ends.

In the PRC's case this slowdown is occurring at a time when the country has a very unusual GDP structure on the expenditure side that complicates what the country needs to do to maintain healthy development in the near and more distant future. Put succinctly, the household consumption rate as a share of GDP is much too low, and the investment rate is too high. The data and how they compare with other economies in East Asia are presented in Figures 2 and 3. There have been challenges to the reliability of these estimates, and it is likely that the official Chinese figure for household consumption as a share of GDP is in reality somewhat lower than it would be if such things as the implicit share of housing in consumption

Figure 2. **Share of Household Consumption in GDP**



GDP = gross domestic product, NSB = National Statistical Bureau, PPP = purchasing power parity, PWT = Penn World Tables.

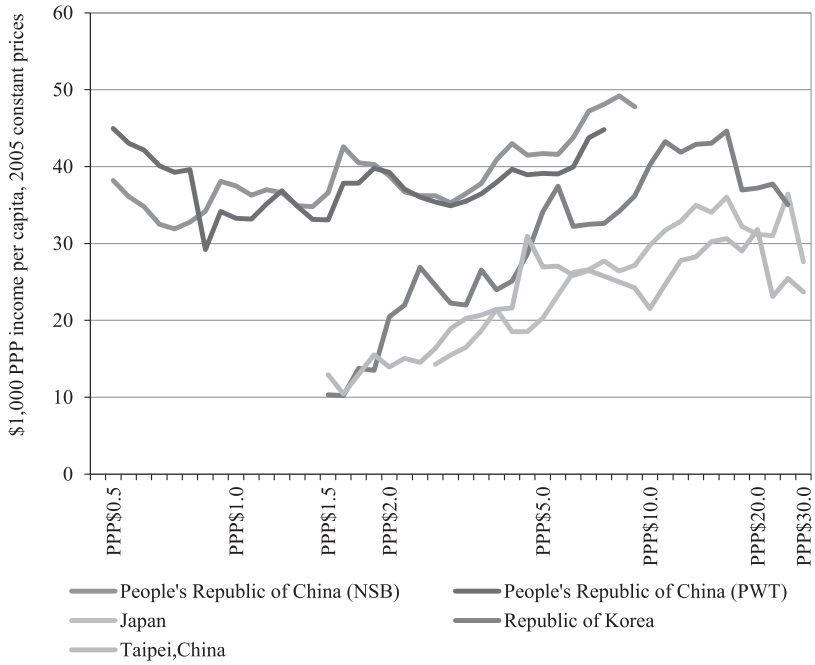
Note: Matching shares of household consumption to GDP per capita and placing the economies in a single figure for comparative purposes is an inexact process. The patterns, however, are clear even though one has to approximate the consumption level for any given per capita income. The consumption shares are those in current prices.

Sources: Author's computations; Heston, Alan, Robert Summers, and Bettina Aten. Penn *World Tables 7.1*. Center for International Comparisons of Production, Income and Prices, University of Pennsylvania; National Bureau of Statistics. 2013. *China Statistical Yearbook 2013*, p. 62. Beijing: China Statistics Press.

were properly measured. Adjusting for these possible biases, however, still leaves the household consumption share unusually low.

Another way to view this structure is to realize that the low household consumption share virtually requires that the investment share be excessive. An unusually high investment rate in turn will typically mean that the marginal rate of return on investment and overall total factor productivity (TFP) will be lower than it would be if the investment share were smaller. There is reason to believe that is the case in the PRC at present and may well be the case in the years ahead. In contrast, the PRC in the 1980s and through the first years of the 21st century maintained a high rate of TFP growth and avoided a declining rate of return on investment in part because of large shortages in transport and housing resulting from 2 decades of neglect of these sectors before 1978. Later in this essay, we shall deal with the nature of these high transport and housing investment requirements and why their absence in the future will not justify a similarly high rate of investment in the decade or two ahead.

Figure 3. **Share of Investment in GDP**



GDP = gross domestic product, NSB = National Statistical Bureau, PPP = purchasing power parity, PWT = Penn World Tables.

Sources: Author's computations; Heston, Alan, Robert Summers, and Bettina Aten. *Penn World Tables 7.1*. Center for International Comparisons of Production, Income and Prices, University of Pennsylvania; National Bureau of Statistics. 2013. *China Statistical Yearbook 2013*, p. 62. Beijing: China Statistics Press.

II. The Low Household Consumption Share in GDP

The PRC began the reform period in 1978 with consumption already accounting for a low share of GDP, and that share has fallen steadily since. The initially low consumption level was partly because most investment went into heavy industry in urban areas, while restrictions on rural-to-urban migration prevented a large majority of the population from sharing in the income generated by that investment. Meanwhile, urban wages were held down by the potential availability of low-cost surplus labor in the countryside.

Migration restrictions encouraged more capital-intensive production methods than would normally occur in a country with low per-capita income and a large labor surplus.[1] As a result, household incomes in the PRC were a low 55.9% of GDP in

[1]There is a seeming contradiction between the observations that migration restrictions led to more capital-intensive investment than otherwise should have been the case, while those same restrictions did not increase pressure on urban wages. This was due in part to the ability of urban employers to draw on a large pool of urban women workers who had not previously been employed; but to the extent there was wage pressure, the government could have simply

1981.[2] The freeing up of migration beginning the 1980s made it even easier for enterprises to hold down wages despite a loosening of government wage controls. In 2012, compensation of employees was still only 51.5% of GDP, although if household property income were added to the 2012 total, the share would probably not have declined.[3]

Household savings had been low in 1981 but has risen substantially with a further reduction in consumption demand. One indicator of the rise in household savings rate is the accumulated bank deposits of households. Such deposits were only 29.5% of annual household income in 1981, but amounted to 154.3% of household income by 2012, when households also had more places other than bank accounts to invest their savings.[4]

The solution to raising household consumption as a share of GDP is to raise household incomes as a share of GDP and reduce the average household saving rate. The government for a number of years has wanted to achieve a higher household consumption rate, but this is difficult to do. Incomes are now largely determined by market forces and the main way for income share to rise is for wages to rise faster than GDP. As Cai and Du (2011) and others have shown, wages of unskilled migrant workers do seem to be growing faster than GDP now and are catching up with the wages of low-skilled registered urban workers.[5] This wage acceleration results mainly from the end of the growth of the total labor force due largely to the one-child policy and even more to the drying up of the rural labor surplus. Surveys have shown that most of the registered rural labor force between the ages of 18 and 40 have already left farming and taken up urban jobs.

Future rural-to-urban migrants will come mainly from the children left behind in the village whose parents have taken up work in the cities. They will likely leave the village as soon as they complete their education and reach working age, but the number of these migrants will be smaller than in the past. Consequently, the productivity dividend from transferring rural workers in low productivity jobs to higher productivity urban jobs will be much lower than in the recent past.

With this demographic situation, will wages continue to grow faster than GDP for a decade or two and thus raise the share of household income in national income?

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allowed enterprises to hire workers from the countryside. Both wages and the right to hire were tightly controlled by the government. In fact, in the 1980s, the enterprises on their own began to contract with rural townships and village enterprises to take over some of the more labor-intensive components of their products.

[2]The GDP figure for 1981 was taken from National Bureau of Statistics (2012). The household income share was derived by adding the per capita income of the rural population multiplied by the total rural population to the total national wage bill (mainly for urban employees). There were effectively no urban property incomes in 1981 (State Statistical Bureau 1981, 429–31).

[3]Compensation of employees is different from total household income because households also had some income from property in 2012 (although very little in 1981). In the US household income share in national income was 81.9% (2012) or 70.5% of GDP but 22.8% of that household income came from proprietors income, rental income, and dividends. The Chinese share from these latter sources would presumably be smaller.

[4]The 1981 data are from the *Statistical Yearbook of China 1981* (State Statistical Bureau 1981, 408–409).

[5]See, for example, Cai and Du (2011, 601–10).

Will non-wage sources of household income also rise relative to wage income, and will the non-wage income be distributed across a large proportion of the population or just be highly concentrated among a few? I have no answer to these questions and the data on relevant international experience is not readily available except for a few high-income countries.

The main way that government policies can affect the growth of household incomes is not through direct intervention in the labor market. The government can increase rural spending out of existing income by taking over a larger share of education and health costs. Whether this will increase nationwide expenditure, however, will depend on how these extra payments are financed. By freeing up bank interest rates, the government can also directly influence household non-wage income, and assuming that freed interest rates will be higher than the current repressed rates, that will increase incomes of much of the population. Increasing direct subsidies to the poor is another direct way of raising incomes. None of these measures by themselves are going to raise the share of household consumption in GDP dramatically, but taken together, they could make a large difference.

The direct effects of raising the rate of interest on bank deposits by 2 percentage points could raise consumption by slightly over 1% of GDP, and using government subsidies to raise the income of the bottom 10% of the urban population and the poorest 20% of the rural population by 20% could raise household consumption by over 2% of GDP, assuming that these subsidies were not financed through increases in taxes on households.[6] Subsidizing rent payments made by rural-to-urban migrants would not only lead to better housing for these migrants but would also increase their income and consumption directly. How these latter two steps can be accomplished and the unanticipated consequences they may generate is a topic well beyond the scope of this essay.

Government measures designed to lower the rate of savings are more numerous at least potentially. In general, there is much the government can do, and to some degree is already doing, to remove part of the precautionary motive for a high savings rate. Two major motivations for the high precautionary reason for savings are the cost of health care and the lack of access by much of the population to pensions. The government has introduced universal health insurance and is working toward a national pension system, but these have a long way to go before they deal with enough of the problem to have a major impact on the savings rate. National health and pension insurance systems are complex and need to be designed carefully from the start. Getting rid of the *hukou* or household registration system and its restrictions on migrants, for example, is a good first step, but one cannot simply replace it by putting all of the migrants under the existing urban health and pension systems.

[6]Calculations made by the author using data from household surveys published in the *China Statistical Yearbook 2013* (National Bureau of Statistics 2013).

Table 1. **Foreign Trade Growth Rates (%)**

	Export Growth	Import Growth
1979–1989	25.0	25.1
1990–1999	23.5	20.1
2000–2007	24.5	23.3
2008–2013	6.6	8.7

Note: Export growth rates in the last period may have been influenced by currency speculation leading to over-invoicing of exports in order to move foreign exchange into the PRC. These figures are for exports and imports in current prices and are not deflated by price indices.
Sources: National Bureau of Statistics. 2014a. *Zhongguo Tongji Zhaiyao 2014*, (China Statistical Abstract 2014) p. 90. Beijing: China Statistics Press.

If the PRC succeeds in raising the share of household consumption in GDP, then consumption will be rising faster than GDP on a sustained basis. That in turn will mean that the domestic market for household goods and services will also be growing faster than GDP. That may not absorb all or even most of the unused capacity among Chinese manufacturers, but it will help offset the fact that the market for Chinese manufactured household goods will not be as hard hit by the sharp slowdown in exports of these items in recent years. As we will discuss in the next section, the recent slowdown has been dramatic and is probably irreversible.

III. The Slowing of Export Growth

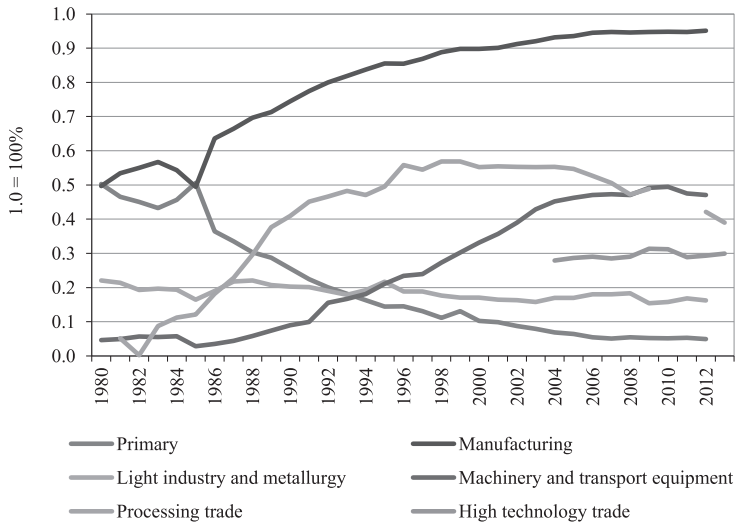
For roughly 30 years, Chinese manufacturers not only enjoyed a fast-growing domestic market as household incomes rose, they also benefitted from an even faster growth of export demand for their products. One reason for this sustained rapid rise in exports was that the PRC started the reform period with an unusually low level of exports. Exports in 1978 were 4.5% of GDP using the official exchange rate to convert exports in dollars into yuan.[7] The reforms over time changed that situation dramatically and exports rose to 24.1% of GDP by 2013. The rates of export growth that produced this large rise in the export share are presented in Table 1.

In 1978, the PRC's exports amounted to only $9.75 billion and formed a tiny share of world exports, but in 2012, Chinese exports reached $2,209.6 billion, or about 11.1% of world merchandise exports (World Trade Organization 2012, 24). This is the largest share of any country in the world—roughly equivalent to the exports of the entire European Union (EU), a third more than the United States (US), and more than double the export share of Japan.

Throughout the 1980s and 1990s, one could argue that the PRC's export statistics exaggerated the true size of the country's export trade, as so much of that

[7]If the exchange rate of CNY1.7 per dollar overvalued the Chinese currency as seems likely, the share of exports in GDP would be even lower than 4.5%.

Figure 4. **Sector Exports as a Share of Total Chinese Exports**



Sources: National Bureau of Statistics. Various years. *China Statistical Yearbook*. Beijing: China Statistics Press; National Bureau of Statistics. 2014b. *Statistical Communique of the People's Republic of China on the 2013 National Economic and Social Development*, p. 43. Available online at www.stats.gov.cn/english/PressRelease/201402/t20140224_515103.html.

trade involved processing or assembly of components supplied by other economies, notably the other major exporting economies in East Asia. In effect, these other economies were producing a large share of the components in particular products and then shipping them to the PRC for assembly and shipment to their final destination. The PRC's processing trade as a share of total trade, however, peaked in 1999 at 57%, and by 2013, that share had fallen to 39% (Figure 4).

Even if one eliminated all processing trade from the export figures in 2013, the PRC's exports would still nearly match the exports of Germany and the US and would be far larger than those of Japan. The share of processing trade will probably continue to fall as the PRC's wages rise and the largely labor-intensive processing trade moves out to lower-wage countries.

Export growth rates of the kind the PRC experienced prior to 2008 (well over 20% a year in nominal terms, perhaps 20% a year in real terms) are clearly not sustainable, and the rates since 2008 are probably a more realistic guide to what is possible going forward. World trade in the 8 years from 2005 to 2012 grew at 8% per year, and the PRC's rate might exceed that by a small amount if the country continues to succeed in moving up to more sophisticated and higher technology exports. If the PRC's exports were to grow at 20% a year over the next decade, the PRC would account for one-third of the world's exports, an enormous and unrealistic share.[8]

[8]This calculation assumes a Chinese export growth rate of 20% a year and a world export growth rate of 8% a year.

Table 2. **The Gross Capital Formation Rate and Capital–Output Ratio of the People's Republic of China**

	Annual Averages (% of GDP)	Capital–Output Ratio
1978–1992	33.3	3.88
1993–2002	38.1	4.41
2003–2007	41.8	3.92
2008–2013	47.1	5.26

GDP = gross domestic product.

Note: Capital and the share of capital in GDP in Chinese official sources are calculated from current price sources. When these figures are used to estimate the capital–output ratio, some of the movement in the ratio can be attributed to differences in the price deflator for GDP and that for capital. In these calculations, therefore, constant price GDP data are used and the percentage rate of capital formation was applied to those figures. The capital–output ratios in the table use the total capital accumulated in 1978–1991 divided by the increase in output in 1979–1992 (1992GDP–1978GDP), etc.

Sources: Author's computations; National Bureau of Statistics. 2014a. *Zhongguo Tongji Zhaiyao 2014* (China Statistical Abstract 2014), pp. 23–5. Beijing: China Statistics Press.

Japan's share of world merchandise exports, by way of comparison, rose rapidly from the 1950s through the 1980s reaching 9.9% of the world total in 1993, but that share has since fallen to about 4.5% (World Trade Organization 2012, 22). The PRC will have to vigorously upgrade the efficiency and quality of its manufacturing sector (and also its service sector) if it is to maintain its share of world exports. Continuing to increase that share will be an even bigger challenge.

A slowdown in export growth, however, does not necessarily mean that GDP growth would also slow down. A decline in net exports (exports minus imports) would mean a decline in aggregate demand, and hence GDP growth, other demand variables staying the same, but a decline in export growth rates alone could involve simply a shift in production to other items in demand. The impact on GDP growth depends on a further assumption that it is much easier and more profitable (i.e., provides a higher rate of return) to expand existing production and market share than it is to develop new products of greater technical sophistication and sell them against established firms in those sectors. The PRC is succeeding in doing this, but at a much slower pace than was the case with labor-intensive products where the country in the past had a large cost advantage over most competitors.

IV. The Rising Share of Investment in GDP Expenditure

The PRC's rate of capital formation as a share of GDP has been rising steadily since the beginning of the reform period in 1978 from a base level that was already high compared with other developing economies as a result of investment increases in the pre-reform period. The data for the reform period are presented in Table 2.

By way of contrast, gross capital formation in Taipei,China peaked at 32% of GDP in 1979–1981 and that in the Republic of Korea peaked in the 1990s at 37%,

a decade that most analysts feel saw a poorly thought-out investment acceleration by many of the large companies (*chaebol*). If the increase of 8.9% in the capital formation rate in the PRC from 1993 to 2002 and 2008 to 2012 had not occurred, the PRC's GDP growth rate after 2002 would have been 1 percentage point lower (9.4% versus 10.4%) even if the increase in capital formation had a zero rate of return. The assumption of a zero rate of return on the additional capital formation in the latter period may not be far off reality given the large increase in the capital–output ratio in the period 2008–2012. The higher capital–output ratio in 1993–2002 than the periods before and immediately after probably reflects the unusually (up to that time) high rate of investment in 1993–1995 (average per year of 41.1%) that resulted in a high rate of inflation (for the PRC) of 18.6% per year during those years.

Clearly, part of the story of the PRC's slowdown in GDP growth can be attributed to the rising inefficiency of investment. We shall take some initial steps to try to understand the sources of that inefficiency, but a full accounting would require at a minimum a sector-by-sector analysis of the sources of this rising inefficiency. That is far beyond what can be undertaken in this short essay.

Outright private and self-employed investment is only 27.5% of the total (in 2012) while enterprises that are fully state owned account for 25.7%. However, there is another 33.1% made by shareholding and limited liability enterprises, a substantial share of which (probably somewhat over half) are state controlled (National Bureau of Statistics 2013, 155–56). There are published data for the return on assets in the industrial sector, and these indicate that the rate of return in private industry has actually risen substantially since 2004 from 10% to 14%. State-enterprise profits in contrast did rise slightly from 2002 to 2007 but only from 3% to just over 6% and then fell back to 4%–5% (Lardy 2014, 126). It is questionable, however, whether even this low rate of return in the state-owned and state-holding sector reflects the real return on assets for most state enterprises, as 60% of those profits are in the highly regulated gas, oil, coal, tobacco, and electric power sectors (National Bureau of Statistics 2013, 485–87).

In this section, we shall make a few comments about the impact on investment of the PRC's gradual shift toward a service-sector economy followed by brief comments on certain industrial sectors. However, our focus will mainly be on two areas of investment where the PRC is probably running into decreasing returns because the demand is not there to justify sustaining the rate of growth of production in these sectors. The two sectors are real estate, particularly housing, and certain infrastructure investments.

As the economy shifts away from manufacturing toward services, the role of investment in the economy can be expected to decline. One reason for this is that manufacturing, particularly for middle-income and higher-income countries is typically more capital intensive than most services other than transport. Wholesale and retail services are labor intensive, while education, health care, and financial and business services are human capital but not physical capital intensive. In the

case of the PRC, the ratio of investment in fixed assets to increases in output, for example, was 3.1:1 during 2010–2011, while that in services (minus real estate and transport) was 2.3:1.[9] Thus, if the share of services rises while that of industry falls, assuming a constant rate of GDP growth, there will also be a decline in the share of investment in GDP which will have to be made up by increasing consumption. Transport and real estate will be discussed separately below.

Some of the investment in industry in the PRC during the most recent few years has almost certainly been excessive. This is most obviously the case with the extraordinary expansion of the steel and cement industries during this period. These industries continued to expand capacity to meet immediate high demand notably from housing and transport that, as we shall argue below, was likely to level off or decline in the future.

The PRC, as of 2013, produced 48.5% of the world's crude steel and 59.3% of the world's cement in 2012.[10] It is widely believed that state enterprises, as part of government efforts to stimulate the economy, expanded capacity right through the world recession, whether or not domestic and export demand for the output of those assets was likely to grow at a rate that would justify that investment. An in-depth (sector-by-sector) analysis of the investment behavior of state-owned industrial enterprises is beyond the scope of this essay, but clearly, these enterprises are prone to political intervention, which helps explain why their rate of profits is so far below that of the private sector.

One can say more about the likely future investment in three broad sectors of the economy: real estate, including residential housing; transport; and water and the environment. These three sectors have by far the largest investments other than manufacturing. Together they constituted 42.8% of all investment in fixed assets in 2003 and 2012. The first two are likely to slow down and contribute to a slower GDP growth overall, while water and the environment are likely to see further investment growth, possibly a very large rise.

V. Housing Supply and Demand

Investment in real estate in general and in the construction of residential housing has played a major role in the overall rise in investment as a share of GDP, particularly beginning around the year 2007. Real estate and housing investment

[9]Transport was eliminated because it is highly capital intensive and will be discussed below. Real estate was eliminated from the service sector because the data for real estate services in GDP include only such items as real estate company rental services, while the fixed asset investment in real estate enter GDP through other sectors (notably but not exclusively via construction). The asset/value-added ratios are calculations of the author from data published in the *China Statistical Yearbook 2013* (National Bureau of Statistics 2013, 54 and 159–61. The figures are not strictly speaking capital–output ratios because the fixed asset data involves some double counting whereas the output data are value added.

[10]Data obtained from the World Steel Organization (available online at www.worldsteel.org, accessed 23 January 2014) and the European Cement Association (2014).

has in turn been a major source of demand for cement and steel. It is not possible to say much about the future growth of investment in office buildings, as it depends on sources of demand that are not transparent, but it is possible to say something systematic about the demand for residential housing.[11] For much of the past 3 decades, urban housing construction was filling the gap in housing supply resulting from almost complete neglect of housing construction during the 2 decades prior to the beginning of reforms in 1978. By 1978, the average per-capita housing space in urban areas was 7.2 square meters (m^2). By 2010, this figure had risen to 31.6 m^2 and it has continued to rise slowly since then. The major question now is whether the current rate of housing construction that filled the gap left by decades of neglect is sustainable over the next 1 to 2 decades.

Before addressing this question, however, the nature of housing demand in the PRC needs to be clarified. Some of the demand was created by local governments and developers building houses that were not sold to consumers or even to investors and thus remained empty, although that was not the major reason for the large demand for housing that occurred in the late 1990s and after 2000. If households were purchasing housing out of current income, a decision to reduce this expenditure would simply involve increased expenditure on something else and the growth rate in aggregate demand would be unaffected. In the PRC, however, virtually all urban housing prior to the late 1990s had been owned by the state and both by state-owned enterprises or the government more directly. When housing was privatized, it was sold mainly to current occupants at prices far below market value. Urban residents thus received a large wealth windfall when they sold their property at market prices, and the windfall was further magnified by rapidly rising housing prices. Many then proceeded to use that windfall to purchase much better housing than they could previously afford.[12] This was, in short, a one-shot major increase in demand that cannot be repeated because most housing other than that for low-income urban residents had already been privatized. Housing demand going forward will therefore have to depend mainly on household current income plus whatever mortgage borrowing they can negotiate, which itself depends to a large degree on estimates of their current and future income.

The data on annual rates of completed housing are presented in Figure 5, while the shares in GDP of investment in the completed housing through time is presented in Figure 6.

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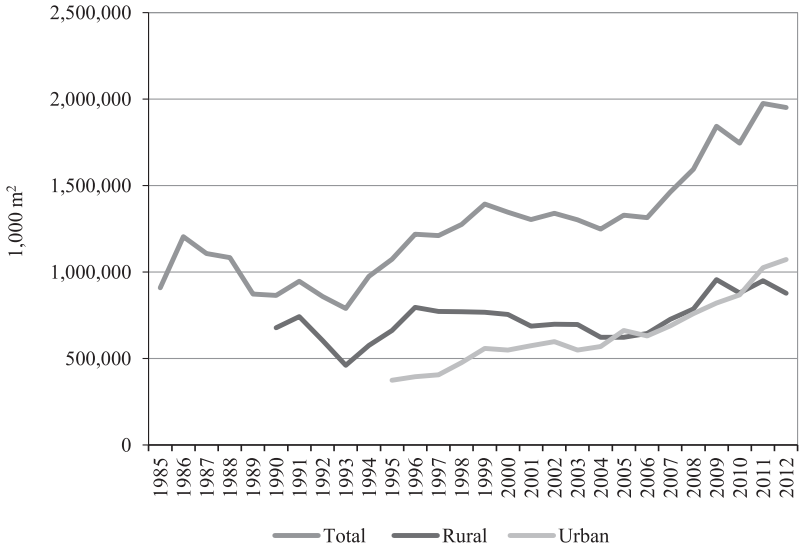
[11] Demand for government office buildings, for example, depends to a large degree on whether government officials in a decision-making position want better offices or larger office space, and that may have little relationship to the rise in the number of government office workers or other easily measurable reasons for building new offices. Private office space will also depend on such things as the size of corporate profits or the desire of a chief executive to move offices closer to where he lives, among many other impossible to forecast motivations.

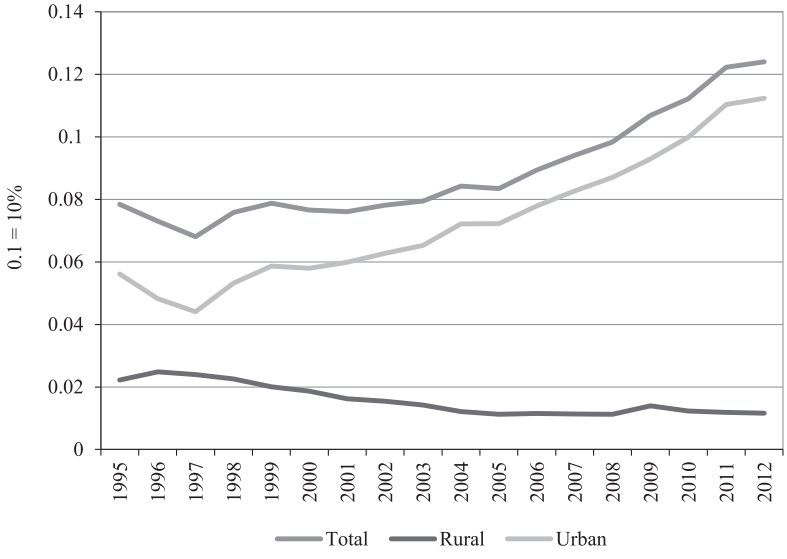
[12] Many of these transactions involved government decisions to demolish the existing housing after privatization that would have involved compensation to the owners. Anecdotal evidence suggests that this compensation was closer to market values than to the original highly subsidized purchase price. In some cases, those forced out of particularly valuable locations could extract a kind of monopoly rent over and above the normal price for that land.

Figure 5. **Residential Housing Completed Annually**



Source: National Bureau of Statistics. 2013. *China Statistical Yearbook 2013*, pp. 183 and 195. Beijing: China Statistics Press.

Figure 6. **Residential Housing Expenditure as a Share of GDP**



Note: The urban figure was derived by subtracting the rural figure from total investment in residential construction. The residential construction value figures used here are gross expenditures not including housing repairs and are different from housing investment value-added expenditure in the national accounts. Thus, the share in this figure overstates the contribution of real estate expenditures to GDP by a substantial margin. The trend, however, should not be substantially different if we had data on value-added expenditure on residential housing.
Source: National Bureau of Statistics. 2013. *China Statistical Yearbook 2013*, pp. 154–95. Beijing: China Statistics Press.

During the past 27 years, the PRC constructed 25.9 billion m^2 of housing of which 11.6 billion m^2 was constructed in urban areas with 39% of the urban total (4.55 billion m^2) constructed during the 5-year period 2008–2012. Unfortunately we do not have a reliable estimate of the total urban housing stock. Using census data, Yao (2013b, 1) estimates that the total urban housing stock in 2010 was 16.8 billion m^2. The National Bureau of Statistics (2013, 11) however, reports a figure of 31.6 meters per capita for urban areas which, if multiplied by the official figures for the urban population in 2010, would imply a housing stock of 21 billion m^2 (23.4 billion m^2 in 2012).[13] Thus, somewhere between a fifth and a quarter of all housing in use in 2012 was built during the 5 short years.

This level of housing construction in value terms over the past 7 years (2007–2012) accounts for a substantial portion of the increase in gross capital formation in the PRC over those years. With 2005 as base year, the share in GDP of housing investment rose from 8.3% to 12.4% of GDP, the latter figure an unusually high level even for rapidly growing developing countries. The entire increase was accounted for by investment in urban housing, not rural housing.

To understand whether this level of housing construction is sustainable, one must make assumptions about the following:

(i) The rate of demolition of the existing urban housing stock. Demolition is different from depreciation since the latter includes the deteriorating quality of existing housing in the absence of upkeep and repairs. No attempt here will be made to estimate what these upkeep and repair expenses might be, although they will no doubt be substantial.

(ii) The rate that housing stock will be provided for new urban residents and for existing urban residents who do not currently have even minimally adequate urban housing. These comprise mainly migrants from the rural areas who are already in the cities or are likely to move to the cities over the next 1 to 2 decades.

(iii) The expansion in the existing housing stock to accommodate increased demand for larger homes by the existing registered urban population as their incomes continue to increase.

(iv) The degree to which families own more than one dwelling and the degree to which these are vacation homes designed for seasonal use or simply a form of investment. If houses are mainly for investment, it then becomes important

[13]Housing space per capita sometimes includes only the direct living space of the family, while it can also include such things as hall space in apartment buildings. In that respect, what the figures reported here cover is unknown to this author.

to know what percentage of these investment properties is unoccupied. If the unoccupied share is very large, that alone would be evidence that the real estate market had been overbuilt and the bubble would be likely to burst. Unfortunately, we do not know of any estimates of the occupancy rate of Chinese urban housing.

One serious estimate of the rate of demolition of existing housing is again by Yao (2013b, 2). She estimates the rate of demolition during 2006–2010 to be 370 million m^2 per year. If this rate were to continue through 2020, there would be little or no housing by that date in urban areas built before 1990.[14] That may be a possibility but is it likely? Tearing down apartments with the shared kitchens and bathrooms that were common in pre-1980 housing has largely been completed outside of *hutong* areas in Beijing and similar places. For illustrative purposes below, I will assume a demolition rate of 200–300 million m^2 per year, a figure still double or more the official rate during 2003–2004.

Most rural-to-urban migrants at the beginning of the second decade of the 21st century lived in very crowded substandard conditions ranging from tents to dormitories to rental space with as many as six to eight people per room. Most migrant households would probably be in the bottom 40% of the urban population if we had a measure of their income. The average annual income of urban households in the second 20% of the urban population, reckoned from the bottom, was CNY50,000 ($8,000). Those in the bottom 20% earned CNY27,000 ($4,400).[15] People at this level of income cannot afford to purchase a 90 m^2 apartment at CNY490,000 ($79,000), the average sales price of commercial real estate in all of the PRC. Some, however, might be able to purchase a smaller apartment 30 or more years old particularly in the smaller cities. Most housing for recent migrants, however, will have to be public housing with subsidized rents. The actual construction rate for migrant housing, therefore, is likely to be determined more by government policy than just by migrant demand.

According to the 2011 report of the National Population and Family Planning Commission, the number of migrants at that time was 221 million, and 76% of those wanted to live permanently in cities.[16] Another 300 million are expected to move from rural to urban areas over the next 30 years. These figures imply that there will be a need for housing for roughly 370 million people over the next 2 decades. That suggests an immediate need for the 170 million people who want to remain permanently in the cities now plus 10 million more each year. Assuming

[14]This calculation is also based on Yao's (2013b) estimate of the age structure of the housing stock in 2010.

[15]These figures are based on the per capita disposable income of urban households in these groups multiplied by the number of people per household. The US dollar figures assume an exchange rate of CNY6.2 per dollar.

[16]"Mass migration, major problems," Chinadaily.com.cn 10 October 2011. The 221 million figure is from the 2010 census and is for residents whose household registration is in a different place other than in the same city. It thus includes some people who are not rural-to-urban migrants.

Table 3. **Annual Demand for Housing**
(Million m^2)

Demand	Size
Replacing demolished housing	200–300
Housing for migrants	370–493
Improved urban housing	120–290
Total annual demand	**690–1,083**

Source: Author's calculations.

a family size of 3 and an apartment size of 80 m^2, housing construction for this purpose would average 493 million m^2 per year (somewhat more in the early years because of the backlog of demand and somewhat less in later years). If the average family size was 3.5 and the apartment size was 70 m^2, the figure would be 370 million m^2 per year. The average cost of urban housing construction per square foot in 2012 was CNY2,184, not including the purchase of land. If that were the cost of construction of public housing, perhaps adding some payment for land, the cost for public housing would come to CNY808 billion to CNY1,077 billion (1.6% to 2.1% of GDP in 2012, a lower percentage in later years).

Estimating the pace at which the PRC's existing urban residents will upgrade their housing, presumably mainly by buying new, larger, or higher quality apartments, is very difficult.[17] The average annual increase in the size of the PRC's apartments per household has generally ranged between 0.5 m^2 to a bit over 1.23 m^2 per year since 1992 (Yao 2013a, 1). The lower figure implies a figure of 120 million m^2 per year and the higher figure about 290 million m^2 annually. Putting these speculative estimates together, one gets a total annual demand of around 690–1083 million m^2 per year over the next 2 decades (Table 3). It should be underlined that this estimated range assumes a robust program to house rural-to-urban migrants. Without such a program, the projected demand for housing would be much lower. As of 2014, the government has yet to make a commitment to provide public housing for migrants of anything like this magnitude.

Finally, it needs to be emphasized that this speculative forecast is a long-term forecast and not a comment on whether or not the housing market of 2014 is overbuilt or housing prices are too high. In 2014, there is probably still a demand for housing as an alternative investment to putting money in banks at low interest rates even if the housing remains empty for long periods (but demand of this sort will evaporate if prices begin to fall). This source of demand should also fall as individuals in the PRC are allowed to invest in a wider range of assets (including overseas stock markets), and interest rates on bank deposits rise to market-determined levels.

It is also the case that the urban population had been growing during the past 5 years (2008–2012) at a little over 20 million people per year, double the rate of

[17] People could also expand the size of their existing housing by buying out and remodelling the interiors of neighboring apartments.

the projections used above, although some of this presumably involves redrawing of urban boundaries rather than actual new migrants. Official statistics indicate that urban employment increased by 12.5 million people annually over the same period (2008–2012). Similarly, employment in the secondary and tertiary sectors rose by 12.7 million per year. Employment in the primary sector (mainly agriculture) has fallen by roughly 10 million per year. Population growth is now under 0.5% per year or 6.5 million people per year (down from 13 million per year in the 1990s). It is the smaller figure of 6.5 million that is an indicator of the size of the pool of labor in the countryside that will be available to move to the cities 10 to 15 years from now (or will have already moved as children with their migrant parents by then).[18]

The overall conclusion is that for the next several years there will probably be enough demand to sustain urban housing investment at a level comparable to that of the recent past of around 1 billion m^2 per year (or somewhat less), but it seems unlikely that demand will grow further. Housing investment as a share of GDP should decline as GDP rises. This is very different from the most recent decade (2003–2012) when investment in urban housing rose by 23% per year and completed housing floor space rose by 6% per year.

VI. Transport Investment and GDP Growth

As in the case of housing, the PRC following the Soviet model neglected transport investment throughout the centrally planned command period prior to 1978. Since that time, a substantial share of investment has gone to the sector, but it was only in 1998, during the Asian financial crisis, that construction of a high-speed highway (expressway) system began to expand by several thousand kilometers (km) a year, accelerating to nearly 10 thousand km a year during 2009–2013. That length, as of the end of 2013, reached nearly 104.5 thousand km (65.3 thousand miles), longer than the US interstate highway system (46.9 thousand miles).

At roughly the same time, the Chinese government began making large investments in new airports for provincial capitals and other major cities, and 5 years to a decade or more later, large new terminals were opened at Baiyun Airport in Guangzhou, Pudong Airport in Shanghai, and Capital Airport in Beijing. More than 40 new airports elsewhere are in the current five-year plan. The PRC's first major high-speed railway, from Beijing to Tianjin, began operating in 2008. Since then, new lines have been opening throughout the country and the length operating in 2012 was just over 10 thousand km with an additional 1,672 km added in 2013. With plans to complete four north–south lines and four east–west lines linking all

[18]For more in-depth analyses of the state of the Chinese urban housing market in 2014, see Yao and Gatley (2014), and Yao (2014).

of the most populated parts of the country, the total length is expected to reach 18,000 km by 2017.[19]

A central question about this investment is whether it is being built in response to demand or well ahead of demand. Within the large coastal cities such as Beijing and Shanghai, there is little doubt that construction of highways has been meeting an immediate high level of demand. The expressways around Beijing and in the lower Yangtze delta between Nanjing and Shanghai are jammed with vehicles most of the time. The total number of passenger vehicles plus trucks in the PRC was roughly 120 million in 2013, while the US, with a somewhat shorter expressway system, had 254 million registered passenger vehicles plus large numbers of trucks. At 12 million new passenger vehicles and 10 million other motor vehicles produced a year (the level of production in 2013), the PRC would catch up with the US in terms of number of vehicles in roughly another 7 years or a bit longer if older automobiles and trucks going out of service are taken into account and even longer if many of these vehicles are exported.[20]

Furthermore, the PRC also has a far superior passenger rail transport system to that in the US, and that has also been expanding. Not many Chinese today, unlike Americans, travel long distances by automobile, although that is much less true of trucks, so it will be more years before the PRC's mileage used per vehicle matches that of the US. That said, the PRC's population density alone will almost certainly force the country to follow a path different from the US. If the PRC, as per capita incomes rise to high income levels, were to duplicate the automobile ownership and use of the US, the country would have over a billion passenger vehicles on its roads mostly in an area that is only modestly larger than US territory east of the Mississippi River.

A more relevant comparison would be Europe, where there are over 300 million vehicles and only 66,000 km of "motorways" (in the EU plus members of the European Free Trade Association) but with a good high-speed rail system.[21] The PRC's passenger rail volume has increased by only 3.1% per year since 1990, although, the rate increased after 2002 to 6% per year, in part no doubt due to rising incomes. Civil aviation carried only 17% of the volume of passengers as railroads in 2012, and the long-distance rail lines to a degree compete with domestic air travel. At the time that this is being written, however, both continue to show robust growth.

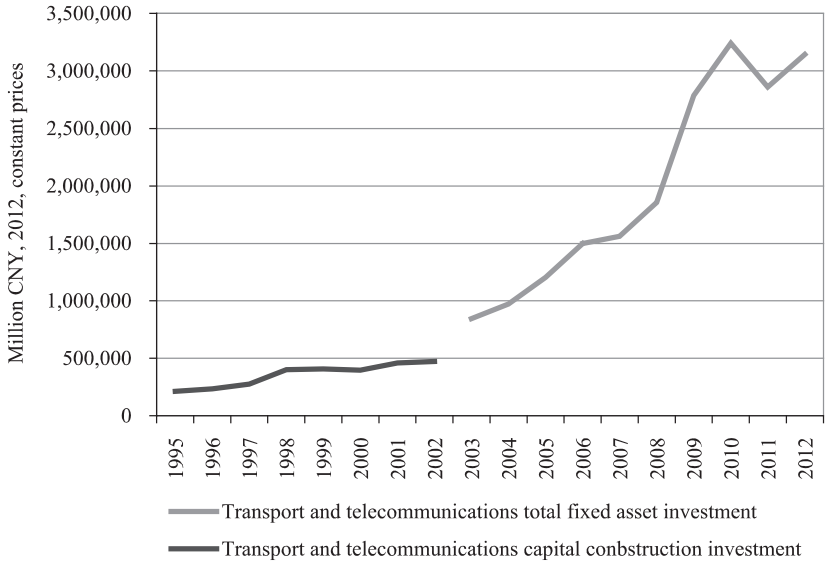
This discussion suggests that the demands on traffic capacity of all kinds may not justify continued investment growth in this area at the accelerated pace of the

[19] Available online: www.travelchinaguide.com/China-trains/high-speed/

[20] To get a full picture of future demand for use of highways, one would have to get an estimate of exports and imports of vehicles plus the number of trucks on the roads and the average distance travelled by each vehicle over a year.

[21] This estimate is calculated using data from *European Road Statistics 2011* (European Union Road Federation 2011, 16–17).

Figure 7. **Investment in Transport and Telecommunications**



Note: The data were divided by the price index for investment in fixed assets to convert the reported data to constant 2012 prices. Total fixed asset investment is more inclusive than capital construction investment but data broken down by sector are only available after 2003.

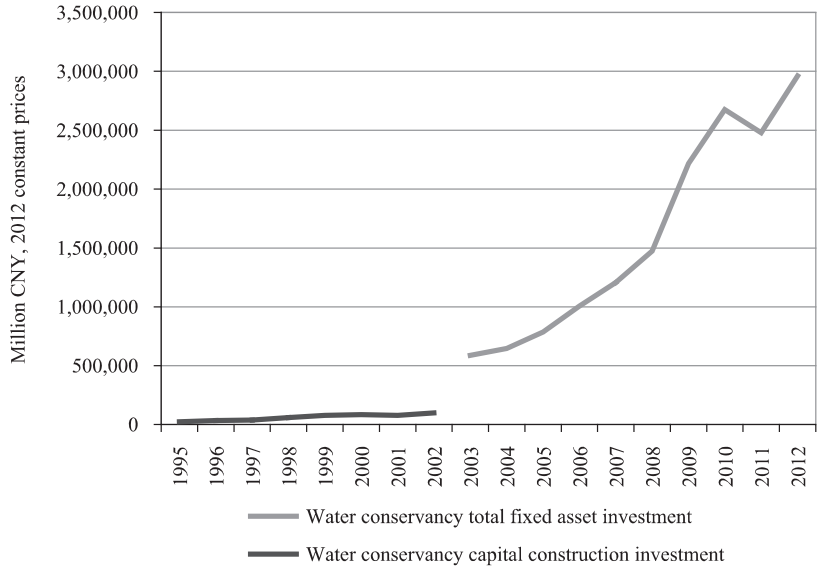
Sources: National Bureau of Statistics. 2013. *China Statistical Yearbook 2013*, pp. 160, 347, *and 2003*, p. 197. Beijing: China Statistics Press.

past decade. The data for total investment in transport and communications in real terms are presented in Figure 7.

Investment in transport and telecommunications over the period 2004–2012 grew at an average annual rate of 14.3% per year, substantially faster than the rate of growth of GDP; the rate of growth during 1996–2002 was somewhat slower at 12.1% per year. However, the earlier growth was only slightly faster than GDP growth. In the more recent period, the share of transport and telecommunications investment in GDP rose from 4% in 2003 to 7.3% in 2010 as the stimulus investment took effect, but fell back to 6% in 2012. Also, involved in the 2010–2012 period was the temporary slowdown in railroad investment due to scandals in the railway ministry.

Is an investment in transport of 6% of GDP likely to continue indefinitely into the future? Even if it does, the rate of increase in investment would likely fall to the rate of growth of GDP. Gross investment, to be sure, will grow partly because recurrent costs for system maintenance will rise rapidly as the transport system ages, but it is net investment that will drive increases in GDP. We have also made no attempt to estimate the portion of investment in these figures that is set aside for telecommunications rather than transport. The likely increase in demand for transport services going forward, however, does not appear to justify continued expenditures at the current level. This conclusion, however, is somewhat speculative since it is not based on careful analysis of the Chinese transport systems, where

Figure 8. **Investment in Water Conservancy and the Environment**



Note: The data were divided by the price index for investment in fixed assets to convert the reported data to constant 2012 prices. Total fixed asset investment is more inclusive than capital construction investment but data broken down by sector are only available after 2003.
Sources: National Bureau of Statistics. 2013. *China Statistical Yearbook 2013*, pp. 160, 347, *and 2003*, p. 197. Beijing: China Statistics Press.

filling key gaps in that system would or would not be highly productive, but such a study is far beyond the scope of this essay.

VII. Water Conservancy and the Environment

Investment in water conservancy and the environment has followed a path very similar to investment in transport up through 2013. Slower but substantial growth before the 21st century was followed by accelerated growth faster than the rate of growth of GDP after the year 2000 (Figure 8). The prospects for future growth in investment in water conservancy and the environment, however, are different from those for transport. The northern part of the country reaching from Shandong Province and the North China Plain to Gansu and Qinghai Provinces in the northwest has a severe shortage of water relative to the region's demand for water.[22] The demand for water in the north is outstripping supply. As a result, the main sources of water in the north, the aquifers under the North China Plain and elsewhere, are being mined,

[22]West of Qinghai and Gansu is mostly desert except for the oases along the historical silk route and the far western portions of Xinjiang, but there has never been a realistic prospect for bringing water to this mainly desert region. Similarly the far northern part of the northern region (the northern part of Inner Mongolia) is the Gobi desert.

leading to a steady fall in the level of these aquifers and the possibility that they could dry up.

The water problem has been recognized for some time now, and the PRC over the past decade has invested well over CNY400 billion (over $70 billion) in the largest single project, the transfer of water from the Yangtze River to the dry northern provinces. The project is designed to move water along three routes to the north, and the eastern-most route has already begun moving water northward. The central route is nearing completion, but the western route is still in the planning stage. Even more ambitious efforts to move water from further south, including from rivers that are also important to Southeast and South Asia, are being talked about. Whether these future possibilities are feasible, and even whether or not the diversion of the Yangtze River water to the north will solve more problems than it creates, remains to be seen.

Large-scale water conservancy investments, therefore, are likely to continue for some time. Over time, it will become increasingly apparent whether continued investments to move water northward will lead to an unacceptable fall in the level of the Yangtze River itself and its tributaries. If further diversion of water is required and economizing efforts in areas of water shortage reach their limits, the main alternative would be to begin shifting industries and urban centers to the south. To some degree, this shift to the south could occur without government direction as individuals and enterprises move to areas where water is more plentiful.

Water conservancy is a kind of environmental investment, but while much of the PRC's water is severely polluted and some feel the Yangtze diversion could make it worse, the issue of investment in the environment goes far beyond water. The air quality problems of many of the PRC's major cities are well known. The PRC's contribution to greenhouse gases and climate change is also widely discussed. The data on investment in fixed assets, however, probably do not capture much of the current investment that is going into efforts to curb the increases in air and water pollution. Much of the investment in dealing with air pollution would normally show up in the accounts of industrial enterprises and in such areas as the higher cost of motor vehicles due to emission controls.

While it is not known, at least to the author of this essay, how much is being spent in the PRC at present to improve the environment, there is little doubt that large sums will have to be spent in the future, especially if the PRC gets serious about reducing its impact on the rise in greenhouse gases. The only way the PRC can have a major impact on its contribution to greenhouse gases is for it to dramatically reduce its dependence on coal. The PRC's coal production since 2000 has increased at a rate of 7.8% per year, and the share of coal in energy consumption has only declined from 69.2% to 66.6% over that period (2000–2012). Energy from gas, hydropower, nuclear, and wind power together rose from 8.6% to 14.6% of total energy consumption, with rapid increases in the imports of petroleum making up the difference of 19% to 21% of energy consumption.

Even these modest structural changes in energy demand have involved large investments. More dramatic changes in coal use, to say 50% of energy consumption, would involve enormous investments in gas pipelines, hydroelectric dams, and nuclear power plants, particularly if energy consumption continued to grow. Coal still accounts for 37% of electricity produced in the US, and its declining use is still a politically contentious issue. The much larger investment (particularly as a share of GDP) needed to bring coal use down in the PRC will also generate resistance from a wide variety of sources. Estimating the likely size of that investment, however, is well beyond what is possible in this essay.

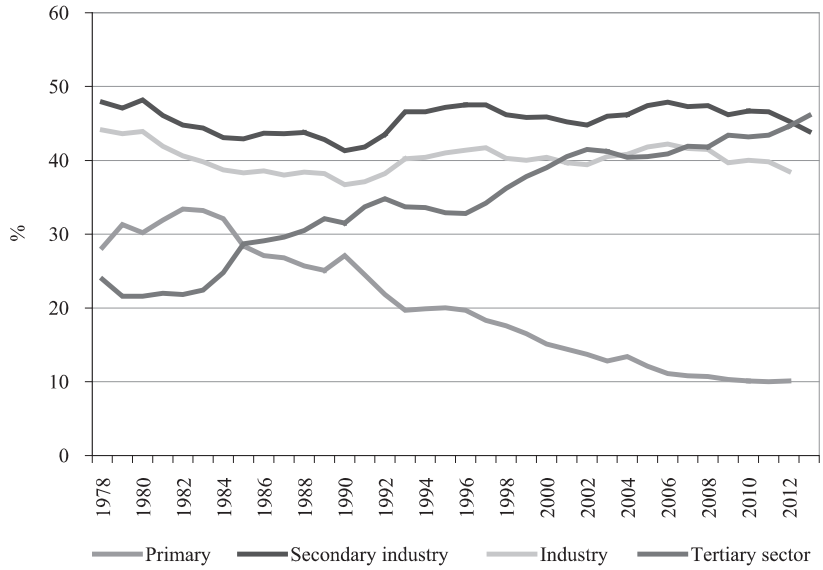
Reducing coal consumption is also an essential component for reducing air pollution, but a great deal can be accomplished in that area by reductions in particular uses for coal (for household heating use for example) rather than an overall sharp decline in use, and that has been occurring in the PRC. Air pollution can be addressed through a range of other investments as well. Some of these methods such as closing small inefficient power plants and replacing them with larger more efficient plants were tried with some success during the 11th five-year plan. A careful estimate of the impact of this effort and of other hypothetical policies such as a carbon tax suggests that the impact was well under 1% of GDP, and when health and other benefits were taken into account, that impact was positive, not negative (Nielsen and Ho 2013).

We do not have an estimate of the up-front costs of ending air pollution overall. From the experience of both Japan and the Republic of Korea, however, we do know that serious air pollution can be eliminated without having a clearly noticeable impact on GDP, although neither used anything close to the amount or share in total energy of coal consumed by the PRC. Whatever that precise up-front cost figure may be, given that the PRC will have to maintain an abnormally high rate of investment for at least the next few years to fully employ its resources, a strong case can be made for shifting investment equivalent to several percent of GDP to dealing with air and water pollution. Much of that investment would be done by the polluting enterprises themselves, and the efficiency of that investment would probably be higher if an increasing number of these enterprises were under private management.

VIII. The Transition from a Manufacturing Economy to a Service-Based Economy

As per capita incomes rise, the structure of the economy initially experiences a shift in production and employment from the agriculture sector to industry, but when per capita incomes rise further, there is another shift from industry to services—that is, industry's share in GDP and employment levels off and begins to decline, while the share of services in GDP and employment continues to rise. The latter shift occurs at anywhere from $8,500 per capita GDP (PPP in 2000 prices) to a little over

Figure 9. **Sector Shares in GDP**



Source: National Bureau of Statistics. 2013. *China Statistical Yearbook 2013*. Beijing: China Statistics Press.

$20,000.[23] The shift of Taipei,China and the Republic of Korea's began in the late 1980s at the low end of the per capita income spectrum, while that of Japan began in the middle of that income range in the early 1970s. More generally, this shift toward services has occurred on average at a lower level of per capita income since the 1980s than before that time, though there are numerous exceptions.

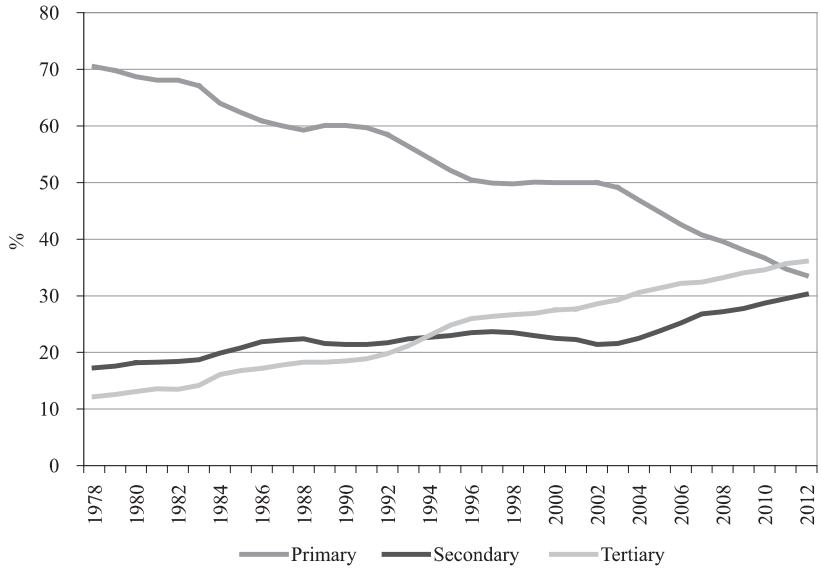
The PRC's shift out of agriculture into industry began in the 1950s and accelerated after 1984, but the share of industry in GDP and employment leveled off in the mid-1990s; that share in GDP began to slowly decline around 2008 when per capita GDP was roughly $7,000–$8,000 depending on whose PPP income estimates are used.[24] Employment in the secondary sector, however, has continued to rise, although much of that rise is due to increasing employment in construction, not manufacturing. The data are presented in Figures 9 and 10. While one cannot be certain that this decline will not be reversed in future years, the PRC appears to be in the early stages of an economy dominated increasingly by the service sector.

The relative shift from industry to services is sometimes referred to as deindustrialization, but in almost all economies, industrial production, although not

[23]These figures are for the shift in employment away from industry, but the shift in production typically begins at roughly the same time. The shift away from agriculture begins early in development and continues until very high income is reached, and so with the share of industry also falling, the service sector is therefore growing faster than GDP. See Eichengreen, Perkins, and Shin (2012, 87).

[24]The PRC's agricultural reforms in the early 1980s led to a high rate of growth in agriculture for a brief period and agriculture's share of GDP actually rose.

Figure 10. **Sector Shares in Employment**



Source: National Bureau of Statistics. 2013. *China Statistical Yearbook 2013*. Beijing: China Statistics Press.

employment, continues to grow. The service sector, however, typically grows at slower rates than the double-digit industrial and manufacturing growth rates one sees in fast-growing countries in the early stages of development. In low-income and middle-income countries experiencing near double-digit rates of growth, that high rate of growth is largely driven by industry, and particularly, manufacturing. There are exceptions, such as India, where high growth has been driven by the service sector, but those exceptions in low-income and middle-income countries are rare. In the PRC, however, the service sector grew considerably faster than GDP (10.8% per year from 1978 to 2012, versus 9.8% per year) and almost as fast as industry (11.35% per year). The share of services in GDP thus rose steadily from 23.9% of GDP in 1978 to an average of 34.1% in the 1990s and an average of 41.7% from the year 2000 onwards. Industry's share in GDP rose rapidly up until the early 1990s, but the share leveled off at roughly 41% for the next 16 years then began to decline beginning in 2009 until 2013.[25]

The PRC's early rapid increase in the service sector, however, was not typical of low-income and lower-middle-income countries. The rising share of services during that earlier period resulted from the fact that services of all kinds during the centrally planned command era prior to 1978 were systematically neglected. Wholesale and even much of urban retail trade had been dominated by a few

[25]The share of manufacturing and industry in GDP at the beginning of the reform period was well above 41% but this reflected the unusually high industrial prices and low agricultural prices then still in place, from the command economy era before 1978.

state-run enterprises, there were few restaurants, banking services for the public were minimal, and investment in transport was kept to a minimum. Services in the Soviet-type system were not included in what the Chinese called national income but which outside economists usually referred to as net material product. Investment in services thus did not contribute much to what was considered at that time to be economic growth.

This situation changed rapidly after 1978. Retail trade in rural and urban areas grew rapidly and was increasingly in private hands. New hotels and restaurants were opened in large numbers, the banking system was gradually modernized, and other financial institutions were created and expanded. Education and health care expenditures also rose rapidly. By 2014, the PRC's service sector appears to have caught up with the level and sophistication of the average middle-income country. Services, however, as already noted, do not typically grow at near double-digit rates. We do not fully understand why this is the case but there is a clear difference between increasing, say steel production, from 100 million tons to 300 million tons in a decade or two than from training the workers needed for expanding labor-intensive financial or business services threefold. Wholesale and retail trade, and transport services will grow primarily with the rate of growth of traded goods (this includes slower growing agriculture as well as industry) and with the rising rate of urbanization, among other things. Whatever the explanation offered for why services grow less rapidly than the double-digit increases that sometimes characterize industry, the PRC's shift toward services in the future should also contribute to a slowing of the GDP growth rate.[26]

It is also important to note here that productivity in services is only likely to grow rapidly if much of the growth and investment in this sector is increasingly dominated by the private sector. The large state-owned banks, for example, performed particularly badly when they were first separated from the Soviet-type mono-bank system of the pre-reform period, and while the improvement in performance since then has been considerable, political considerations in allocating credit, among other problems, still play too large a role. Tight regulation of the financial system has also led to the rapid expansion of a large shadow financial system which is not really effectively overseen by anyone.

In software development, e-commerce, and related areas, it is even more difficult to imagine the state playing a large and effective direct role. The state abandoned much of its role in traditional retail trade early on in the reform period. It is difficult to identify any part of the service sector that would benefit from direct government control outside of areas such as welfare payments and other areas where market failures make government control essential. Government regulation is needed, notably of the financial sector and to internalize to firms external

[26]In Eichengreen, Perkins, and Shin (2012, 36), a cross-country regression was run showing that the GDP growth rate accelerates when the share of manufacturing rises and then levels off as the share of manufacturing. It then falls as services come to dominate.

environmental diseconomies, but even in these areas, government regulation in the PRC has too often been poorly designed and implemented.

IX. Impact of High Investment Rates on Total Factor Productivity

How will the impact of these various shifts in demand—for housing and transport on the negative side and for the environment and consumer products on the positive side—together with structural changes on the supply side (the shift from manufacturing to services) affect the overall rate of growth? An alternative question would be to ask what the impact on GDP growth would be if these structural changes did not occur, but the analysis above has already made a strong case that the impact on the GDP growth rate of no structural change would be negative.

One way to approach an answer to the first question is to analyze the supply-side problem of maintaining a high enough rate of TFP growth to ensure an annual growth rate from 5% to 7%. It would then be desirable to breakdown the required productivity growth by sector to take into account the impact of the structural changes required in the future, but that is a difficult challenge at best and far beyond what is possible in this essay.

During the post-1978 economic reform period through to the middle of the first decade of the 21st century, the PRC experienced high TFP growth that accounted for 40.1% of the growth rate of GDP in that period (Table 4). Put differently, if there had been no TFP growth, the PRC's GDP growth rate, other things being equal, would have been less than 6% per year during 1978–2005. In the latter half of that period, however, the growth rate of TFP fell to just over half of the previous 27 years. As the capital output ratio continued to rise by 30% after that 27-year period and the rate of investment grew to nearly half of GDP, the growth rate first rose to 11.3% per year but then fell to an average of 8.2% during 2011–2013. The trend during the latter period was downward.

In a study based on data through 2005, Tom Rawski and I attempted to get an understanding of how fast TFP would have to grow over the next 1 to 2 decades (2006–2025) for the PRC to maintain a given GDP growth rate (Perkins and Rawski 2008). A summary version of those estimates (speculations) is presented in Table 5. These projections assumed that the rate of investment as a share of GDP would actually decline slightly from the 2000–2005 period where in fact it rose. But that rise, as we have seen, produced only a short-run burst in high growth followed by a sharp fall.[27] The additional capital investment was significantly less productive than in the recent past. Going forward, these projections suggest that TFP would have

[27]In national income accounting, a sharp rise in the rate of capital formation as a share of GDP will itself increase the rate of growth even if that investment is not very productive. Over 2 or 3 years or more as that investment is completed, however, the rate of growth will depend on the increase in goods and services produced by that investment.

Table 4. **Supply Side Sources of Growth in the PRC**

	Growth Rate (%)				Contribution to Growth (%)		
Period	**GDP**	**Fixed Capital**	**Educated Labor**	**TFP**	**Capital**	**Educated Labor**	**TFP**
1953–1957	6.5	1.9	1.7	4.7	12.7	14.9	72.4
1958–1978	3.9	6.7	2.7	–0.5	73.7	39.7	–13.4
1978–2005	9.5	9.6	2.7	3.8	43.7	16.2	40.1
2006–2011	11.0	14.4	2.1	2.1	72.0	8.6	19.4
1953–2005	7.0	7.7	2.6	2.1	47.7	21.4	30.9

Note: The estimates for 1953–2005 were taken from Perkins and Rawski (2008, 839) while those for 2006–2011 were computed using the same basic methodology. Those interested in pursuing this methodology further are referred to the said essay and the authors' websites that include the appendixes to that essay. The educated labor figures and fixed capital figures were computed by Dr. Zhang Qiong using the same methodology as the earlier data, and I am grateful to her for sharing these estimates. The GDP and raw labor data were obtained from the National Bureau of Statistics (2012, 24 and 43) and National Bureau of Statistics (2011, 60 and 112). As the share of labor income in gross national income has fallen steadily and was a low 45% of income in 2010, the shares of labor and capital used to compute the TFP residual were .45 and .55 respectively, while the labor and capital income shares in national income for the earlier years were .53 and .47 respectively.

Sources: Perkins, Dwight, and Thomas Rawski. 2008. Forecasting China's Economic Growth to 2025. In *China's Great Economic Transformation*, edited by Loren Brandt and Thomas Rawski, pp. 829–86. New York: Cambridge University Press; National Bureau of Statistics (various years).

Table 5. **Hypothetical Projections of the Future Sources of GDP Growth**
(%)

	GDP	**Fixed Capital**	**Raw Labor**	**Education Enhanced**	**TFP Growth**
1979–2005	9.5	9.6	1.9	2.7	3.8
2006–2015	9.0	9.8	0.7	2.0	3.6
2016–2025	9.0	8.2	−0.3	1.0	4.9
2006–2015	6.0	8.1	0.7	2.0	1.4
2016–2025	6.0	5.6	−0.3	1.0	3.0

Note: This is a shortened version of a table in Perkins and Rawski (2008, 852–53).

Source: Perkins, Dwight, and Thomas Rawski. 2008. Forecasting China's Economic Growth to 2025. In *China's Great Economic Transformation*, edited by Loren Brandt and Thomas Rawski, pp. 829–86. New York: Cambridge University Press.

to grow at 3.6% to 4.9% a year over the next 1 to 2 decades in order to maintain a GDP growth rate of 9%. The PRC in the past has managed a TFP growth of 3.6% per year but never 4.9%, and in recent years, the figure has been well below even 3.6%. When the beginning of a decline in the total labor force is taken into account, together with the fact that the investment rate is no longer rising, a 2.1% TFP growth will produce only a growth rate of around 6% a year (during 2016–2025) using the data in Table 5. This is not a forecast, but it does suggest that the PRC will have to maintain a higher rate of growth in productivity than in the recent past if it is to achieve a sustained GDP growth rate of above 6%. How realistic is that?

The Third Plenum of the 18th Chinese Communist Party Central Committee outlined a list of 60 points covering areas of reform that were going to be implemented. Many of these directly related to the challenge of maintaining a high rate of TFP growth. The 60 points begin with general guidelines, one of which is that the market should play the decisive role in resource allocation. The document

also calls for securing property rights protection, actively developing diversified ownership (with a particular emphasis on non-public ownership), and eliminating "administrative monopolies" of state enterprises. It also supports a variety of other measures to make the state enterprise sector more productive; to establish market rules that are fair, open, and transparent; to improve financial markets, including allowing qualified private capital; and to create a market-based system for encouraging technological innovation.

The document further states that the role of the government should be changed so that, among other things, the government withdraws from business activities that can be regulated and modulated by markets. The economy should be opened up even more to the outside world and the problem of unequal treatment of rural-to-urban migrants directly dealt with by calling for a full, if no doubt gradual, integration of the rural and urban social-service systems. There are five points dealing with legal reform, including greater transparency in courts and prosecuting bodies as well as fairness and independence of these institutions. Overall, over half of the 60 points deal with issues that are central to maintaining a high rate of productivity growth either directly or indirectly. The issue going forward is not whether this is a good list, it is. The central issue is the pace and thoroughness with which these reforms are interpreted in practice and implemented.

If resistance to these reforms is overcome and they proceed rapidly, however, they will still not fully solve the challenge of maintaining a fairly high rate of growth (6% to 8%) for another 1 to 2 decades. There is very little in the 60 points that deals directly with concrete measures to alter the current imbalance between household consumption and investment, although there are several reforms discussed that would influence that imbalance indirectly, particularly the one dealing with the unification of rural and urban social services. The PRC will probably have to maintain a fairly high rate of investment for the immediate future, but if the current rate—where nearly half of GDP is invested each year—continues indefinitely, this will undermine the ability to raise productivity growth, as it is unlikely that the government and the society at large can find and implement enough high-return investment opportunities to justify that level.[28] It will also make corruption more difficult to control, with profound political as well as economic implications. The PRC's current vigorous anti-corruption campaign will have some impact reducing the level of corruption, but if the opportunities for corrupt actions due to massive public construction and over regulation continue as in the recent past, the anti-corruption effort is likely to fail with highly uncertain but likely negative consequences for economic growth.

There is also the issue that short-term shocks to the economy could derail growth for a time, and enough of them could slow the long-term growth rate further.

[28]It is not that there are limited numbers of investment opportunities in principle, but investors have to find those opportunities, finance them, and then get them efficiently implemented. There is a reason why the demand for investment as a function of the rate of return on investment slopes downward and to the right.

This essay on long-term trends is not the place to attempt to analyze the various external and internal shocks that could derail the PRC's rapid catch-up growth. However, it does need to be pointed out that the emphasis placed in this essay on the need to rely more on sectors that generate high productivity, notably private as contrasted to state-owned enterprise, together with a liberalized financial sector, will mean plenty for how the economy will work going forward. It will no longer be possible for the state to simply order or pressure firms to invest more, nor will it be possible for the government to basically print money to bail out insolvent banks, as done in the past, or bankrupt local governments, as possibly will happen in the near future. A large and failing shadow banking system in the future, for example, would have a direct negative impact on private investment in ways that might not be the case with state investment. Continuing reliance on state-enterprise investment, however, while it might make a recession more easily handled, would also be at the price of a much lower long-term growth rate because of the weak returns to most state-enterprise investment.

The PRC over the next 1 to 2 decades faces formidable challenges if it is to keep the economy growing at a catch-up rate of 5% to 7% a year. A higher rate than that over the next 2 decades is not likely to be achievable however vigorous the reform efforts. The "easy" boosts in productivity from dismantling the old centrally planned command system are in the past, although greatly reducing the role of the state-owned enterprises in favor of private entrepreneurial leadership would clearly help keep the rate of return on investment high. Future productivity growth, however, also will depend on the technically much more difficult task of improving the performance of what is already mainly a market-driven system. The fact that the PRC must achieve this while at the same time restructuring the economy to depend less on excessive levels of investment and with slower growth in exports makes the challenge that much greater.

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Sustaining Growth of the People's Republic of China

JUSTIN YIFU LIN AND FAN ZHANG*

This paper reviews economic growth theory in the framework of economic development and explores the possibility of sustained growth in the People's Republic of China (PRC) in the long run. We argue that the PRC has the potential to sustain relatively high growth rates. First, since the technological gap with major developed countries still exists, the PRC can continue to enjoy its "advantage of backwardness" in the near future. Second, large-scale infrastructure investment, which began several decades ago, may possibly extend to the future and provide the country a basis for further growth. Third, structural readjustment, which is needed in many areas, should similarly be able to support the Chinese economy. This paper argues that to sustain long-term growth in the PRC, a number of general preconditions need to be fulfilled—these include well-functioning markets, a minimum amount of investment, continued structural upgrading, and effective government.

Keywords: GDP growth rate, technological innovation, infrastructure investment, structural adjustment
JEL codes: E6, O43, O47

I. Introduction

Economic development of the People's Republic of China (PRC) over the past 30 years has been an intriguing phenomenon. The country provides an interesting case for the study of economic growth, especially the sources of growth and expectations about future performance. With the PRC's declining growth rate during the past 4 years, there have been heated debates recently on the potential growth rate of the country in the medium and long run. Lin (2012a) argues that the Chinese economy has the potential to grow by 8% annually for another 20 years beginning in 2008.

This paper attempts to provide answers to the question of whether or not the PRC can indeed maintain a relatively high growth rate in the coming decades. We first present a review of the history of growth performance over the past 35 years including the recent slowdown, which had triggered concern about long-run growth

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potential. We also provide a review of the various theories on sustaining growth in the long run, which serve as the basis for subsequent analysis of the PRC's growth potential. Finally, we discuss the preconditions for sustained growth.

II. Historical Review of the PRC's Growth Performance

The PRC has been experiencing extraordinary growth in the past 3 and a half decades, with annual gross domestic product (GDP) growth averaging 9.8% over the 35-year period since 1978. No country has ever grown as fast or for as long a time as the PRC during the past 35 years. Before the transition from a planned economy to a market economy in the late 1970s, the country had been trapped in poverty for centuries. However, it is now an upper-middle-income economy, with GDP per capita of over $6,000.

Prior to the late 1970s, the PRC failed to achieve dynamic growth, as it applied a strategy that prioritized the development of heavy industries. From the 1950s to the 1970s, the Chinese government subsidized the firms in priority sectors through various price distortions and protections. Such a strategy was clearly inconsistent with the comparative advantage of the country during the period. As a result, resources became misallocated, total factor productivity (TFP) remained low, and growth was driven mainly by input increases. Firms in the priority sectors became unviable in an open and competitive market. Despite annual GDP growth of 6.1% and the establishment of a complex system of advanced industries during 1952–1978, household consumption grew by only 2.3% annually during the period (Lin 2012a).

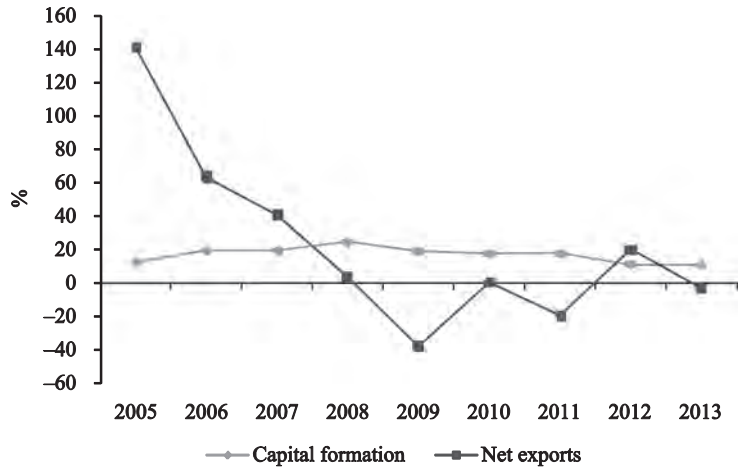
The PRC has achieved rapid growth since the start of economic reform in the late 1970s, with the extraordinary performance partly due to the adoption of a gradual, dual-track transition strategy. On one hand, the government provided protection in the form of transitory subsidies to prioritized heavy industry sectors to maintain stability. On the other hand, it liberalized entry into sectors where the country had comparative advantage based on factor endowments.

The PRC recently experienced a decline in economic growth, which had fallen from 10.4% in 2010 to 7.7% in 2013. This is the longest period of growth deceleration since the country's transition to a market economy in 1979 and has naturally raised concern about the sustainability of growth.

However, the slowdown had not been due to overinvestment, financial repression, the state-led growth model, or other internal structural problems frequently mentioned by observers predicting a crash in the Chinese economy.[1] The recent slowdown of the Chinese economy in fact was mainly caused by external and

[1]These include Paul Krugman in his columns (e.g., Hitting China's Wall, *New York Times*, 18 July 2013) and Nouriel Roubini in his articles (e.g., China's Bad Growth Bet, *Project Syndicate*, 14 April 2011). Others who have commented on the issue include John Aziz (Is China's Economy Headed for a Crash? *The Week*, 13 January 2014),

Figure 1. **Growth Rates of Exports and Investments of the PRC, 2000–2013**



PRC = People's Republic of China.
Source: National Bureau of Statistics. 2014. *China Statistical Yearbook 2014*. Beijing: China Statistics Press.

cyclical factors—specifically, the slow recovery of advanced economies after the 2008 global financial crisis, which has repressed export growth, and the slowdown of the country's investment growth due to the completion of projects supported by the fiscal stimulus in the aftermath of the 2008 crisis (Figure 1).

These same factors triggered growth deceleration in other emerging market economies and in high-income economies. As seen in Figure 2, the slowdown in the PRC had been relatively mild compared to that in other countries.

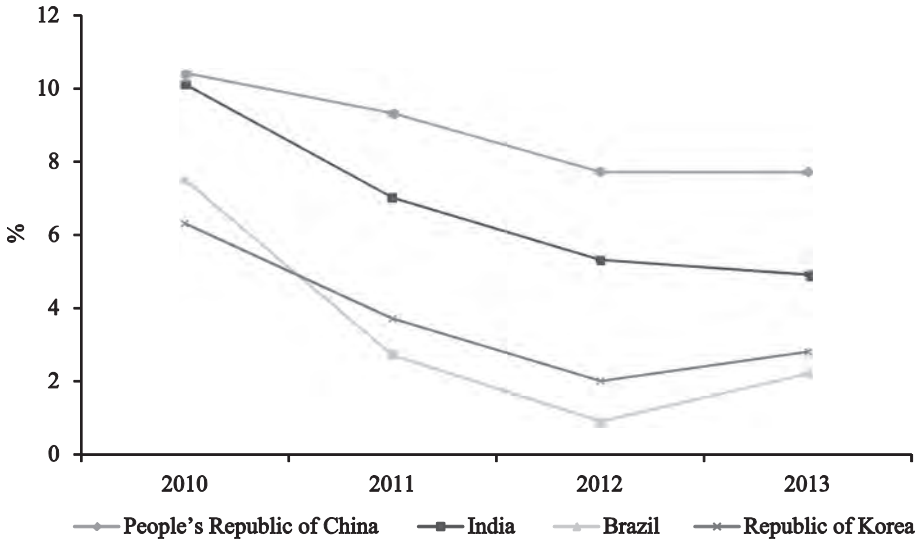
Facing the potential of a "new normal" in high-income countries (i.e., protracted low growth), export growth will likely be subdued in the coming years. The PRC's growth will therefore have to depend on domestic demand—investment as well as consumption. How high the country's growth will be in the coming years meanwhile will depend on its potential growth rate.

III. Theories on Sustaining Growth in the Long Run

The development of theories of economic growth in the long run has been remarkable in the past half century. In this section, we review the basic features of some of the major theories in a framework of economic development.

Nathan Bell (How to Prepare for a China Crash, *The Age*, 24 September 2012), Vitaliy Katsenelson (How China Will Crash and Burn, *Forbes*, 6 July 2011), and John Mauldin (The Only Question about the China Crash is When, *Business Insider*, 24 November 2010). Some observers point to the collapse of the PRC as the biggest risk to the world economy, for instance, as articulated by George Soros in one of his articles (e.g., The World Economy's Shifting Challenges, *Project Syndicate*, 2 January 2014). In these articles, ADB recognizes China as the People's Republic of China.

Figure 2. **GDP Growth in the PRC and Selected Countries in 2010–2013**



GDP = gross domestic product, PRC = People's Republic of China.
Source: World Bank. World Development Indicators database.

The neoclassical growth model, developed in the mid-20th century, is an exogenous growth model of long-run growth set within the framework of neoclassical economics. In these models, the long-run growth rate is exogenously determined by either the savings rate (the Harrod–Domar model) or the rate of technical progress (the Solow model). Solow's model assumes that factors of production are paid according to the value of their marginal products. The marginal product of capital will fall if capital rises faster than labor, which is normal for a growing economy, leading to a fall in the growth rate of output.

Neoclassical growth theory therefore indicates a convergence or catch-up process in which developing countries acquire techniques and learn how to use them efficiently. This supports arguments for the PRC's long-run growth slowdown.

In the late 1980s, a number of economists began to analyze the nature and role of the residual element in neoclassical growth theories by making it endogenous (Romer 1986 and 1990, Lucas 1988). In endogenous growth theory, knowledge (technology) is the instrument of production that is not subject to diminishing returns. The theory tries to explain the lack of convergence by introducing the role of human capital, maintaining that economic growth is primarily the result of endogenous forces—e.g., investment in human capital, innovation, and knowledge—and not external forces.

Economic growth and convergence will be faster the more the economy is invested in human capital. Aghion and Howitt (1992) developed a model of growth through creative destruction in which innovations serve as the underlying source

of growth. In their model, the amount of research in any period depends on the expected amount of research next period, which comes from created destruction. The growth rate and the variance of the growth rate are increasing functions of the size of innovation and skilled labor force, and the productivity of research.

Development economics uses growth theory to analyze economic growth in developing countries. The theories have come in three waves since the 1950s. The first wave involved structuralism (Rosenstein-Rodan 1943, Prebisch 1950, Singer 1950). Based on this thinking, governments were advised to develop industries that were too far advanced compared to their corresponding countries' level of development and that went against comparative advantage. Firms were thus nonviable in competitive markets and needed government policy support for initial investment and continuous operation (Lin 2009).

The second wave of development thinking, neoliberalism, was encapsulated in the Washington Consensus. The term originally referred to the reform package put together by financial institutions based in Washington, DC and recommended to developing countries mired in crisis in the late 1990s. It has since been used to refer to a more general orientation toward a strongly market-based approach.

The Washington Consensus set up a standard for developing countries based on the successful practices of developed economies. It opposed governments playing a proactive role in facilitating entry of firms into sectors even if consistent with a country's comparative advantage. It also failed to recognize that distortions in developing countries may be endogenous and advised governments to immediately eliminate them, causing the collapse of previously prioritized sectors.

The third wave involved what is known as the new structural economics. This development theory argues that each country needs to adjust its economic structure in the process of development according to its comparative advantage as determined by factor endowments (Lin 2012b). It applies a neoclassical economics approach to understand the determinants of economic structure and its evolution. Industrial structure is assumed to be endogenous to the endowment structure, which is given at any specific time and changes over time.

New structural economics argues that, following comparative advantage, which is determined by the endowment structure, developing industries is the best way to upgrade the endowment structure and sustain industrial upgrading, income growth, and poverty reduction. If economic structure upgrading lags behind changes in endowments, the economy will be less competitive, and growth will be lower than the potential growth rate. Improvement of the economic structure provides new sources of growth by reducing the inefficiency within and between sectors. Structural upgrading needs a competitive market system and a facilitating state.

New structural economics also postulates that industrial policy is desirable, and that target industries should be in line with an economy's latent comparative advantage. The theory points out that as long as its government chooses the right set of policies, a developing country has the potential to grow continuously at 8%

or more for several decades and to become a middle-income (or even high-income) country in one or two generations.

A review of growth theory in the framework of development tells us that sustaining growth depends on many factors, not just the productivity of physical capital. It is influenced as well by human capital, technology, and structural change in the economy. All these factors help to determine growth at the dynamic path.

IV. The PRC's Potential for Sustained Growth in the Long Run

By adopting correct policies, the PRC has the potential to sustain dynamic growth in the coming decades. This section presents possible reasons for the country's sustained long-run performance. These are the "advantage of backwardness," the effect of capital investment, and structural readjustment.

A. The Advantage of Backwardness

A backward country has an advantage in economic development because it can borrow from a large backlog of technological innovations from advanced countries and adopt the latest technology without facing resistance from users of old technologies (Gerschenkron 1962). It can thus reduce the costs and risks of technological innovation, allowing it to grow faster than advanced countries. Since the late 1970s, the PRC has achieved high growth by tapping into this advantage of backwardness.

After 35 years of dynamic growth, does the PRC still have the potential to grow dynamically? The answer depends partly on whether or not the advantage of backwardness still exists. One way to measure this is by the gap between per capita GDP of the PRC and of the United States (US). Per capita GDP represents a country's average labor productivity, which in turn reflects the country's average technological level.

The PRC's per capita GDP measured in purchasing power parity (PPP) in 2008 as a percentage of that of the US was similar to that of Japan in 1951, the Republic of Korea in 1977, and Taipei,China in 1975 (Table 1). Annual GDP growth reached 9.2% in Japan during 1951–1971, 7.6% in the Republic of Korea during 1977–1997, and 8.3% in Taipei,China during 1975–1995. After 20 years of growth, Japan's per capita income measured in PPP was 66% that of the US in 1971. The corresponding percentage for the Republic of Korea was 50% in 1997, while that for Taipei,China was 54% in 1995.

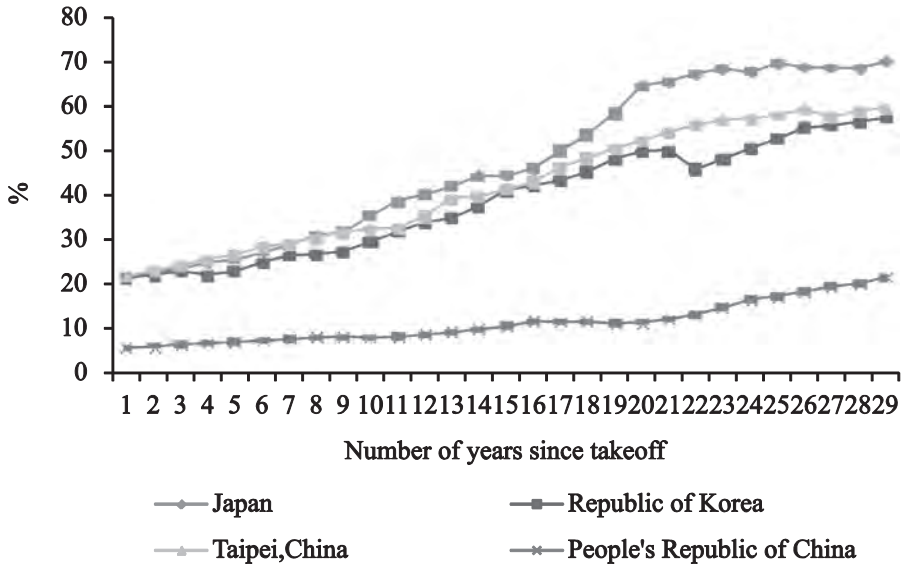
Figure 3 shows the per capita GDP of Asian economies relative to the US per capita GDP from the year these economies started to take off—1951, 1975, 1977, and 1980, respectively, for Japan; Taipei,China; the Republic of Korea; and the PRC. Table 2 meanwhile indicates the degree of the advantage of backwardness

Table 1. **Asian Economies' Per Capita GDP as a Percentage of the US Per Capita GDP**
(%)

	1951	1967	1971	1975	1977	1987	1995	1997	2008
Japan	21	50	66	70	69	75	81	80	73
Republic of Korea	8	11	15	19	21	32	48	50	63
Taipei,China	9	14	18	22	24	39	54	57	67
PRC	5	5	5	5	5	8	12	12	22

GDP = gross domestic product, PRC = People's Republic of China, US = United States.
Note: GDP per capita is measured in 1990 international Geary-Khamis dollars.
Sources: Authors' calculations; Maddison, Angus. 2011. Historical Statistics of the World Economy: 1–2008 A.D. Tables 2c and 5c. Available online at: www.ggdc.net/maddison/Historical_Statistics/horizontal-file_02-2010.xls.

Figure 3. **Asian Economies' Per Capita GDP as a Percentage of the US Per Capita GDP—Since Takeoff**



GDP = gross domestic product, US = United States.
Note: Per capita GDP is based on purchasing power parity valuation of the GDP of an economy.
Sources: Authors' calculations; Maddison, Angus. 2011. Historical Statistics of the World Economy: 1–2008 A.D. Available online at: www.ggdc.net/maddison/Historical_Statistics/horizontal-file_02-2010.xls.

in terms of stocks of capital and human capital per person (that is, by disentangling the extent that output per worker might be driven by differences in these stocks or other features).

We extend growth accounting analysis for the PRC using the Penn World Table (PWT), which decomposes growth in GDP per worker according to various sources—namely, growth of physical capital per worker *k*, human capital per worker *hc*, and TFP *A*. This can be represented by the following equation:

$$\Delta \ln y_{it} = \alpha_{it} \Delta \ln k_{it} + (1 - \alpha_{it}) \Delta \ln hc_{it} + \Delta \ln A_{it}. \quad (1)$$

Table 2. **Comparison of the PRC and the US—Capital Stock and Human Capital Per Capita in 2011**

	GDP Per Capita (2005 $)	**Capital Stock Per Capita** (2005 $)	**Human Capital Per Person**[a]	**No. of Persons Engaged** (millions)	**TFP at Constant National Prices** (2005 = 1)
US	42,446	131,347	3.619	141.8	1.020
PRC	9,324	33,134	2.579	784.4	1.193
PRC/US	22.0%	25.2%			

PRC = People's Republic of China, TFP = total factor productivity, US = United States.
[a]Index based on the number of years of schooling and returns to education.
Sources: Center for International Comparisons at the University of Pennsylvania. Penn World Table 8.0. 2014. Available online at: http://www.rug.nl/research/ggdc/data/penn-world-table (accessed January 2015). National Bureau of Statistics. 2012. *China Statistical Yearbook 2012*. Beijing: China Statistics Press.

Table 3. **Forecasts of the PRC's GDP Growth and Growth Components**

	Real GDP (constant 2005 national prices, %)		**Capital Stock** (constant 2005 national prices, %)		**Human Capital Per Person**[a] (%)		**Number of Persons Engaged** (%)		**TFP at Constant National Prices** (%)	
Average 1952–2011	7.8		8.1		1.2		2.3		2.0	
Average 2001–2011	10.4		11.8		0.9		0.8		3.0	
Forecasts	Low	High	Low	High	Low	High	Low	High	Low	High
2012	8.1		9.1		1.1		0.3		2.0	
2013	7.6		8.8		1.1		0.0		2.0	
2014	7.3		8.3		1.1		0.0		2.0	
2015–2020	6.1	8.0	6.8	8.8	1.0	1.2	0.0	0.0	1.7	2.3
2021–2028	5.4	7.6	5.5	7.5	1.0	1.2	0.0	0.0	1.7	2.3

GDP = gross domestic product, PRC = People's Republic of China, TFP = total factor productivity.
[a]Index based on the number of years of schooling and returns to education.
Note: We use a capital coefficient of 0.59 for 2015–2028.
Source: Authors' computations.

We use the average of the capital coefficient in the past 5 years estimated by the PWT for the period 2015–2028 and calculate the growth of GDP and its components from 2012 to 2028 assuming zero growth rate in the number of workers during the forecasting period (see Table 3).

We assume the following in our economic analysis: a zero growth rate for the number of workers during 2015–2028, which is consistent with the population trend and age structure of the PRC, and a 1%–1.2% increase in human capital per person during 2015–2028, or slightly lower than the actual annual growth of human capital of 1.2% during 1952–2011.

We also assume that the country's capital stock will keep growing albeit at a moderate rate based on the assumptions of continued structural upgrading

Table 4. **A Comparison of Growth Rates in Different Economies in Similar Growth Stages**

	Real GDP (constant 2005 national prices, %)	**Capital Stock** (constant 2005 national prices, %)	**Human Capital Per Person**[a] (%)	**Number of Persons Engaged** (%)	**TFP at Constant National Prices** (%)
Japan 1951–1971	3.6	3.8	0.8	1.3	0.9
Republic of Korea 1977–1997	8.3	11.8	1.1	2.6	1.3
Taipei,China 1975–1995	8.3	10.7	1.1	2.5	1.4

GDP = gross domestic product, TFP = total factor productivity.
[a]Index based on the number of years of schooling and returns to education.
Sources: Authors' computations; Center for International Comparisons at the University of Pennsylvania. Penn World Table 8.0. 2014. Available online at: http://www.rug.nl/research/ggdc/data/penn-world-table (accessed January 2015).

and discovery of new investment areas. The increase will be 6.8%–8.8% during 2015–2020 and 5.5%–7.5% during 2021–2028, lower than the actual growth rate of capital stock during 2001–2011 (11.8%) and 2013 (8.8%).

TFP growth will similarly decline slightly during the forecast period, as the PRC approaches the world technological frontier. We assume a growth rate of 1.7%–2.3% during 2015–2028, lower than the actual growth rate of 3% during 2001–2011.

Our growth accounting analysis shows that the GDP growth rate of the PRC will be in the range of 6.1%–8.0% before 2020 and 5.4%–7.6% during 2021–2018 if capital stock increases by 6.8% to 8.8% during 2015–2020 and by 5.5% to 7.5% during 2021–2028, human capital per person increases by 1% to 1.2% during 2015–2028, and TFP increases by 1.7% to 2.3% during 2015–2028. The assumptions are reasonable and conservative compared to growth rates in previous periods, which are also shown in Table 3.

To support our forecasts, we calculate using PWT data the average annual growth rates of physical capital, human capital, and TFP in Japan; the Republic of Korea; and Taipei,China during the same development stage that the PRC finds itself in currently. The results are shown in Table 4. Since the PRC is in a similar development stage as the Republic of Korea during 1977–1997 and Taipei,China during 1975–1995, it is likely that the country's capital stock and TFP will grow at similar rates in the near future.

To prevent mistakes in forecasting, our assumptions about the growth rates of the PRC's capital stock are tailored to be more conservative than the actual growth rates of capital stock in the Republic of Korea during 1977–1997 (11.8%) and Taipei,China during 1975–1995 (10.7%).

If the PRC maintains an 8% growth in the next 2 decades, by 2030, the PRC's per capita income measured in PPP may reach about 50% of that of the US. The

exploitation of the advantage of backwardness has and will allow the PRC to achieve extraordinary economic growth by reducing the costs of innovation, industrial upgrading, and social and economic transformation.

B. Large-Scale Infrastructure Investment

Public investments, say in infrastructure, may have a positive influence on long-run growth if it raises the marginal productivity of private capital. Barro (1990) develops a closed-economy endogenous growth model where government service is viewed as an input in private producers' production function. The effects of public investment on private producers have also been analyzed in many empirical studies. Aschauer (1989), for instance, studied the US economy during 1949–1985 and found that public investment in infrastructure had maximum explanatory power for the productivity of private capital.

Continued large-scale infrastructure investment, which began when the Chinese economy started to reform and open up, could be another possible factor behind sustained growth in the near future. The PRC has made large-scale infrastructure investments over the past several decades, which updated the country's infrastructure in all sectors and raised productivity, with continued positive effects on future growth. Table 5 shows the gross capital formation in the PRC from 1991 to 2013.

A rough comparison with the US shows that the PRC's gross investment during 2010–2013 measured in US dollars and using official annual average exchange rates was greater than the US gross domestic investment during the period. Although the share of physical investment in GDP declined slightly in recent years, it will remain relatively high in the near future. The quality of physical investment also remains quite high in terms of operating profit, although it declined slightly in recent years.

Real estate investment has been an important part of investment in the PRC in the past 20 years. Table 6 shows the operating statistics of real estate firms in the country. The share of taxes and profits increased dramatically beginning in 2005 and continued to be relatively high until 2012. This suggests that investments in real estate and physical capital will keep growing at a comparatively high rate in the near future.

From the most recent data, we expect that returns on investment will gradually fall but will stay at a level high enough to attract investment. Based on this, we forecast that investment in physical capital will continue to grow at a rapid pace in the near term.

Many economists worry that the PRC's economic growth relies too heavily on saving and investment. They posit that a large contribution of capital means a small contribution to technological progress, a condition that may not be sustainable. However, none of the existing methods measuring technological progress has successfully accounted for the technological progress embedded in capital. Capital investment brings about new approaches of production as well as new teams of

Table 5. **Investment in the PRC during 1991–2013**

	Gross Capital Formation (CNY billion)	**% of GDP** (expenditure approach)
1991	786.80	34.8
1992	1,008.63	36.6
1993	1,571.77	42.6
1994	2,034.11	40.5
1995	2,547.01	40.3
1996	2,878.49	38.8
1997	2,996.80	36.7
1998	3,131.42	36.2
1999	3,295.15	36.2
2000	3,484.28	35.3
2001	3,976.94	36.5
2002	4,556.50	37.8
2003	5,596.30	41.0
2004	6,916.84	43.0
2005	7,785.68	41.5
2006	9,295.41	41.7
2007	11,094.32	41.6
2008	13,832.53	43.8
2009	16,446.32	47.2
2010	19,360.39	48.1
2011	22,834.43	48.3
2012	25,277.32	47.8
2013	28,035.61	47.8

GDP = gross domestic product, PRC = People's Republic of China.
Source: National Bureau of Statistics. 2014. *China Statistical Yearbook 2014*. Beijing: China Statistics Press. Tables 2–18.

workers, which together increase productivity and bolster growth. There may also be a time lag between capital investment and the functioning of capital stock.

The potential role of physical capital in development depends on the relationship between investment and technical progress. Scholars working on growth, especially those focusing on technology diffusion and TFP, have been studying this potential role. Caselli and Wilson (2004) found strikingly large differences in investment composition across countries, with the composition of capital accounting for large observed differences in TFP across countries. They also found that the differences were based on each equipment type's degree of complementarity with other factors whose abundance differs across countries (Caselli and Coleman 2001).

Comin and Hobijin (2004) observed a trickle-down mechanism in the diffusion of technologies across countries, which meant that although most of the technologies originating from advanced economies were adopted there first, other countries that lag economically could still benefit subsequently. The determinants of the speed at which a country adopts technologies include the country's human capital endowment, type of government, degree of openness to trade, and adoption of predecessor technologies.

Table 6. **Operating Statistics of Real Estate Firms**

	Revenue from Principal Business (CNY100 million)	**Share of Taxes and Profits** (%)
1992	528.56	19.9
1993	1,135.91	22.2
1994	1,288.19	20.4
1995	1,731.66	13.5
1996	1,968.79	5.6
1997	2,218.46	4.2
1998	2,951.21	4.3
1999	3,026.01	3.6
2000	4,515.71	6.4
2001	5,471.66	7.3
2002	7,077.85	8.8
2003	9,137.27	10.1
2004	13,314.46	9.5
2005	14,769.35	13.2
2006	18,046.76	15.5
2007	23,397.13	17.5
2008	26,696.84	19.7
2009	34,606.23	21.1
2010	42,996.48	22.3
2011	44,491.28	21.6
2012	51,028.41	20.8

Source: National Bureau of Statistics. 2014. *China Statistical Yearbook 2014*. Beijing: China Statistics Press. Tables 5–38.

Jorgenson and Vu (2010) introduced a new framework for projecting the potential growth of the world economy, emphasizing the contribution of information technology. Investment in information and communications technology (ICT) raises the amount of capital available for labor, thus increasing labor productivity, likely increasing economic growth. It also introduces new technologies into the production process.

Inklaar and Timmer (2013) discuss new measures of capital stocks in PWT version 8.0, while Aghion (2014) notes the positive relation between ICT share (in value-added) and economic growth, using panel data. The contribution of investment in ICT has increased in all regions of the world, but especially in industrialized economies and developing Asia.

To explore the sustainability of the PRC's future growth in physical capital investment based on the composition of capital, we collected data on the growth of ICT capital services. Data show that ICT capital services grew at a more rapid pace in the country than in Japan, the Republic of Korea, and the US during 2000–2013 (Table 7).

This suggests that the potential exists for further increases in productivity and capital investment in the PRC in the near future. The average annual contribution of ICT capital services to overall growth in capital services in the country was 1.06

Table 7. **Growth in ICT Capital Services**
(in difference, %)

	PRC	Japan	Republic of Korea	US
2000	28.73	6.62	20.07	18.44
2001	26.44	7.24	17.30	13.86
2002	24.90	6.74	10.75	8.12
2003	24.48	5.27	6.13	5.94
2004	25.78	5.64	3.39	6.59
2005	26.46	4.76	4.62	7.31
2006	25.17	3.30	7.27	8.06
2007	22.06	3.69	8.93	9.19
2008	20.92	5.62	8.32	9.00
2009	19.71	7.84	6.39	6.59
2010	17.18	8.66	6.05	5.10
2011	15.52	8.94	7.87	5.58
2012	15.82	9.89	9.42	6.87
2013	17.39	10.73	10.50	8.21

ICT = information and communications technology, PRC = People's Republic of China, US = United States.
Source: The Conference Board Total Economy Database. Available online at: http://www.conference-board.org/data/economydatabase/ (accessed January 2014).

percentage points from 2004 to 2013, compared with 5.57 percentage points for non-ICT capital services during the same period.

In addition to rapid physical capital accumulation, the PRC has seen large-scale human capital accumulation. The country has been improving its stock of human capital over the past 30 years, owing to government commitment and increasing returns to education. Education spending by the Chinese government in terms of the share of total government spending is lower than that in the US but higher than in the United Kingdom and Japan (Bai, Wang, and Qian 2010).

Higher education in the PRC has grown at a faster pace than both primary and secondary education. College admission and enrollment has increased tenfold, with 6.4 million bachelor's and 514,000 master's and PhD degree holders produced by Chinese universities in 2013 (Table 8). The quality of human capital investment in the country has also improved through the years. The number of college students graduating as a percentage of the total has risen in the 2010s compared to the 1990s.

Table 9 similarly shows that the number of graduates from college and senior secondary schools in the PRC has increased dramatically in recent years. This trend, which has greatly improved the country's quality of education, is expected to continue in the near future. As Aghion (2014) and other authors have pointed out, education is important in bolstering economic growth.

C. Structural Readjustment

The PRC has been experiencing structural changes in the past 3 decades. Structural readjustment, which allows a transfer of resources from sectors with

Table 8. **Graduates in the PRC**
(thousands)

	College	MA and PhD	MA and PhD/ Undergraduates (%)
1991	614.0	32.5	5.0
1995	805.0	31.9	3.8
2000	949.8	58.8	5.8
2005	3068.0	189.7	5.8
2013	6,387.2	514.0	7.4

MA = Master of Arts, PhD = Doctor of Philosophy.
PRC = People's Republic of China.
Sources: National Bureau of Statistics of China. 2010. *Sixty Years of New China.* Beijing: China Statistics Press; National Bureau of Statistics of China. 2014. *China Statistical Yearbook 2014.* Beijing: China Statistics Press.

Table 9. **Number of Graduates by Level and Type of School**
(millions)

	Regular College	Regular Senior Secondary Schools	Secondary Vocational Education	Junior Secondary School	Regular Primary School
1978	0.165	6.827			22.879
1990	0.614	2.330		11.230	18.631
2000	0.950	3.015		16.335	24.192
2010	5.754	7.944	6.653	17.504	17.396
2012	6.247	7.915	6.749	16.608	16.416
2013	6.387	7.990			15.811

Source: National Bureau of Statistics. 2014. *China Statistical Yearbook 2014*. Beijing: China Statistics Press. Tables 20–9.

Table 10. **Annual Growth Rate of Patents Granted**

Period	(%)
1985–1989	27
1990–1994	17
1995–1999	15
2000–2004	20
2005–2009	19
1985–2009	19

Source: Xie and Zhang 2014.

lower productivity to sectors with higher productivity, serves as another source of economic growth.

Brandt, Hsieh, and Zhu (2008) decomposed the PRC's growth according to agriculture and non-agriculture sources during 1978–2004 and found that labor reallocation from agriculture to non-agriculture contributed 24.6% to the country's overall growth. They attribute this to the large productivity gap between agriculture and non-agriculture sectors during the period.

Theoretically, GDP growth in a multisector model can be divided into four components—the contributions of capital, labor, pure technical progress (weighted average of technical progress in all sectors), and structural change.

The current Chinese economy is still far from its long-term steady state. Large productivity gaps still exist between sectors of the economy, while endowments continue to change as income rises. The production structure clearly needs to change to follow the changes in endowments. These structural readjustments should be able to provide new sources of economic growth and raise the potential for a relatively high growth rate in the medium to long run.

Heterogeneity at the firm level is a source of productivity growth. Aghion (2014) points out that the heterogeneity between firms is much larger than that between sector averages. In the US, the productivity of the top 10% most productive firms is twice that of the bottom 10%. Hsieh and Klenow (2009) find the corresponding multiple to be as high as 5 times in the PRC. This huge difference shows the country's potential for structural improvements in the future.

The enormous size of the Chinese economy benefits structural readjustment, as a wide enough industrial spectrum makes an update of the industrial structure and a widening of product variety possible. The huge product space makes it possible for the country to upgrade its industrial structure at a wide scale. This feature differentiates the PRC from mid-sized countries such as Japan and the Republic of Korea.

Aside from well-functioning markets and continued structural upgrading, there are other factors that contribute to the structural improvement of the Chinese economy and that help drive future growth. These include private sector development and privatization of state-owned enterprises to spur greater competition, greater protection of intellectual property rights and other legal support to encourage R&D and innovation in the manufacturing sector, bilateral investment treaties and free trade zones to foster greater openness of the economy, and deregulation and introduction of greater competition to improve productivity in the services sector.

Innovation is a key driver of long-run growth, one that is particularly important for middle-income countries such as the PRC. Xie and Zhang (2014) find that domestic Chinese firms have become increasingly more innovative in terms of patent applications, and that private firms, rather than state-owned firms, have been the engine of innovation. Facing increasing wages, the firms have had to invest more in technologies to substitute the more expensive labor. The annual growth rate of patents granted during 1985–2012 averaged at 19%, almost twice the annual growth rate of GDP during the same period (Xie and Zhang 2014).

Overall, on one hand, the PRC is still far behind the world technology frontier and will continue to enjoy the advantage of backwardness. On the other hand, it is closer to the world technology frontier than at any time previously and possesses greater capital and skilled labor than it did 30 years ago. This provides a basis for updating industries and further economic development.

V. Preconditions for the PRC's Sustained Growth and Policy Suggestions

The PRC has the potential to sustain a relatively high growth rate in the long run provided government adopts the right policies. There are a number of general preconditions or prerequisites that must be met in order to achieve this goal.

The PRC needs to narrow income disparities and fight corruption to maintain social stability. Greater income disparity and corruption are the results of the dual-track transition strategy where the government continues to provide subsidies and protection to nonviable firms in prioritized capital-intensive sectors, creating distortions in factor markets and monopolies in certain service sectors while allowing or facilitating the entry of new firms to the labor-intensive sector that had been previously repressed. Such an approach allows the country to achieve stability and dynamic growth simultaneously.

However, distortions in factor markets and monopolies in telecommunications and financial sectors create rents and encourage rent-seeking, leading to greater income disparity and corruption. Many capital-intensive firms in the old prioritized sectors have become viable because of the change in the endowment structure, which was a consequence of rapid growth and capital accumulation over the past 35 years. It is time for the country to eliminate these distortions and complete the transition to a well-functioning market economy, allowing prices to play a decisive role in resource allocation to improve efficiency and eliminate the root of income disparity and corruption (Lin 2012a).

The PRC needs to continue investing in physical and human capital in order to change its endowment structure. It also needs to continue upgrading technologies, transforming its industrial structure, and tapping latecomer advantages. As developments continue, factor endowments and industrial structure will keep changing, and the country will need to update its infrastructure accordingly. The inconsistency between the two means leaving the equilibrium path and lowering trend growth.

Finally, the Chinese government also needs to play an enabling role in future economic development. It needs to help firms reduce transaction costs by improving both soft and hard infrastructure. A sound fiscal position, at both central and local government levels, will be beneficial to economic growth. An enabling government is also essential to overcome inherent externalities of technological innovation and industrial upgrading. State effort is also needed to improve the country's environmental quality and achieve environmental sustainability.

VI. Concluding Remarks

In sum, the PRC can sustain a relatively high growth path over a long period based on three basic arguments. First, since a substantial technological gap still exists between the PRC and major developed countries, it can continue to enjoy the

advantage of backwardness. Second, the long period of large-scale infrastructure investment that began several decades ago can still continue and provide the country a basis for further growth. Third, structural readjustment, which is needed in many fields, should be able to bolster economic growth in the long run. These arguments are supported by growth accounting analysis.

We argue that to realize the potential for sustained growth, a number of general preconditions or prerequisites need to be fulfilled. These include well-functioning markets, an appropriate rate of investment, continued structural upgrading, and an enabling government that can facilitate the appropriate structural transformation. If the economic adjustments are done correctly and in a timely manner, sustained growth should be possible in the medium- and long-term.

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* ADB recognizes "China" as the People's Republic of China.

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Trilemma Challenges for the People's Republic of China

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This paper first reviews recent developments in exchange rate regimes, capital account liberalization, interest rate liberalization, and monetary policymaking in the People's Republic of China (PRC). It then observes that the PRC's monetary policy autonomy may have been reduced with falling capital control effectiveness and a rigid exchange regime that is still tightly managed against the United States (US) dollar. This hypothesis is investigated empirically using both the Taylor rule and a McCallum-like rule to test whether the PRC's money market interest rate and/or quantity of money supply are being increasingly influenced by the US interest rate or reserve accumulation. The paper concludes that there is considerable evidence suggesting diminishing monetary policy autonomy in the PRC. To regain policy autonomy, the monetary authority needs to substantially increase exchange rate flexibility of the renminbi as long as it continues to pursue capital account opening.

Keywords: trilemma, exchange rate regime, capital controls, monetary policy autonomy, interest rate liberalization, Taylor rule, McCallum rule
JEL codes: E52, E58

I. Introduction

The People's Republic of China (PRC) is facing trilemma challenges as it continues to liberalize its capital account. The trilemma hypothesis claims that a country's monetary authority cannot achieve exchange rate stability, financial market (or capital account) openness, and monetary policy autonomy at the same time.[1] Thus, as financial market openness has increased over time in the PRC, its monetary authority must choose greater exchange rate flexibility to retain a high degree of monetary policy autonomy.

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[1] In the PRC, monetary policy is largely decided by the government (the State Council and the executive branch), while its central bank—the People's Bank of China (PBoC)—serves as a policy implementation agency rather than a main policy decision maker. To reflect this reality, this paper uses the term "monetary authority" to refer to a main monetary policy decision maker. The paper also uses the term monetary policy "autonomy" rather than "independence" to avoid possible confusion with the issue of political and/or operational independence of a central bank.

The PRC has been pursuing a policy of gradually opening its financial markets. Since the 1980s, the authorities have liberalized inward and then outward foreign direct investment (FDI). While strict controls used to be imposed on portfolio investment flows, these controls have also been relaxed in recent years to expand the range of investors and the type of financial assets permitted for cross-border transactions. The authorities introduced the system of qualified foreign institutional investors (QFII) for inward portfolio investment and that of qualified domestic institutional investors (QDII) for outward portfolio investment. The policy of internationalizing the renminbi (RMB), launched in the wake of the global financial crisis (GFC), has also facilitated greater financial market openness. Authorities now allow firms to settle merchandise trade in RMB, permit non-residents to hold offshore RMB deposits, and allow both PRC residents and non-residents to issue offshore RMB bonds and equities.

The PRC used to peg the RMB tightly to the United States (US) dollar, but exited from the dollar peg in July 2005. It began to engineer currency appreciation against the US dollar by shifting to a crawling-peg regime, thus allowing a certain degree of exchange rate flexibility. Although the authority temporarily restored a dollar-peg regime during August 2008–May 2010, it once again adopted a crawling-peg-like regime in June 2010. In general, the degree of exchange rate flexibility has gradually increased over time but remains highly limited.

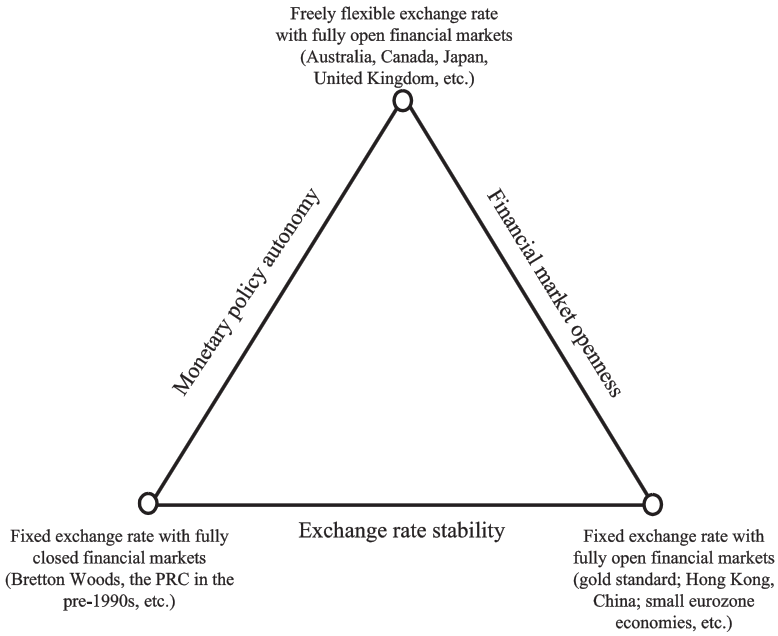
This paper argues that while the PRC's financial markets have become increasingly integrated with external markets, particularly those in Hong Kong, China, the degree of RMB exchange rate flexibility has not risen much, and the combination of greater openness of its financial markets and lack of sufficient exchange rate flexibility has constrained the ability of the monetary authority to pursue autonomous monetary policy.

II. The Trilemma Hypothesis in International Finance

Achieving noninflationary, stable economic growth is one of the most important policy objectives for monetary authorities, particularly central banks, in the world. Many authorities find it desirable to have stable or even fixed exchange rates, as currency stability can help achieve price stability by establishing inflation anchors and/or reducing macroeconomic and financial volatility. Exchange rate stability can also foster international trade and investment by lowering exchange rate uncertainty and currency risk premiums.

Many authorities also find it useful to have open financial markets as they allow countries to diversify economic and financial risks and smooth consumption, investment, and/or output over time. Financial market openness enhances the efficiency of financial intermediation and savings and investment decisions of households and corporations.

Figure 1. **The Trilemma Triangle**



PRC = People's Republic of China.
Source: Ito and Kawai (2014).

Finally, many authorities find it highly attractive to retain monetary policy autonomy, that is, the ability to set and implement monetary policy to offset other countries' monetary shocks and monetary policy changes, without being constrained by their choice of exchange rate regime. Monetary policy autonomy significantly helps contribute to economic stabilization in the sense of achieving low inflation and stable economic growth.

Conceptually, higher levels of exchange rate stability, financial market openness, and monetary policy autonomy would all be useful and attractive for any monetary authority. But no authority can retain all three at any one time. This is the fundamental hypothesis—the "impossible trinity" or the "trilemma"—that dominates monetary policymaking in any open economy (Mundell 1963). The PRC is no exception.

The trilemma is often illustrated using a triangle as shown in Figure 1, with the three sides representing the three desirable properties: exchange rate stability, financial market openness, and monetary policy autonomy (Ito and Kawai 2014). While it is possible to achieve desired levels of two out of the three attributes, it is impossible to achieve desired levels of all three. For example, a country's authority may choose to stand at one of the three corners in the triangle, but it is impossible to achieve all three simultaneously. As only two out of three can be achieved to their

full extent (or any extent), we often observe three distinctive policy combinations: (i) a fixed exchange rate regime and full monetary policy autonomy (with closed financial markets, as in the case of the lower left-hand corner—representing, for example, the Bretton Woods system and the PRC in the pre-1990s); (ii) a fixed exchange rate regime and fully open financial markets (while giving up monetary policy autonomy, as in the case of the lower right-hand corner—representing, for example, the gold standard system, a currency board system similar to Hong Kong, China and small eurozone countries); and (iii) fully open financial markets and full monetary policy autonomy (while adopting a freely flexible exchange rate regime, as in the case of the top corner—representing, for example, Australia, Canada, Japan, and the United Kingdom).

While history is full of episodes of systems that represent such "corner solutions," monetary authorities can also adopt an intermediate combination of the three properties, that is, a "dot" inside the triangle. There are an infinite number of such combinations. The reason a monetary authority may select such a dot is that it may wish to compromise in selecting the level of attainment of each of the three properties. For example, a monetary authority may wish to have some exchange rate stability, some financial market openness, and some monetary policy autonomy. Or, if a monetary authority wishes to retain full monetary policy autonomy, it needs to strike a good balance between some exchange rate stability (or flexibility) and some financial market openness (or some capital controls). In many developing countries, monetary authorities often limit financial market openness as it would make the economy vulnerable to external financial shocks and capital flow volatility, creating boom and bust cycles and, potentially, financial crises.

The PRC's monetary authority used to peg the RMB exchange rate to the US dollar while maintaining tight capital controls (the lower left-hand corner of the triangle in Figure 1). This enabled the authority to retain monetary policy autonomy. However, as it began to gradually open its financial markets over time, its position in the triangle in Figure 1 started to shift from the lower left-hand corner toward the side of financial market openness. If the authority continues to maintain exchange rate stability, this shift will take place horizontally along the bottom of the triangle, thus compromising monetary policy autonomy. On the other hand, if the PRC authority wishes to maintain monetary policy autonomy, the shift will take place upward along the left side, thus allowing greater exchange rate flexibility.

The choice of exchange rate regime therefore must be made in the context of the trilemma hypothesis, that is, in conjunction with the choices on monetary policy autonomy and financial market openness. For a large economy like the PRC, maintaining monetary policy autonomy is an important requirement for effective macroeconomic management. So as financial market (or capital account) openness increases over time, the authority needs to choose greater exchange rate flexibility to retain a sufficiently high degree of monetary policy autonomy.

III. Exchange Rate Policy and Rate Flexibility

A. Renminbi Exchange Rate Behavior since 2005

On 21 July 2005, the PRC authority de-pegged and revalued the RMB exchange rate against the US dollar by 2.1%, from CNY8.28 to CNY8.11 per US dollar. Accompanying the revaluation, the authority also announced a set of measures to shift the exchange rate regime to a more flexible "managed float" system. The RMB's valuation from that point onward would be determined with reference to a basket of currencies. Prior to this change, the RMB had been on a fixed exchange rate system pegged to the US dollar with occasional devaluations.[2]

The new RMB exchange rate regime gave the authority a new policy tool to manage its economy. The authority announced a daily reference trading spot rate, called the central parity rate (CPR), for the RMB to trade against the US dollar. The PRC launched a steady appreciation immediately following the RMB revaluation in July 2005. Until January 2006, the authority would set the CPR for the next trading day at the previous trading day's market close. In January 2006, a new pricing mechanism was introduced to set the CPR using a weighted average scheme.[3] Currency weights were determined by the China Foreign Exchange Trading System according to the previous day's transaction volumes of individual market participants. In addition, other indicators, such as quoted prices from the automatic price matching system, could be used in principle as a reference. However, such information was often not available in real time. Thus, it was difficult for the market to determine how a daily CPR was set and whether it would be subject to various external political pressures and internal economic objectives (Liu and Pauwels 2012).

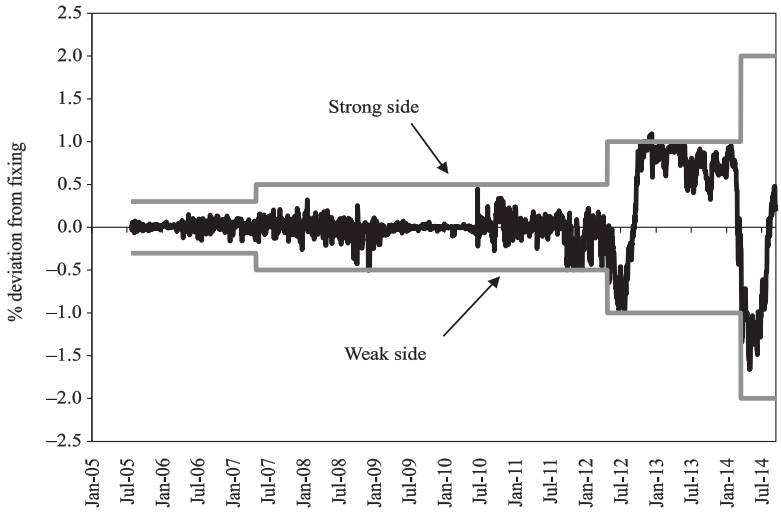
The steady appreciation of the RMB against the US dollar was temporarily halted toward the end of July 2008 with the eruption of the GFC. The peg lasted for almost 2 years until June 2010 at a rate of CNY6.83 per US dollar before resuming a steady path of appreciation. During this re-peg period, the PRC authorities prevented the RMB from appreciating vis-à-vis the dollar in order to help exporters cope with the sharp drop in demand from the US and the rest of the world.

In the past, once the CPR was determined against the US dollar, the exchange rate was then set against the euro, the yen, and the Hong Kong dollar using the market cross rates of these currencies with the US dollar. Since 2012, RMB direct trading has been allowed for the yen, Australian dollar, New Zealand dollar, pound

[2] In January 1994, the RMB was devalued from CNY5.35 to CNY8.28 per US dollar, after which the rate stayed at the same level for more than 10 years.

[3] The new CPR had three distinct features: (i) over-the-counter (OTC) trading was introduced as the main form of currency trading; (ii) more CPR pairs of the RMB against the US dollar, the euro, the yen, and the Hong Kong dollar were announced at 9:15 am Beijing time of each business day; and (iii) the CPR was calculated using a weighted average based on trading volume.

Figure 2. **The Renminbi Exchange Rate with a Widening Band**



Source: Bloomberg.

sterling, euro, and Korean won. As a result, Shanghai market liquidity for these currencies has become a factor affecting these currencies' onshore rates against the RMB, in addition to their market cross rates calculated against the US dollar.

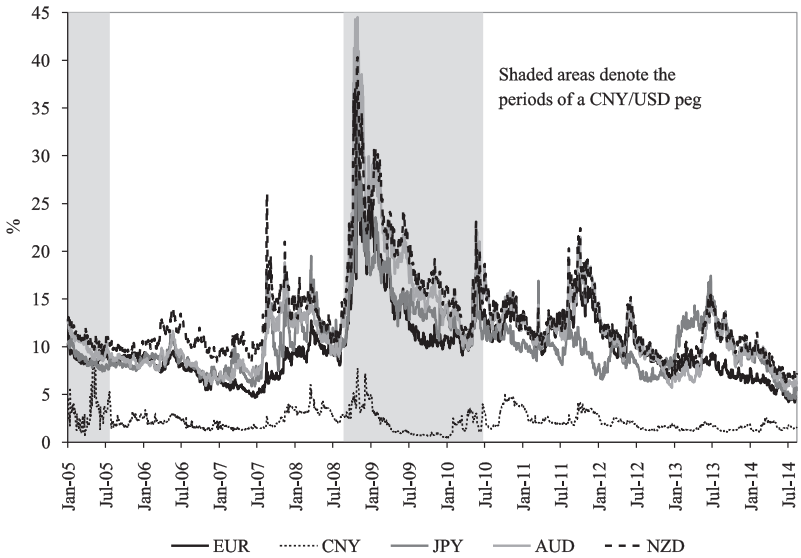
The RMB trading band vis-à-vis the US dollar was initially set at a tightly controlled range of ±0.3%, which was later widened to ±0.5% in May 2007, ±1% in April 2012, and then to ±2% in March 2014. Indeed, the RMB's exchange rate flexibility has increased progressively with an enlarged trading band over time (Figure 2).

Although the RMB exchange rate band has been widened over time, RMB volatility has been limited in comparison to the volatility of other freely floating currencies such as the euro, yen, and Australian dollar. Using an option-based currency volatility measure, Figure 3 shows that 1-month at-the-money implied volatility of the euro, yen, Australian dollar, and New Zealand dollar fluctuated at an average of 10%–20% during the GFC period of September 2008–June 2010. Afterward, the average volatility of these currencies still fluctuated at around 10%. In contrast, the option price implied volatility of the RMB reached only 5% with the eruption of the GFC and has since settled down to less than 2%. Thus, RMB exchange rate volatility has remained limited.

B. Exchange Rate Policy after the 2005 De-pegging

After the RMB's exit from the dollar peg, its exchange rate was supposed to reference a basket of currencies, with its exchange rate reform strategy being to take

Figure 3. **Option Price Implied Volatility of Major Currencies and the Renminbi**



AUD = Australian dollar, CNY = renminbi, EUR = euro, JPY = yen, NZD = New Zealand dollar, USD = US dollar.
Note: The chart displays the 1-month at-the-money implied volatility of the various currencies.
Source: Bloomberg.

an approach marked by "self-initiative, controllability, and gradualism" to improve the RMB exchange rate formation mechanism (PBoC 2009).

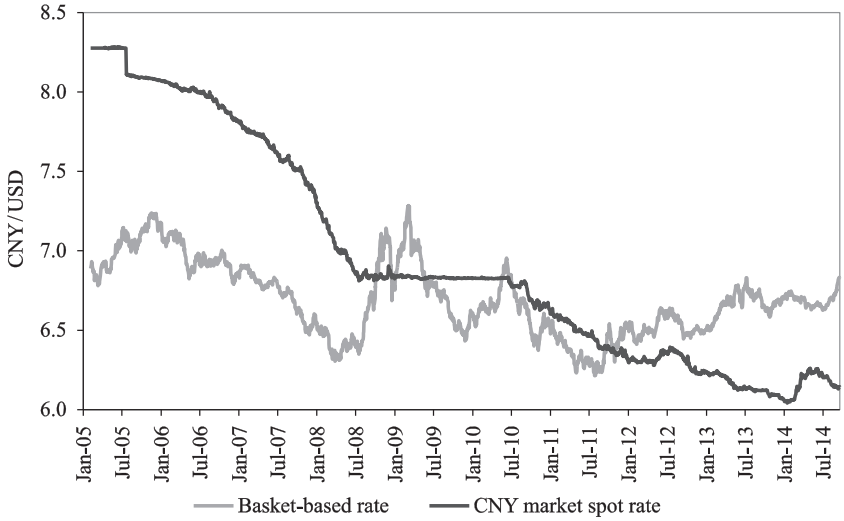
Whether the RMB has actually been referenced to a basket of currencies can be examined empirically using two approaches. One is to construct a currency basket that reflects enough of the PRC's trade with the rest of the world and see whether the RMB exchange rate has actually followed the valuation derived from this basket of currencies. The other approach is to use the Frankel and Wei (1994) model to econometrically identify major international currencies and estimate their weights in an RMB currency basket.

1. Basket of a Large Number of Currencies?

First, using 11 currencies that make up 70% of the PRC's trade with the rest of the world, we constructed a currency basket for the RMB and expressed it as an implied RMB exchange rate against the US dollar.[4] The basket-based RMB rate is depicted in Figure 4 together with the market RMB spot rate against the US dollar.

[4]The methodology closely follows the usual calculation of a nominal effective exchange rate (NEER)—that is, constructing a geometric average of the 11 currencies' exchange rates against the US dollar and then expressing the value of this currency basket as an exchange rate against the US dollar rather than as an index. The currency basket assigns large weights to the US dollar (34.2%), euro (22.5%), Japanese yen (14.9%), and Korean won (10.2%),

Figure 4. **Basket-based Renminbi Rate versus Market Renminbi Rate**



CNY = renminbi, USD = US dollar.
Source: Authors' computations using data from Bloomberg.

The figure shows that from July 2005 to September 2008, the movement of the market RMB spot rate followed that of the basket-based RMB rate reasonably well, with a correlation coefficient of 0.91, although the basket-based rate was stronger in value than the market rate vis-à-vis the US dollar. Beginning in September 2008, the basket-based RMB rate started to show more volatile movements than the market spot rate due to sharp changes in the exchange rates of the PRC's trading partners during the height of the financial crisis and the RMB's re-pegging to the US dollar. Between October 2008 and June 2010, the correlation coefficient between the two rates was 0.49. Between June 2010 and August 2014, the correlation even turned negative to –0.39. The figure clearly shows that in 2012 the market and the basket-based RMB rate began to diverge, with the market rate appreciating and the basket-based rate depreciating against the US dollar, both as a trend.

2. Frankel–Wei Estimation of a Currency Basket

The second approach is to examine the major international currencies that have a large influence on the observed movements of the RMB exchange rate and determine the weights assigned to these major currencies using the Frankel–Wei

followed by the Singapore dollar, pound sterling, Malaysian ringgit, Australian dollar, Thai baht, Canadian dollar, and the Russian Federation ruble, with their weights ranging from 2% to 3%.

Table 1. **Changes in Observed Exchange Rate Regimes for the Renminbi**

Estimation Period	US Dollar	Euro	Yen	Pound Sterling	R-squared
Post-AFC period	0.999***	0.000	0.000	−0.000	0.999
(3 January 2000–30 June 2005)	(0.000)	(0.000)	(0.000)	(0.000)	
Pre-Lehman period	0.934***	0.044***	0.028***	−0.017	0.979
(21 July 2005–21 July 2008)	(0.009)	(0.013)	(0.007)	(0.013)	
GFC period	0.970***	0.023***	0.003	0.003	0.996
(1 August 2008–31 May 2010)	(0.006)	(0.008)	(0.004)	(0.005)	
Post-GFC period	0.940***	0.034***	0.011**	0.002	0.985
(1 June 2010–31 March 2014)	(0.008)	(0.007)	(0.005)	(0.008)	

AFC = Asian financial crisis, GFC = global financial crisis.
Notes: The values in parentheses are the estimated robust standard errors. ** = 5% level of statistical significance, *** = 1% level of statistical significance.
Source: Kawai and Pontines (2015).

model. Table 1 summarizes the estimation results reported by Kawai and Pontines (2015). The table clearly indicates that the US dollar is still assigned the largest and predominant weight throughout the sample period, while other major international currencies such as the euro and the yen only have limited, occasional influence on the RMB exchange rate.

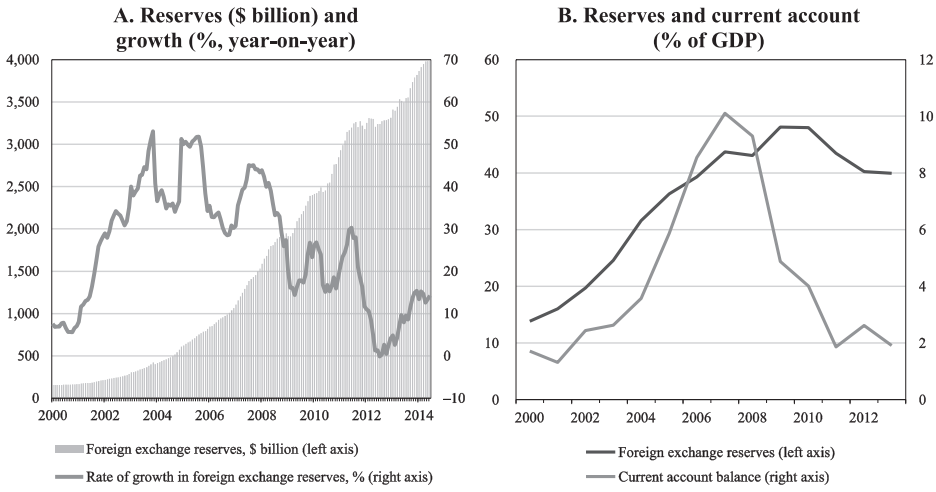
Thus, the post-2005 RMB exchange rate regime has not truly referenced a basket of a wide range of currencies in setting the value of the RMB exchange rate. The RMB exchange rate has relied and continues to rely heavily on the US dollar as its anchor currency, with limited exchange rate volatility.

3. Accumulation of Foreign Exchange Reserves

Limited exchange rate volatility, together with a prevailing one-way bet on the RMB's continued appreciation against the US dollar, led to significant capital inflows into the PRC, which required the PRC's monetary authority to engage in massive currency market interventions. Figure 5 shows that the pace of foreign exchange reserve accumulation had been rapid until the outbreak of the GFC. After the crisis, the rate of growth decelerated, with reserves hardly growing during Q2 2011–Q4 2012. But the reserves began to rise once again in 2013, albeit at a lesser pace than in the pre-crisis period.

As a share of gross domestic product (GDP), foreign exchange reserves increased from 14% in 2000 to 48% during 2009–2010, and then declined somewhat to 40% in 2013. As the PRC's current account surplus as a ratio of GDP declined sharply after the GFC, from its peak at 10% in 2007 to only 2% in 2014, the pace of reserve accumulation naturally slowed down. As will be shown later, reserve accumulation has been accompanied by a rapid increase in the PRC's monetary base. This suggests that the PRC's monetary policy has been increasingly influenced by external conditions.

Figure 5. **Foreign Exchange Reserves of the People's Republic of China**



GDP = gross domestic product.
Source: CEIC.

IV. Effectiveness of Capital Controls

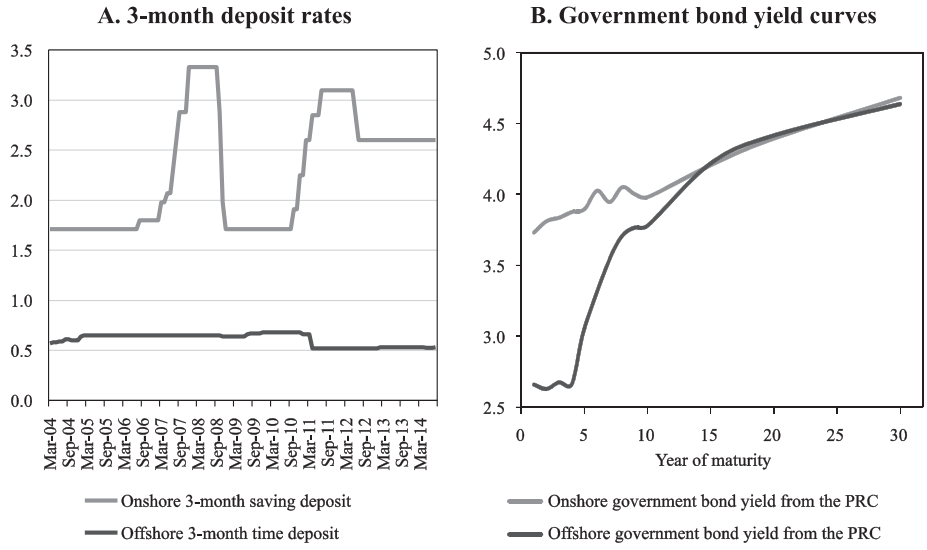
A. Renminbi Internationalization and Rising Arbitrage Opportunities

The PRC started to encourage international use of the RMB for trade purposes in September 2009. This led to rapid increases in the number of RMB offshore trading centers such as in Hong Kong, China; Singapore; Taipei,China; and London. Among these offshore trading centers, the RMB market of Hong Kong, China, commonly referred to as the CNH market, remains the largest and most active. Total RMB deposits in the banking system of Hong Kong, China, including certificates of deposit, exceeded CNY1.2 trillion in the first half of 2014, a sizable amount comparable to the value of the PRC's new loans extended per year before 2005. The main drivers of the rapid rise of RMB deposits in Hong Kong, China have been trade settlements invoiced in RMB. Total trade settlements using RMB between Hong Kong, China and the PRC reached CNY3.8 trillion in 2013.

Meanwhile, offshore capital markets for the RMB have also developed rapidly. The RMB bond market of Hong Kong, China, nicknamed the "dim sum" market, experienced a surge with a total outstanding amount of CNY310 billion in 2013 and CNY374 billion in Q3 2014. The bonds raised in the RMB market of Hong Kong, China could be repatriated to the PRC via an approval from the State Administration of Foreign Exchange or via an RMB QFII scheme.

Since July 2013, commercial banks have been allowed to transfer their RMB deposits outside the PRC to their domestic branches, making RMB repatriation to

Figure 6. **Onshore and Offshore Renminbi Interest Rate Differentials**
(%)



PRC = People's Republic of China.
Note: Offshore refers to Hong Kong, China.
Sources: Bloomberg, CEIC.

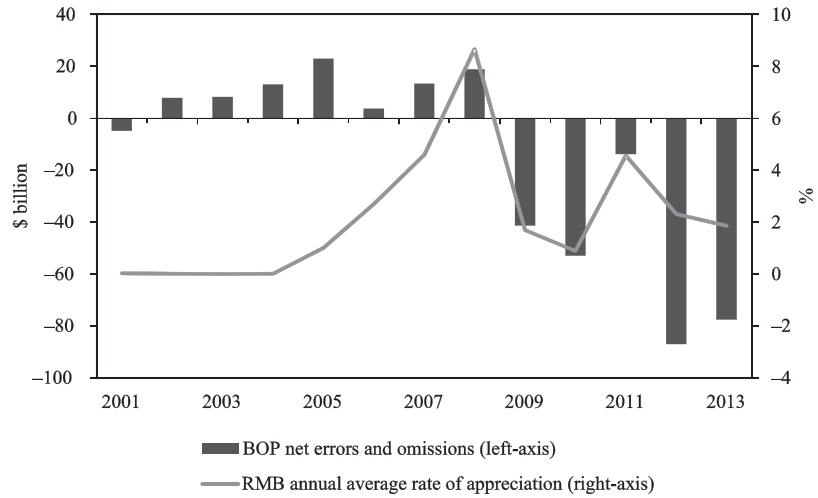
the PRC easier. The linking of the Shanghai and Hong Kong, China stock markets, launched in late 2014, has allowed investors in both markets to buy each other's listed shares and is another step toward a more open capital account.

The rapid RMB internationalization process also means that the PRC's capital account is opening at a faster pace, allowing market participants to arbitrage away exchange rate and interest rate differentials between markets in Hong Kong, China and the PRC. Therefore, it is natural to assume that the existing capital control measures will become less effective.

However, casual observations suggest that RMB assets of the same maturity in both onshore and offshore markets still enjoy large yield differentials. For example, 3-month RMB savings deposits onshore obtain a return of 2.6% per annum, while 3-month time deposits in Hong Kong, China only offer a return of around 0.5% (see Figure 6A). Meanwhile, 3-month Ministry of Finance bonds from the PRC issued in Shanghai and Hong Kong, China still have yield differentials, with the shorter-dated bonds having larger yield differentials (Figure 6B).

These observations appear to suggest that the PRC's capital controls are still effective or binding. It is these control measures that drive a wedge between onshore and offshore yields by limiting arbitrage activities in the form of capital flows. These straightforward yield comparisons could be misleading, however, as they do not take

Figure 7. **Errors and Omissions in the Balance of Payments of the People's Republic of China and the Rate of Renminbi Appreciation**



BOP = balance of payments, RMB = renminbi.
Source: IMF, International Financial Statistics.

into account factors such as interest rate controls, transactions costs, and the risk of arbitrage due to capital controls.

One sign of this is the fact that the PRC's unaccounted capital flows have started to grow over time. Figure 7 shows that until 2008, errors and omissions in the PRC's balance of payments had been around $10 billion–$20 billion, mostly in the form of unaccounted inflows, coinciding with the expectation of RMB appreciation. Since 2009, errors and omissions have become large outflows, at an average of close to $55 billion. Errors and omissions numbers became even larger during 2012–2013 to around $82 billion, suggesting that the leakage from capital controls has become larger over time, even when the RMB exchange rate has been on a steady appreciation.

B. Measuring Capital Control Effectiveness

A useful benchmark for comparing yield differentials in two markets is to rely on the covered or uncovered interest rate parity (IRP) conditions or some modified IRP conditions that can capture distortions caused by capital controls. Under free capital mobility, the IRP condition states that investors should be indifferent to nominal interest rate differentials in two countries because the exchange rate between the two currencies is expected to adjust in a way that offsets nominal interest rate differentials, thus removing any arbitrage opportunities.

Using the IRP approach, Ma and McCauley (2007) found that the PRC's capital controls remained effective in driving a wedge between onshore and offshore interest rates of the same type of assets for the period before the RMB's circulation offshore. A more appropriate approach to investigate the PRC's capital control effectiveness would be to follow a seminal study by Otani and Tiwari (1981), who looked at Japanese bond yield differentials in both the Tokyo and London markets at the early stage of Japan's capital account liberalization in the late 1970s.

Following their approach, we present two calculations of the IRP condition to investigate deviations from IRP in both the Hong Kong, China and Shanghai markets. First, we look at the Hong Kong, China CNH market, which is not subject to many controls or market distortions. Second, we look at cross-border investments involving onshore RMB (CNY) and offshore CNH transactions. The difference between the two deviations can be viewed as a capital control effectiveness measure that addresses transaction costs and other distortions in both markets.[5]

The deviation from the IRP condition in the Hong Kong, China CNH market can be defined as follows:

$$Deviation_{CNH\_1} = \frac{(1 + r_{CNH})\, S_{CNH}}{(1 + r_{USD})\, F_{CNH}} - 1, \tag{1}$$

where r_{CNH} is the 3-month offshore RMB (CNH) interbank interest rate; r_{USD} is the 3-month US dollar interbank rate in Hong Kong, China; S_{CNH} is the CNH spot rate against the US dollar; and F_{CNH} is the CNH deliverable forward rate. Since we use the 3-month interest rates, the annualized interest rate is divided by a factor of 4 and the results should be interpreted as percentage points.

Similarly, the deviation from the IRP condition in cross-border investment can be expressed as follows:

$$Deviation_{CNY\_1} = \frac{(1 + r_{CNY})\, S_{CNY}}{(1 + r_{USD})\, F_{CNH}} - 1, \tag{2}$$

where r_{CNY} is the 3-month onshore RMB (CNY) interbank interest rate; r_{USD} is the 3-month US dollar interbank rate in Hong Kong, China; S_{CNY} is the onshore RMB (CNY) spot rate against the US dollar; and F_{CNH} is the CNH deliverable forward rate. Note that this IRP condition uses the Hong Kong, China CNH forward rate, rather than the onshore RMB (CNY) forward rate, which has not been fully developed in terms of depth and liquidity.

[5]Detailed technical derivation of these equations can be found in Otani and Tiwari (1981).

Alternatively, investors may use the offshore non-deliverable forward (NDF) rate also quoted in Hong Kong, China, F_{NDF}, rather than F_{CNH}, as the RMB NDF market in Hong Kong, China is larger and more liquid at this stage. Many investors still use this market to hedge their onshore RMB exposures. Therefore, the above expression can be changed to:

$$Deviation_{CNH\_2} = \frac{(1 + r_{CNH})\, S_{CNH}}{(1 + r_{USD})\, F_{NDF}} - 1 \qquad (1)'$$

$$Deviation_{CNY\_2} = \frac{(1 + r_{CNY})\, S_{CNY}}{(1 + r_{USD})\, F_{NDF}} - 1 \qquad (2)'$$

Finally, capital control effectiveness (CCE) measures can be derived by comparing Equations (1) and (2) and Equations (1)' and (2)'. The difference between onshore and offshore deviations from IRP means that after adjusting for interest rate differentials and forward premiums, the distortion remaining can be attributed to capital controls. Specifically, the CCE measures can be expressed as:

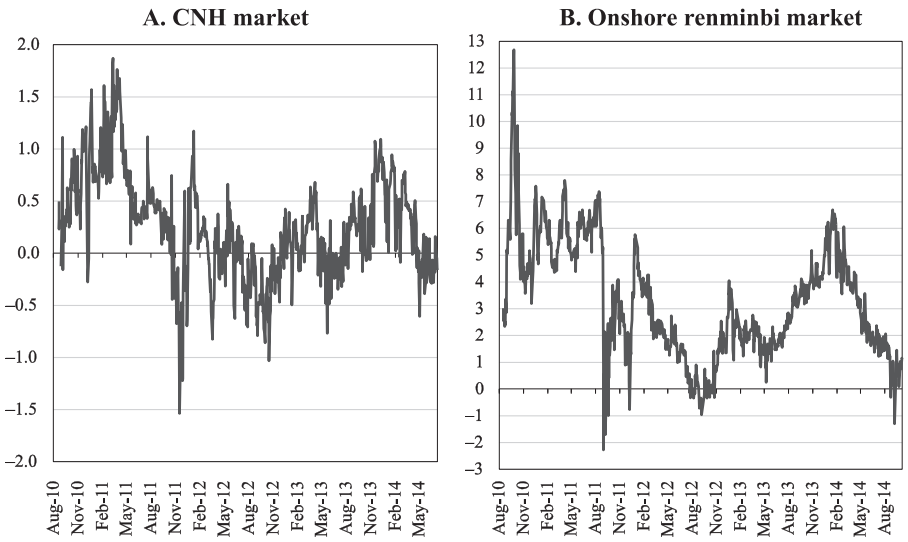
$$CCE1 = |Deviation_{CNY\_1} - Deviation_{CNH\_1}| \qquad (3)$$

$$CCE2 = |Deviation_{CNY\_2} - Deviation_{CNH\_2}| \qquad (3)'$$

Using data from 2010 to the present, we can calculate the deviations from IRP for Equations (1) and (2), and Equations (1)' and (2)'. Figure 8A depicts the deviations from IRP based on Equation (1), which indicates that despite limited liquidity and market depth, deviations in the Hong Kong, China market have become smaller over time. Since March 2012, the deviations have become on average negligible (within $\pm 1\%$) and are not far from parity. This means that the Hong Kong, China CNH market has quickly become an efficient market, with limited arbitrage opportunities between offshore transactions in US dollars and CNH.

However, this is not the case for cross-border investment involving onshore RMB (CNY), as we do observe large deviations in Equation (2). Figure 8B shows that using the onshore RMB (CNY) interbank rate and onshore RMB (CNY) spot rate, we find the deviations from IRP can be as large as 6%–7% on average before September 2011. This means that if the same amount of RMB were to have been shifted from offshore to onshore markets, the arbitrage returns would have been 6%–7%. From November 2011 to September 2014, we observe a fall in arbitrage opportunities of an average of 1%–3%. Though this is a sharp reduction from the pre-September 2011 period, deviations from IRP for cross-border investment involving onshore RMB (CNY) have remained much larger than those in the Hong Kong, China CNH market.

Figure 8. **CNH Deviation from Interest Rate Parity**
(%)



CNH = renminbi market of Hong Kong, China.
Source: Authors' computations using data from CEIC and Bloomberg.

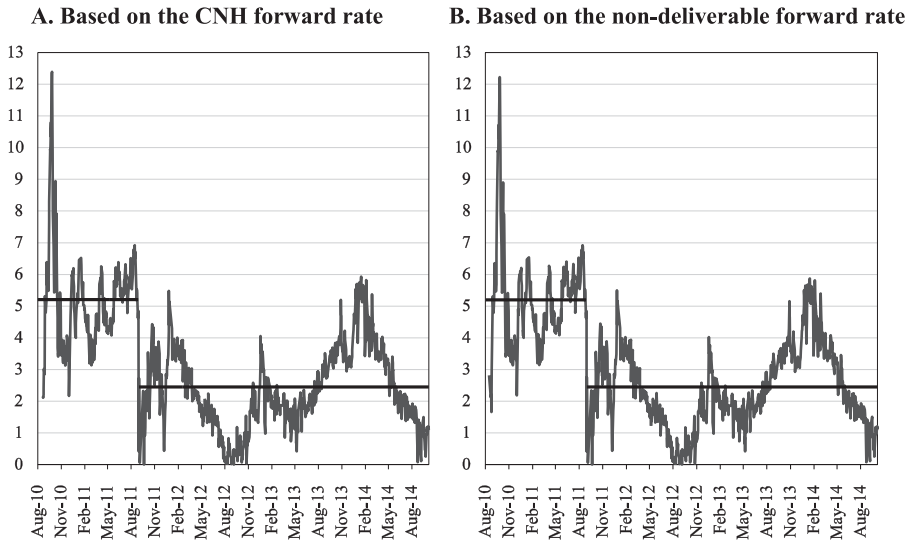
C. Declining Capital Control Effectiveness

The two charts in Figure 9 are constructed using Equations (3) and (3)' and provide two CCE measures, one based on the CNH forward rate and the other the NDF rate. Over the period 2010–2014, it appears that the PRC's capital control regime, in general, has remained effective despite the rapid RMB internationalization process and the accelerated pace of capital account opening.

Examining the calculations more carefully, we observe that CCE has been declining since September 2011, when the CNH market in Hong Kong, China began to grow larger, became more liquid, and was better regulated. While this structural break has yet to be tested statistically, the decline has been sizable. We find that there is no significant difference between CCE1 (Hong Kong, China CNH investment using the CNH forward rate) and CCE2 (onshore RMB [CNY] investment using the NDF rate). Both measures declined from an average of 5.2% in the period before September 2011 to an average of 2.5% in the period after September 2011.[6]

[6]It may be noted that while the CCE measures saw sharp declines in 2012, they started to rise in the second half of 2013, reaching as high as 5.9% in February 2014, before falling again back to the range of 0%–2% in the second half of 2014. The rise of the CCE in the first half of 2014 could be largely attributed to rising exchange rate volatility as well as a sharp exchange rate depreciation engineered by the PRC's monetary authority. Once the RMB returned to a one-way bet for appreciation with little volatility in the second half of 2014, the CCE measures dropped again.

Figure 9. **Capital Control Effectiveness Measures**
(%)



CNH = renminbi market of Hong Kong, China.
Source: Authors' computations using data from CEIC and Bloomberg.

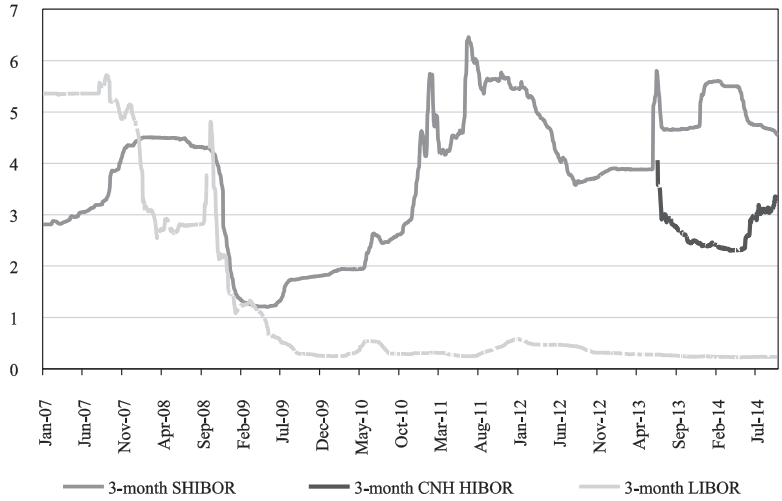
This finding suggests that the de jure capital controls adopted by the PRC authority may no longer be successful in preventing profit-driven capital flows between Hong Kong, China and the PRC. The large and growing trade integration of the PRC with Hong Kong, China may have contributed to the de facto financial integration of the PRC with Hong Kong, China over time, for a given degree of de jure capital controls, through an expanded use of the current account for capital account purposes such as trade mis-invoicing.

Indeed, the RMB's role as a trade settlement currency has facilitated de facto capital flows through trade transactions. For example, the PRC's export figure in Q1 2013 was abnormally large. The anomaly could be explained by the round-tripping of goods between Shenzhen and Hong Kong, China, an international entrepôt, as well as the over-invoicing of exports from Shenzhen.

These trade activities intend to seek financial gains on large onshore and offshore interest rate differentials (see Figure 10), leading to large capital inflows, which pose challenges to the PRC's monetary policy while adding appreciation pressures to the RMB exchange rate. The authorities have had to engage in periodic crackdowns and sudden foreign exchange market interventions to slow such activities.

Recent policy developments allowing firms located in the Shanghai Free Trade Zone to experiment with further capital account liberalization by tapping into offshore markets for funding will make the existing capital control measures even

Figure 10. **3-Month SHIBOR, CNH HIBOR, and LIBOR**
(%)



HIBOR = Hong Kong, China Interbank Offered Rate (for offshore renminbi [CNH]), LIBOR = London Interbank Offered Rate (for the US dollar), SHIBOR = Shanghai Interbank Offered Rate (for onshore renminbi [CNY]).
Source: Bloomberg.

less effective. If the current trend of de facto financial market opening continues, the PRC's de jure capital controls will lose effectiveness faster than expected. This will also mean that its capital account could be opened (de facto) much faster than is currently expected by 2020.

V. Monetary Policy Challenges in the People's Republic of China

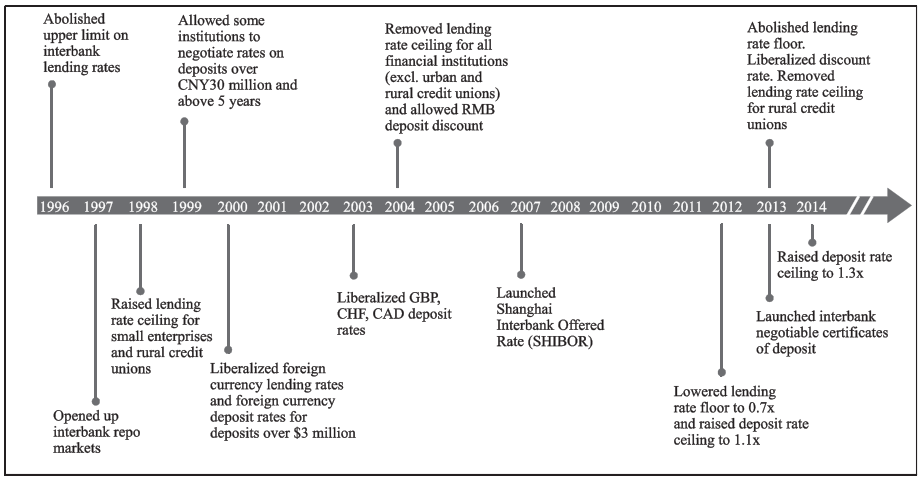
The PRC authority is facing significant challenges in its pursuit of monetary policy. This section discusses the impact of incomplete interest rate reform, the spread of shadow banking, and rising signs of monetary policy ineffectiveness.

A. Interest Rate Reform

The PRC has used financial repression in the form of controlled interest rates and credit allocation with an aim to support investment and economic growth. Interest rate controls and other financial repression measures have also led to the underdevelopment of the financial sector, inefficient allocation of savings, excessive investment, and overcapacity in certain sectors of the economy.

In 1996, the PRC embarked on an interest rate reform by gradually liberalizing interbank lending rates. Since then, various reform measures have been completed, including the abolishment of the upper limit on interbank lending rates in 1996, the

Figure 11. **Timeline of the People's Republic of China's Interest Rate Liberalization**



CAD = Canadian dollar, CHF = Swiss franc, GBP = pound sterling, RMB = renminbi.
Source: People's Bank of China.

liberalization of foreign currency lending rates in 2000, the removal of lending rate ceilings for most financial institutions in 2004, the launch of the Shanghai Interbank Offered Rate (SHIBOR) in 2007, the abolishment of the lending rate floor in 2013, and the launch of interbank negotiable certificates of deposit (NCDs) in 2013, as shown in Figure 11.

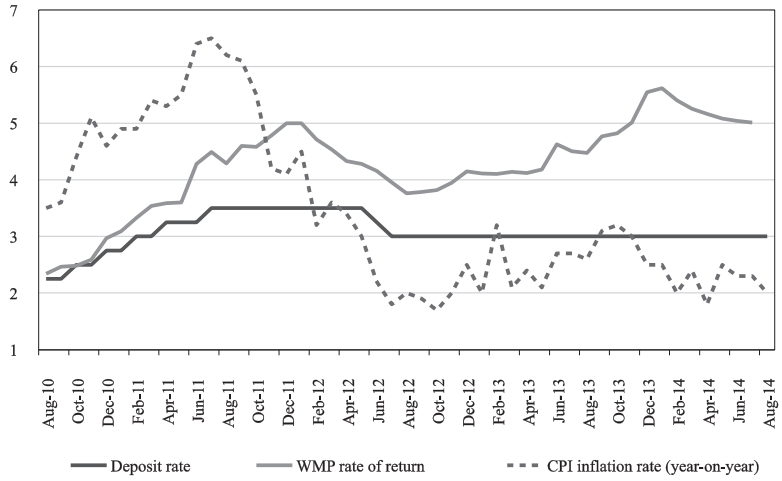
Among the recent policy changes, one of the most significant was the removal of the bank lending rate floor in July 2013, which allowed banks to freely set their own lending rates. While this was a big step in interest rate reform, the actual impact on the real economy has been quite limited. Before the reform, although commercial banks had been allowed to offer a discount of up to 30% of the benchmark lending rate, banks in practice had rarely done so.[7] Only about 11% of loans were offered below the benchmark rate through most of 2013. The average weighted 1-year lending rate actually increased from 6.7% in March to 7.2% by the end of 2013.

After the removal of the lending rate floor, the monetary authority launched a system for a prime loan rate (PLR) in October 2013. This is an indicative interest rate at which commercial banks lend to their prime customers. The PLR is calculated as the weighted average of a panel of banks' lending rates that they charge their best clients. This was also seen as a step toward further interest rate liberalization, as the PLR could replace the current benchmark policy lending rate and be gradually used as a new market-driven benchmark for lending rates.

[7]With the loan rate discount, the minimum loan rate banks could charge on 1-year loans became 4.2% when the 1-year benchmark loan rate was 6%.

Figure 12. **Deposit Interest Rate, Wealth Management Product Rate of Return, and Consumer Price Index Inflation Rate (year-on-year)**

(%)



CPI = consumer price index, WMP = wealth management product.
Sources: CEIC, WIND.

The PRC's deposit rate remains controlled. To add some flexibility to the controlled deposit ceiling rate, the authority has been taking a gradual approach to liberalizing bank deposit rates. Commercial banks were allowed to charge a deposit rate premium, increasing the rate by up to 10% from the benchmark deposit rate in 2012, and up to 30% in November 2014.[8] In addition, commercial banks were allowed to issue interbank NCDs from December 2013, which were priced with reference to the SHIBOR. This reflects the actual supply and demand conditions of the interbank market since interbank NCDs are tradable. This means that large deposits are now priced according to market demand and supply. These policy measures have made deposit rates less binding over time.

In addition, commercial banks have used off-balance-sheet activities to evade the controlled deposit ceiling rate via wealth management products (WMPs). Close to 45,000 WMPs were issued in 2013 amounting to CNY10 trillion, around 10% of the PRC's total deposits. On average, WMPs offer a rate of return of around 5.5%, which is much higher than traditional deposit rates (Figure 12). Financial innovations, such as internet-based financial products, have been competing with the banking system for deposits, thus putting further pressure on banks to offer higher deposit rates and more attractive WMP yields to compete for bank funding.

[8]With the deposit rate premium, the maximum deposit rate banks could offer on 1-year deposits became 3.9% as the 1-year benchmark deposit rate was 3%.

B. Spread of Shadow Banking Activities

Shadow banking refers to credit intermediation involving entities or activities by nonbanks, particularly financial intermediation outside the regulated banking system (IMF 2014). To apply this concept to the PRC, its shadow banking consists of financial institution business (off-balance-sheet assets by banks not subject to regulation), trust products, and underground banking. We estimate that the shadow banking activities in the PRC could be at least CNY30 trillion, equivalent to 52% of GDP in 2013 or 19% of total bank assets in the PRC.

Commercial banks are subject to tight regulations, such as a limit on the deposit rate ceiling, the 75% loan-to-deposit ratio requirement, and the capital adequacy requirement. Given the rising demand for credit, commercial banks in the PRC began to evade such tight regulations through various measures. These include: (i) financial institution business, i.e., channeling large amounts of deposits to other financial institutions (both banks and nonbank financial institutions) which, unlike corporate lending business, is not subject to the 75% loan-to-deposit ratio requirement or the high capital requirement; (ii) trust products, i.e., collecting quasi-deposits (trust funds, WMPs, etc.) from the public to finance off-balance-sheet activities;[9] and (iii) underground banking, i.e., undertaking informal banking in the form of directly intermediating private funds among enterprises and individuals, which is not subject to the normal regulations of the formal banking system.

Internet financial products and money market funds have also developed rapidly to evade formal banking regulations. Yu'e Bao, the biggest internet financial product, is an investment product offered by Alipay, users of which can put their money into the product with no minimum amount requirement and withdraw their cash anytime, akin to an open-end money market fund. Money market funds put more than 90% of their money as financial institution deposits in commercial banks. Financial institution deposit rates are negotiable, and not subject to the banks' reserve requirements.

The shadow banking system has posed regulatory challenges to the PRC's financial stability. First, its rapid development could force the regulated banking sector to expand its off-balance-sheet activities in order to compete with nonbank financial institutions for deposits, internet financial products, etc. Large off-balance activities could make commercial bank deposits more short-term, thus exacerbating maturity mismatches and destabilizing the overall banking system. Second, certain financial institutions are not subject to the same prudential regulations as deposit-taking institutions. As a result, they could increase their financial leverage, magnifying both

[9] With regard to quasi-deposits, in addition to borrowing among themselves, banks normally issue WMPs to finance off-balance-sheet products. Overall, fixed-rate WMPs provide much higher yields than regulated deposits. Typically, commercial banks set up a "capital pool" which consists of bonds, trust products, loan-like claims, and interbank loans. Based on this pool, commercial banks issue short-tenor WMPs to match long-term assets, much like what an asset management company (within a bank) does.

profits during a boom year and losses during a downturn. Third, the formal banking sector has the incentive to provide loans to nonbank financial institutions because such loans are subject to only a quarter of the regulatory capital requirement. This would increase financial links between banks and nonbank financial institutions. Thus, the expansion of shadow banking could pose financial risks to the formal banking sector because of its rising interconnectedness with potentially unstable shadow banking activities.

C. Rising Signs of Policy Ineffectiveness

Since the eruption of the GFC, the PRC's monetary authority has adjusted its monetary policy stance in response to changing prospects of GDP growth and consumer price index (CPI) inflation. Facing the GFC in the final quarter of 2008, the monetary authority quickly loosened policy by lowering the benchmark deposit and loan rates as well as the reserve requirement ratio. Together with its large fiscal stimulus package, monetary policy easing seemed to have had a stabilizing impact. With the recovery of the economy and rising CPI inflation during 2010–2011, the monetary authority shifted its monetary stance from fighting against the crisis to combating inflation by raising the benchmark deposit and loan rates and the reserve requirement ratio. The reserve requirement ratio was raised 12 times, while the interest rate was adjusted 5 times during this period. When the European financial crisis deepened in the second half of 2011 and 2012, the monetary authority gradually eased its policy.

1. From "Cash Crunches" to "Quantity Swings"

From May 2012, the monetary authority seemed to have avoided the use of its traditional policy toolkit, such as adjusting the reserve requirement ratio and the benchmark interest rate to conduct monetary policy. Instead, it began to rely on open market operations intensively via repos and reverse repos to inject and withdraw liquidity from the banking system. As a result, large swings of interest rates and loan quantities were observed during June–July 2013.

In mid-June 2013, a sudden repricing of counter-party risk brought about a surge in the short-term interest rate and thereafter, significant volatility in the money market. The 7-day repo rate, a reliable indicator measuring market liquidity conditions, surged to almost 12% from less than 4% in a day, with the high rate lasting for 2 weeks. The market panic created "cash crunches" in the PRC's interbank markets. The authority finally injected liquidity into the banking system 2 weeks later via the short-term lending facility (SLF), which eased market liquidity conditions in July 2013. The 7-day repos remained quite volatile until January 2014 after the authority engaged in "double interventions," i.e., interventions in both the foreign exchange

and money markets via unsterilized interventions, leading to RMB depreciation and money market rate declines.

Since the June 2013 "cash crunches," the authority appears to have become more proactive in managing money market liquidity conditions. However, the quantity of loans provided has become less stable than before. The PRC's new RMB loans were only CNY385 billion in July 2014, much lower than the market consensus of CNY780 billion. For the same month, the PRC's aggregate financing, including new loans, also surprised the markets on the downside. This was also the lowest level since the September 2008 Lehman collapse.[10]

Such large swings, in terms of money market rates or loan quantities, could create significant shocks to the financial system and raise risk premiums sharply, thereby causing large swings in real GDP growth.

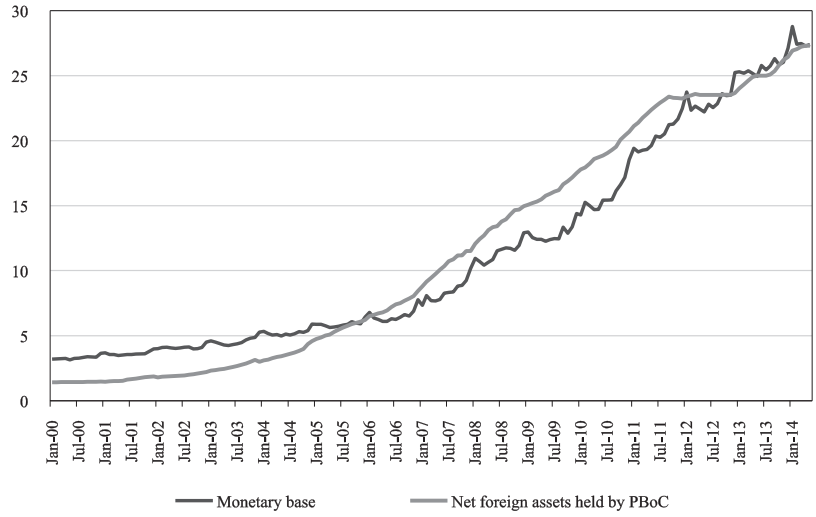
2. Changing Monetary Policy Environments

While the monetary authority has not adjusted its policy stance in a significant way since July 2012, the global financial environment and domestic economic conditions have changed. Domestically, the PRC's growth has moderated from around 9% to 7.5%. As the output gap narrowed sharply, the risk of deflation has risen. The PRC's producer price index (PPI) has experienced persistent deflation since March 2012. Externally, the US Federal Reserve System (Fed) expanded asset purchases quantitative easing (QE), ended QE, and is now heading toward monetary policy normalization; the European Central Bank (ECB) cut interest rates thrice; and the Bank of Japan began an aggressive quantitative and qualitative easing program under the banner of Abenomics.

Some key central banks in Asia and Oceania (the Reserve Bank of Australia, the Bank of Korea, and the Bank of Thailand) have cut their own policy rates in order to reduce interest rate differentials in an attempt to prevent currency overvaluation for competitiveness reasons. The PRC's authority, on the other hand, refrained from using its traditional policy toolkits, such as changes in the benchmark interest rate and the reserve requirement ratio, because of the need to nurture a policy target interest rate. Instead, it has relied on open market operations to manage liquidity conditions. As shown in the previous section, the large interest rate differential between onshore and offshore markets with little exchange rate volatility led to large capital inflows (Figure 7). In 2013 alone, net capital inflows into the PRC were close to $500 billion. For the first 2 quarters of 2014, net capital inflow was more than $200 billion.

[10] Undiscounted bank bills declined by CNY416 billion in July 2014, following a CNY144 billion increase in the previous month, largely owing to the crackdown on commodity financing following the Qingdao port fraud case. Trust and entrusted loan growth also softened, indicating that shadow banking activities have slowed down sharply, with further negative implications for the property sector.

Figure 13. **Monetary Base and Net Foreign Assets Purchased by the People's Bank of China**
(CNY trillion)



CNY = renminbi, PBoC = People's Bank of China.
Source: WIND.

While the PRC has taken irreversible steps to progressively open the capital account, its exchange rate policy has remained rigid, steadily appreciating against the US dollar. This condition has drawn large capital inflows on sizable interest rate differentials and expectations of RMB appreciation, thus potentially limiting monetary policy effectiveness and autonomy.

3. Rising Signs of Asset Price Bubbles

Corporate loans as a percentage of the PRC's aggregate financing have continued to decline and PPI inflation has remained negative for nearly 2 years, suggesting that demand for credit from the real sector has remained weak. Meanwhile, banks' reserve money has risen on large capital inflows that have led to a rapid accumulation of foreign exchange reserves (Figure 13). To meet their profit growth target, commercial banks have created new financial vehicles to expand their balance sheets for financial activities. Such activities have resulted in a surge in money supply without significant financial intermediation in the real sector.

Money has bypassed the real sector and has been channelled to high-return, high-risk sectors such as the property market. In 2013, the PRC's property prices soared again, led by first-tier cities. While the stock market has remained depressed, other asset markets, such as for art collections and physical gold investments, have become buoyant, reflecting a simmering asset price bubble.

VI. Empirical Evidence on Diminishing Monetary Policy Autonomy in the People's Republic of China

The previous section considered the various challenges facing the PRC's monetary policy. Much documented data suggest that monetary policy effectiveness has declined in the PRC and its policy autonomy has eroded with rapid RMB internationalization and a limited, yet increasingly open, capital account. The problem seems to stem from the fact that the PRC's capital controls have become less effective over time, while its exchange rate regime has remained rigid despite recent efforts to make it more flexible. In this section, we examine the PRC's monetary policy effectiveness and autonomy using a set of econometric analyses.

A. Monetary Policy Framework of the People's Republic of China

The objective of the PRC's monetary policy is to maintain price stability so as to promote economic growth under the mandate of the law of the People's Bank of China (PBoC). To achieve these dual policy objectives, the monetary authority may use various policy instruments such as reserve requirement ratios, benchmark interest rates, re-discounting, central bank lending, open market operations, and other administrative or window guidance measures. When pursuing policy mandates, the monetary authority encounters some practical constraints. Given the less developed financial markets, it also has the responsibility to promote financial market liberalization and reforms.

It may be argued that the PRC's authority applies both quantity and price instruments to conduct monetary policy while being constrained by the less efficient financial system. Laurens and Maino (2007) describe the process of setting the monetary policy framework in the PRC in the following way: the monetary authority first sets numerical targets for the quantity of money supply and credit growth as its intermediate quantity targets at the beginning of each year, and then monitors these intermediate targets closely during the course of the year and fine-tunes deviations from these targets by a number of policy instruments such as reserve requirements, open market operations, policy interest rates, and window guidance measures. Liu and Zhang (2010) argued that the use of short-term interest rates alone would be inadequate in the PRC, due to the weak interest-rate transmission channel, partly reflecting the dominance of state-owned commercial banks with a penchant to lend to state-owned enterprises (SOEs). They also demonstrated that neither a standard Taylor rule (Taylor 1993) nor a quantity of money rule in the spirit of McCallum (1988, 2000) would track the PRC's policy rate or M2 growth well. Kwan (2013) estimated the Taylor rule for the PRC during the post-Lehman period and found that the interest rate policy did not play a role in stabilizing the PRC's macro economy. On the other hand, Fan, Yu, and Zhang (2011) found that the McCallum rule was able to explain the movement of real money supply well.

In this section, we attempt to identify the PRC's monetary policy rule and examine whether the rule that used to work well under the rigid capital control system has become loose and increasingly constrained by its own exchange rate regime and/or external monetary developments.[11] If we find that a major monetary policy instrument, such as the policy interest rate and growth of monetary aggregates, was used successfully to achieve domestic policy objectives (price stability and economic growth) without being significantly constrained by foreign monetary policy changes or its own exchange rate regime, then we can conclude that the PRC authority retains monetary policy autonomy. And if the policy instrument is influenced by the foreign interest rate (in the case of the policy interest rate as a policy instrument) or by the pace of foreign exchange reserve accumulation (in the case of the growth of monetary aggregates as a policy instrument) rather than by the consideration of domestic economic stabilization, we can conclude that the PRC authority does not have policy autonomy.

B. Empirical Models for Testing Monetary Policy Autonomy

1. Short-Term Interest Rate as a Policy Instrument

First, following Ito and Kawai (2014), we propose using the following equations to test the PRC's monetary policy autonomy:

$$i_t = \alpha_0 + \beta_0 i_t^* + u_t \tag{4}$$

$$i_t = \phi_0 + \phi_{0y}\tilde{y}_t + \phi_{0\pi}\tilde{\pi}_t + v_t \tag{5}$$

$$i_t = \alpha_1 + \beta_1 i_t^* + \phi_{1y}\tilde{y}_t + \phi_{1\pi}\tilde{\pi}_t + w_t, \tag{6}$$

where i_t is the policy interest rate the PRC authority sets and i_t^* is the US dollar London Interbank Offered Rate (LIBOR).[12] In the Taylor rule of Equation (5), $\tilde{y}_t$ is the growth rate of industrial production and $\tilde{\pi}_t$ is the inflation gap, i.e., the difference between the actual and target inflation rates.[13] Equation (6) is a combination of Equations (4) and (5).

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[11] We do this despite the claim made by the PBoC that the monetary authority has multiple policy targets (such as employment, price stability, balance of payments, and promoting financial reform) and that neither price-based (interest rate) rule nor quantity-based (money supply) rule is suitable to the PRC.

[12] For i_t^*, Ito and Kawai (2014) use the synthetic foreign interest rate from the point of view of a country, which is the weighted average of the foreign interest rates, with the weights being estimated from the Frankel and Wei (1994) model. Given that the RMB exchange rate has assigned a weight of over 94% to the US dollar, we use the US dollar LIBOR as the foreign interest rate.

[13] The Taylor equation typically includes the GDP gap, i.e., the difference between actual GDP and potential GDP as well as the inflation rate gap on the right-hand side of Equation (5). One might argue that the right-hand side of the equation should also include the exchange rate gap, in the case of the PRC, as the country has been stabilizing the exchange rate. We simplify our analysis by ignoring this possibility. As GDP data are available at most on a quarterly basis, its use would limit the number of observations in our sample. Thus, we have decided to use the monthly growth rate of industrial production in estimating Equations (5) and (6) as this would allow us to have a larger number of observations.

Ito and Kawai (2014) then use the overall estimation performance of Equations (4), (5), and (6) to judge the degree of monetary policy autonomy. If the PRC's monetary policy closely follows the monetary policy of the base country, the coefficient β_0 is significantly positive and close to unity, and the goodness of fit of Equation (4) is high. In this case, the PRC has no monetary policy autonomy. If the PRC authority follows the Taylor rule to achieve domestic objectives, then $\phi_{0y} \geq 0$, $\phi_{0\pi} \geq 0$, and the goodness of fit of Equation (5) is high. In this case, the PRC authority has full monetary policy autonomy. When the authority follows both the foreign interest rate and domestic objectives, then $\beta_1 \geq 0$, $\phi_{1y} \geq 0$, $\phi_{1\pi} \geq 0$, and the goodness of fit of Equation (6) is high. In this case, the PRC authority has some, but not full, monetary policy autonomy. We need to pay attention to the signs and statistical significance of the estimated coefficients as well as the size of the adjusted R-squared in judging the degree of monetary policy autonomy.

2. Monetary Aggregates as a Policy Instrument

We next consider the possibility that monetary aggregates, ranging from narrow to broad definitions of the money supply (M0, M1, and M2), are used as policy tools.[14] For this purpose, we consider the following three equations:

$$\Delta M/M_t = \mu_0 + \gamma_0 \Delta FXR/FXR_t + \varepsilon_t \tag{7}$$

$$\Delta M/M_t = \theta_0 + \theta_{0y}\tilde{y}_t + \theta_{0\pi}\tilde{\pi}_t + \nu_t \tag{8}$$

$$\Delta M/M_t = \mu_1 + \gamma_1 \Delta FXR/FXR_t + \theta_{1y}\tilde{y}_t + \theta_{1\pi}\tilde{\pi}_t + \omega_t. \tag{9}$$

Equation (7) states that when an economy's exchange rate regime is rigid and prevents the exchange rate from changing in the face of balance of payments imbalances, the monetary authority will intervene in the currency market to accumulate or reduce foreign exchange reserves. Unless fully sterilized, the effect of a payment imbalance will be to change the economy's monetary aggregates ($\Delta M/M$), so $\gamma_0 \geq 0$. If γ_0 is unity, the monetary authority has no policy autonomy.

In contrast, the monetary authority may follow a rule similar to that of McCallum (1988, 2000) by setting the monetary aggregates to achieve its objectives of price stability and economic growth.[15] The McCallum-like rule, as postulated in

[14]The definitions of M0, M1, and M2 are as follows. M0 is currency in circulation. M1 is the sum of M0 and demand deposits. M2 is the sum of M1, household savings deposits, and corporate time deposits. In addition, M2 began to include securities company customer margin deposits in June 2001, RMB deposits of foreign-funded and joint financial institutions in 2002, and deposits of the Housing Provident Fund Management Center and deposits of non-depository financial institutions in depository financial institutions in October 2011. It is noted that M0 is a narrower concept of money supply than the monetary base.

[15]In his formulation, McCallum (1988, 2000) attempts to explain the rate of change in the monetary aggregate variable in terms of the growth rate of nominal GDP. Our formulation is a variant of his original formulation and, thus, we call it a McCallum-like rule.

Equation (8), sets the quantity of money in reaction to industrial production growth and the inflation rate gap. The equation states that when the actual inflation rate is higher than the target inflation rate, and when industrial output expands, the money supply should decrease to contain the overheating or inflationary pressure in the economy, and vice versa. Thus, we expect $\theta_{0y} \leq 0$ and $\theta_{0\pi} \leq 0$. Equation (9) is a hybrid of Equations (7) and (8).

As in the case of the Taylor rule, we consider the signs of the estimated coefficients and the size of the adjusted R-squared of Equations (7), (8), and (9) to judge the extent of monetary policy autonomy. If the monetary authority is constrained by its choice of fixed exchange rate regime and thus has no policy autonomy, then $\gamma_0 \geq 0$ and the goodness of fit of Equation (7) is high. If the monetary authority follows the McCallum-like rule to achieve domestic objectives and thus has full monetary policy autonomy, then $\theta_{0y} \leq 0$, $\theta_{0\pi} \leq 0$, and the goodness of fit of Equation (8) is high. When the monetary authority is partially constrained by reserve accumulation while partially trying to achieve domestic objectives, then $\gamma_1 \geq 0$, $\theta_{1y} \leq 0$, $\theta_{1\pi} \leq 0$, and the goodness of fit of Equation (9) is high.

In what follows, we first test the PRC's monetary policy autonomy by using Equations (4), (5), and (6) under the assumption that the short-term interest rate is a policy instrument. If we find evidence that the PRC's monetary policy followed the Taylor rule in earlier years, but not as closely in later years, we may conclude that monetary policy autonomy has diminished. Next, we test monetary policy autonomy by examining Equations (7), (8), and (9) under the assumption that monetary aggregates are the policy instruments. Similarly, if we find that the PRC authority followed the McCallum-like rule in the past, but not as closely as before in more recent years, we can conclude that the authority has lost at least partial monetary policy autonomy.

As the specification of Equations (7) and (9) may be subject to simultaneity problems, we use the generalized method of moments (GMM) procedure to obtain consistent estimators for the model parameters. Lagged values of foreign assets purchased by the PBoC and the trade balance are used as instrumental variables when carrying out GMM estimations.

C. Testing Monetary Policy Autonomy with the Interest Rate as a Policy Instrument

We first examine whether the PRC's monetary policy autonomy has eroded under the assumption that its primary policy instrument is the short-term interest rate. This involves the estimation of Equations (4), (5), and (6). We use monthly averages of the 7-day repo rate and 7-day China Interbank Offered Rate (CHIBOR) as the PRC's policy interest rates. See Appendix for data used in the empirical analysis and their sources.

Table 2. **Estimation of the Short-Term Interest Rate of the People's Republic of China Using the Foreign Interest Rate**

	Δi_t (7-day repo rate)			Δi_t (7-day CHIBOR)		
Sample period	Oct 2004–Oct 2014	Oct 2004–Dec 2008	Jan 2009–Oct 2014	Sep 2001–Sep 2014	Sep 2001–Dec 2008	Jan 2009–Sep 2014
Δi_t^*	0.141**	−0.089	0.841***	0.146***	0.013	0.886***
	(0.108)	(0.257)	(0.000)	(0.018)	(0.741)	(0.000)
Constant	0.165	0.175	0.541	0.172**	0.077	0.583***
	(0.168)	(0.204)	(0.004)	(0.068)	(0.278)	(0.003)
No. of observations	121	51	70	157	88	69
F-statistic	2.629	1.315	21.084***	5.731***	0.110	21.863***
	(0.108)	(0.257)	(0.0000)	(0.018)	(0.741)	(0.000)
Adjusted R-squared	0.013	0.006	0.225	0.029	−0.010	0.235

CHIBOR = China Interbank Offered Rate.
Notes: The values in parentheses are p-values. ** = 5% level of statistical significance, *** = 1% level of statistical significance.
Source: Authors' computations.

1. Impact of the Foreign Interest Rate

In Equation (4), i and i^* refer to the short-term rates of 7-day repo or 7-day CHIBOR and the same maturity LIBOR, respectively. In estimation, we take first differences in interest rates (i.e., 1-month changes in rates) in order to avoid the noise or volatility that may cause the problem of nonstationarity, and thus affect both the coefficient estimates and adjusted R-squared.

We conducted unit root tests on Δi_t and Δi_t^*, with both test statistics indicating stationary. We also tested for structural breaks in our sample. Chow's multiple breakpoint test identified several structural breaks in the years 2008, 2011, 2012, and 2013 on unexpected shifts in the time series, for which the F-statistics are larger than the critical values. Dummy variables were added to the first difference version of Equation (4) to take into account that major events may have caused structural breaks and affected the interest rate policy choices.[16] However, the results have not indicated much difference.

The regression results of the first difference version of Equation (4) for the two short-term interest rates (7-day repo and 7-day CHIBOR) are summarized in Table 2. We separate the sample (October 2004–October 2014 in the case of the 7-day repo, and September 2001–September 2014 in the case of the 7-day CHIBOR) into two subperiods— that is, the period before the GFC and the period after—to consider the significant changes in the global financial environment.

The results indicate that in the case of the 7-day repo for the full sample, the US dollar LIBOR rate appears to have a positive and statistically significant

[16]The US Fed's quantitative easing takes the value of 1 during the period November 2008–September 2014 as QE3 ended in October 2014.

influence on the PRC's short-term interest rate. However, the explanatory power measured by the adjusted R-squared is low at 0.013. For the pre-GFC subsample period (October 2004–December 2008), the LIBOR rate does not have much influence on the PRC interest rate, as the coefficient of Δi^* is negative though statistically insignificant. The adjusted R-squared is low at 0.006. For the most recent subsample period (January 2009–October 2014), the PRC's short-term interest rate appears to be significantly influenced by the LIBOR rate. The coefficient is as high as 0.84, suggesting a 1 percentage point change in LIBOR could cause a 0.84 percentage point change in the PRC's interest rate. Meanwhile, the adjusted R-squared is 0.225, much higher than the pre-GFC sample result. This suggests that the PRC's short-term interest rate is highly influenced by LIBOR rates in the most recent period, indicating less autonomous monetary policy in the post-GFC period.

The estimation results for the 7-day SHIBOR are generally similar to those of the 7-day repo rate.

2. Taylor Rule Estimation

Next, we estimate a Taylor rule as specified in Equation (5), which describes the response of the policy interest rate to changes in industrial production and the inflation rate gap. The rule stipulates to raise the interest rate (introduce tighter monetary policy) when industrial production grows or the actual inflation rate is above the target rate, and vice versa. The coefficient estimates of ϕ_{0y} and $\phi_{0\pi}$ are expected to be positive.

First, stationarity and stability tests were conducted. The time series are generally stable but the stability test identified several structural breaks among the variables. Year dummies are included in Equation (5) to control for structural changes in the estimating equation.

The regression results are summarized in Table 3 with the 7-day repo rate and the 7-day CHIBOR used as the policy interest rates. The sample period is again divided into two subsample periods, i.e., before and after the GFC.

Looking at the 7-day repo rate in the pre-GFC period (October 2004–December 2008), the PRC's monetary policy appears to have followed the Taylor rule, with the estimated coefficients of both industrial production growth and the inflation gap being statistically significant and positive. This suggests that the PRC's monetary policy took domestic economic conditions into consideration. The result is consistent with the results reported in Table 2 where the PRC's policy rate was not affected by the US LIBOR rate in the pre-GFC period.

In the post-GFC period, the estimated coefficient of industrial production growth has become statistically insignificant, though the inflation rate remains statistically significant and positive. This means that the PRC's monetary policy has responded to the inflation rate gap but not to real economic activity. It appears that

Table 3. **Estimation of the Taylor Rule**

	Δi_t (7-day repo)			Δi_t (7-day CHIBOR)		
Sample period	Oct 2004–Sep 2014	Oct 2004–Dec 2008	Jan 2009–Sep 2014	Sep 2001–Sep 2014	Sep 2001–Dec 2008	Jan 2009–Sep 2014
$\tilde{y}_t$	0.068***	0.091***	0.036	0.056***	0.044***	0.038
	(0.032)	(0.043)	(0.324)	(0.020)	(0.038)	(0.319)
$\tilde{\pi}_t$	0.409***	0.164***	0.663***	0.385***	0.157***	0.683***
	(0.000)	(0.020)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	0.191**	0.134	0.417***	0.134**	0.050	0.420***
	(0.056)	(0.305)	(0.001)	(0.081)	(0.436)	(0.002)
No. of observations	120	51	69	157	88	69
F-statistic	28.149***	3.652***	46.501***	36.899***	8.098***	44.976***
	(0.000)	(0.033)	(0.000)	(0.000)	(0.001)	(0.000)
Adjusted R-squared	0.313	0.096	0.572	0.315	0.140	0.564

CHIBOR = China Interbank Offered Rate.
Notes: The values in parentheses are p-values. ** = 5% level of statistical significance, *** = 1% level of statistical significance.
Source: Authors' computations.

the PRC's monetary authority followed the Taylor rule in the pre-GFC period, while only partially following the Taylor rule in the post-GFC period.[17]

The results for the CHIBOR are largely the same as those for the 7-day repo rate.

3. Hybrid Taylor Rule Estimation

We then explore the sensitivity of the short-term policy interest rate to the foreign interest rate as well as the domestic economic conditions. The regression results of Equation (6) are summarized in Table 4. In both the pre- and post-GFC period, the PRC's short-term interest rate did not respond to the US interest rate in a statistically significant way. In the pre-GFC period, the PRC's interest rate did respond positively to domestic output growth and the inflation gap, particularly when the 7-day CHIBOR was the policy interest rate. This further supports the view that the PRC's monetary policy was autonomous prior to the GFC.

In contrast, in the post-GFC period, the PRC's short-term interest rate continued to have positive responses to the inflation rate gap, but did not have a significantly positive response to domestic output growth. The results for the CHIBOR clearly indicate that there is less support for the Taylor rule in the post-GFC period than in the pre-GFC period.

[17] Even though the short-term interest rate has significantly positive responses to both output growth and the inflation rate gap in the pre-GFC period, it should be noted that the estimated coefficient on the inflation rate gap is only 0.16. This suggests a weak response of monetary policy. The reason is that when the inflation rate rises by 1%, the short-term interest rate rises by only 0.16%, which is not sufficient to raise the real interest rate and possibly contain inflation.

Table 4. **Estimation of the Hybrid Taylor Rule**

	Δi_t (7-day repo)			Δi_t (7-day CHIBOR)		
Sample period	Dec 2004–Sep 2014	Dec 2004–Dec 2008	Jan 2009–Sep 2014	Sep 2001–Sep 2014	Sep 2001–Dec 2008	Jan 2009–Sep 2014
Δi_t^*	0.170***	−0.094	−0.225	0.123***	0.033	−0.221
	(0.019)	(0.401)	(0.284)	(0.017)	(0.370)	(0.317)
$\tilde{y}_t$	0.062***	0.106***	0.027	0.050***	0.040**	0.030
	(0.047)	(0.030)	(0.465)	(0.037)	(0.061)	(0.45)
$\tilde{\pi}_t$	0.415***	0.118	0.742***	0.378***	0.163***	0.760***
	(0.000)	(0.189)	(0.000)	(0.000)	(0.043)	(0.000)
Constant	0.210***	0.194	0.346***	0.181***	0.059	0.350***
	(0.033)	(0.196)	(0.016)	(0.021)	(0.369)	(0.019)
No. of observations	120	51	69	157	88	69
F-statistic	21.395	2.660	31.468	27.326	5.657	30.332
	(0.000)	(0.059)	(0.0098)	(0.000)	(0.001)	(0.000)
Adjusted R-squared	0.340	0.091	0.573	0.336	0.138	0.564

CHIBOR = China Interbank Offered Rate.
Notes: The values in parentheses are p-values. ** = 5% level of statistical significance, *** = 1% level of statistical significance.
Source: Authors' computations.

The results for the 7-day repo rate are less clear, but do not suggest rising monetary policy autonomy in the post-GFC period. The overall results for Equation (6) again support the view that the PRC's monetary policy was more autonomous in the pre-GFC period than in the post-GFC period.

To summarize, the PRC's short-term interest rate in the pre-GFC period responded positively to both output growth and the inflation rate gap, without being constrained by the foreign interest rate. This suggests that the PRC's monetary policy was relatively autonomous. In contrast, in the post-GFC period, the PRC's interest rate responded positively only to the inflation rate gap. This suggests eroding monetary policy autonomy in the post-GFC period.

D. Testing Policy Autonomy with Monetary Aggregates as a Policy Instrument

We next examine whether the PRC's monetary policy autonomy has been reduced under the assumption that its primary policy instrument is one of the monetary aggregates, such as M0, M1, and M2. This involves the estimation of Equations (7), (8), and (9).

1. Impact of Foreign Exchange Reserve Accumulation

Equation (7) tests whether changes in the monetary aggregate variable are influenced by changes in foreign assets purchased by the monetary authority. The coefficient on the change in foreign assets purchased is expected to be positive

and close to unity if the PRC authority adopts a rigid exchange rate regime and, as a result, gives up monetary policy autonomy. The monetary aggregate variable represents year-on-year growth of M0, M1, or M2.[18] As changes in the monetary aggregate variable can also cause changes in foreign exchange reserves, Equation (7) potentially involves the problem of simultaneity and could result in inconsistent estimates. To address this problem, the GMM procedure has been employed.

The regression results of Equation (7) are summarized in Table 5. The estimated coefficient on $\Delta FXR/FXR_t$ is significantly negative in the pre-GFC period, while that for the post-GFC period is significantly positive regardless of the definition of monetary aggregates. The size of the adjusted R-squared is larger in the post-GFC period than in the pre-GFC crisis. These results suggest that the PRC's monetary policy autonomy was reduced in the post-GFC period.

2. McCallum-like Rule Estimation

We next examine whether the McCallum-like rule explains monetary policy in the PRC. The McCallum-like rule states that the quantity of money set by the authority reacts negatively to changes in industrial production and the inflation rate gap. Equation (8) postulates that when output grows and the inflation rate is higher than the target rate, the money supply should decline, and vice versa.

Regression results are summarized in Table 6. The results indicate that the PRC's monetary policy does not appear to have followed the McCallum-like rule in the case of M0 or M1, but may have followed the rule in the case of M2 in the post-GFC period. First, M0 had a significantly negative response to output growth and a significantly positive response to the inflation rate gap (in contrast to the prediction of the McCallum-like rule) in the pre-GFC period, while it did not respond significantly to domestic economic conditions in the post-GFC period. Second, M1 had a significantly positive response to output growth (in contrast to the prediction of the McCallum-like rule) and a statistically insignificant response to the inflation rate gap during the pre-GFC period, while it did not respond to domestic economic conditions in the post-GFC period.

Finally, in the case of M2, the McCallum-like rule seems to be observed in the post-GFC period but not in the pre-GFC period. That is, M2 responded positively to output growth (in contrast to the prediction) and negatively to the inflation rate gap in the pre-GFC period, while it responded negatively to both output growth and the inflation rate gap (as expected by the McCallum-like rule) in the post-GFC period. Thus, we have mixed results on monetary policy autonomy in the post-GFC period. We observe no evidence of policy autonomy based on M0 or M1, but we observe some evidence of rising policy autonomy based on M2.

[18] We use year-on-year growth to avoid the problem of nonstationarity as monetary aggregate variables and foreign exchange reserves are usually nonstationary.

Table 5. **Estimation of Money Supply of the People's Republic of China Using Foreign Exchange Reserves**

	$\Delta M/M_t$ (M0)			$\Delta M/M_t$ (M1)			$\Delta M/M_t$ (M2)		
Sample period	Oct 2004–Sep 2014	Oct 2004–Sep 2009	Oct 2008–Sep 2014	Oct 2004–Sep 2014	Oct 2004–Nov 2008	Dec 2008–Sep 2014	Oct 2004–Sep 2014	Oct 2004–Sep 2008	Oct 2008–Sep 2014
$\Delta FXR/FXR_t$	0.128**	−0.316**	0.328***	0.238***	−0.443**	0.474**	0.087**	−0.149***	0.196**
	(0.048)	(0.080)	(0.014)	(0.011)	(0.060)	(0.063)	(0.082)	(0.009)	(0.090)
Constant	8.759***	25.426***	7.563***	8.743***	33.680***	8.344***	15.108***	23.227***	14.930***
	(0.000)	(0.001)	(0.000)	(0.000)	(0.001)	(0.010)	(0.000)	(0.000)	(0.000)
No. of observations	120	48	72	120	50	70	120	48	72
J-statistic Prob (J-stats)	14.441	5.479	6.436	0.335	8.402	0.939	8.003	1.195	11.905
	(0.000)	(0.019)	(0.011)	(0.563)	(0.004)	(0.332)	(0.005)	(0.274)	(0.001)
Adjusted R-squared	−0.086	−0.166	0.020	−0.059	−0.769	0.161	−0.095	−0.102	0.099

Notes: Estimation follows the generalized method of moments procedure. The values in parentheses are p-values. ** = 5% level of significance, *** = 1% level of significance.
Source: Authors' computations.

Table 6. **Estimation of the McCallum-like Rule**

	$\Delta M/M_t$ (M0)			$\Delta M/M_t$ (M1)			$\Delta M/M_t$ (M2)		
Sample period	Dec 1997–Sep 2014	Dec 1997–Sep 2008	Oct 2008–Sep 2014	Mar 1997–Sep 2014	Mar 1997–Sep 2008	Oct 2008–Sep 2014	Mar 1997–Sep 2014	Mar 1997–Sep 2008	Oct 2008–Sep 2014
$\tilde{y}_t$	−0.522	−0.920*	−0.265	−0.384	1.369***	−1.039	−0.221	1.570***	−1.080***
	(0.241)	(0.149)	(0.711)	(0.450)	(0.001)	(0.372)	(0.388)	(0.000)	(0.032)
$\tilde{\pi}_t$	0.762***	0.840***	0.737	0.163	0.216	−0.709	−0.754***	−0.813***	−1.056***
	(0.025)	(0.036)	(0.265)	(0.668)	(0.354)	(0.509)	(0.000)	(0.000)	(0.023)
Constant	11.635***	11.562***	11.872***	15.162***	15.663***	13.249***	16.737***	16.378***	16.671***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
No. of observations	202	130	72	211	139	72	211	139	72
F-statistic	2.851**	2.239	1.076	0.300	15.381	3.336	22.015***	31.910	27.887
	(0.06)	(0.111)	(0.346)	(0.741)	(0.000)	(0.041)	(0.000)	(0.000)	(0.000)
Adjusted R-squared	0.018	0.019	0.002	−0.007	0.172	0.062	0.167	0.309	0.431

Notes: The values in parentheses are p-values. ** = 5% level of significance, *** = 1% level of significance.
Source: Authors' computations.

3. Hybrid McCallum-like Rule Estimation

The estimation results of Equation (9) suggest that the PRC's monetary aggregate variable did not respond to domestic economic conditions, but did respond positively and significantly to foreign assets purchased in the post-GFC period (Table 7). First, M0 responded negatively to foreign exchange reserve accumulation and negatively to output growth in the pre-GFC period, while it responded positively to foreign exchange reserves and the inflation rate gap (in contrast to the prediction of the McCallum-like rule) in the post-GFC period. Second, the results for M1 and M2 are similar. That is, M1 and M2 responded negatively to foreign exchange reserves and positively to output growth (in contrast to the prediction of the rule) in the pre-GFC period. They responded positively to foreign exchange reserves and output growth (in contrast to the prediction of the rule), but negatively to the inflation rate gap (as expected by the rule) in the post-GFC period.

Thus, the McCallum-like rule does not explain the M0 and M1 behavior in the pre-GFC or post-GFC period. The McCallum-like rule explains the M2 behavior to some extent in the post-GFC period. However, there is strong evidence that the PRC's monetary policy in the post-GFC period is positively affected by foreign exchange reserves, whether M0, M1, or M2 is used. Thus, there is not much evidence of increasing monetary policy autonomy in the post-GFC period relative to the pre-GFC period, even when M2 is used.

Empirical results presented so far do not clearly show that the PRC's monetary policy fully follows either the Taylor rule or the McCallum-like rule. The estimation results of Equations (5) and (6) summarized in Tables 3 and 4 suggest that the PRC's monetary policy likely followed the Taylor rule in the pre-GFC period, but not in the post-GFC period. The estimation results of Equation (8) as reported in Table 6 suggest the possibility that the PRC's monetary policy, using M2, followed the McCallum-like rule in the post-GFC period, but this is not the case when M0 or M1 is used. PRC's money supply, including M2, also responded positively and significantly to changes in foreign assets purchased during the post-GFC period. In this sense, the PRC's monetary policy autonomy seems to have increasingly eroded over time. Our interpretation of this is that the diminishing monetary policy autonomy has been due to the rising ineffectiveness of the PRC's de jure capital control system—in the face of gradual capital account liberalization and RMB internationalization—and a highly managed exchange rate regime that prevents sufficient exchange rate flexibility.

VII. Policy Implications

The above analysis suggests that the PRC's monetary policy has become less effective and autonomous over time with the progress on capital account

Table 7. **Estimation of the Hybrid McCallum-like Rule**

	$\Delta M/M_t$ (M0)			$\Delta M/M_t$ (M1)			$\Delta M/M_t$ (M2)		
Sample period	Nov 2004–Sep 2014	Nov 2004–Oct 2008	Oct 2008–Sep 2014	Nov 2004–Sep 2014	Jan 2004–Oct 2008	Oct 2008–Sep 2014	Nov 2004–Sep 2014	Jan 2004–Oct 2008	Oct 2008–Sep 2014
$\Delta FXR/FXR_t$	0.108**	−0.855*	0.327***	0.089**	−0.135**	0.666***	0.041**	−0.082***	0.355***
	(0.072)	(0.150)	(0.016)	(0.076)	(0.108)	(0.001)	(0.070)	(0.009)	(0.000)
$\tilde{y}_t$	−0.006	−1.825	0.049	1.649***	1.270***	2.863***	0.459**	0.342**	1.213***
	(0.990)	(0.369)	(0.906)	(0.005)	(0.016)	(0.000)	(0.080)	(0.072)	(0.000)
$\tilde{\pi}_t$	1.152***	0.456	0.794*	−0.468	0.491	−2.88***	−1.168***	−0.066	−2.552***
	(0.017)	(0.625)	(0.113)	(0.466)	(0.163)	(0.001)	(0.000)	(0.604)	(0.000)
Constant	9.383***	48.168**	7.908***	12.459***	20.770***	5.189**	16.185***	20.412***	12.285***
	(0.00)	(0.057)	(0.000)	(0.000)	(0.000)	(0.055)	(0.000)	(0.000)	(0.000)
No. of observations	119	48	72	119	48	72	119	48	72
J-statistic Prob (J-stats)	0.898	0.011	0.161	21.291	12.229	4.598	47.337	10.528	4.207
	(0.343)	(0.915)	(0.688)	(0.000)	(0.007)	(0.204)	(0.000)	(0.016)	(0.240)
Adjusted R-squared	−0.172	−0.256	0.018	−0.080	0.180	−0.231	0.210	0.197	0.259

Notes: Estimation follows the generalized method of moments procedure. The values in parentheses are p-values. * = 10% level of significance, ** = 5% level of significance, *** = 1% level of significance.
Source: Authors' computations.

liberalization and the spread of shadow banking. Therefore, the authorities should review their current monetary policy framework, fix the fundamental root issues, and establish supporting infrastructure to improve the monetary policy transmission mechanism and the financial stability framework. The PRC should also accelerate interest rate liberalization. For example, the authorities could set up a deposit insurance system, introduce a short-term policy interest rate, and develop a deep, liquid bond market to help form stable yield curves.

A. Greater Exchange Rate Flexibility

To cope with the trilemma constraint, the first priority is to address the rigid exchange rate system. That is, the PRC must adopt a more flexible exchange rate regime in order to regain policy autonomy. At this stage, the PRC's capital control regime is unevenly enforced. Capital inflows have had limited controls, while capital outflows are still under severe restrictions. Therefore, large interest rate differentials with small exchange rate volatility have attracted large capital inflows, which have forced the authority to engage in larger currency market interventions and accumulate foreign exchange reserves. A one-way bet on the RMB's continued appreciation has led to even larger capital inflows. For this purpose, the authority may enlarge the RMB–US dollar trading band further so as to facilitate greater exchange rate flexibility.

Furthermore, to offset exchange market pressure due to capital inflows, the PRC authorities must encourage capital outflows. This could be achieved by allowing private firms and residents to invest abroad using both the RMB and foreign currencies, particularly the US dollar. The two-way flow of capital will naturally lead to greater volatility of the RMB exchange rate against major currencies.

B. A Short-Term Policy Interest Rate for the People's Republic of China

As the PRC's lending and deposit rates are becoming increasingly liberalized de facto, the monetary authority must choose a short-term benchmark interest rate as its policy instrument and help create a market-driven yield structure of interest rates. The authority can carry out its monetary policy by adjusting its short-term policy interest rate and employing a new short-term liquidity facility. This policy rate will be used as the basis for banks to set reference rates, which then will be used to price financial derivatives and products.

According to the Bank for International Settlements (BIS 2013), reference rates based on unsecured interbank term lending and borrowing are the dominant types of reference rates used in the world. BIS found that:

(i) More than 50% of all syndicated loans signed in 2011 were linked to either the LIBOR or the Euro Interbank Offered Rate (EURIBOR).

Table 8. **The Shanghai Interbank Offered Rate and Repo Rate**

	SHIBOR	Bond Repurchase Agreement
Tenor	Overnight, 1-week, 2-week, 1-month, 3-month, 6-month, 9-month, and 1-year	1-day, 7-day, 14-day, 21-day, 1-month, 2-month, 3-month, 4-month, 6-month, 9-month, 1-year
Credit Line	Need to set up credit line	No need to set up credit line
Risk	Credit risk	Risk-free, secured transaction
Collateral	Credit-based	Government bonds, PBoC bills, and credit bonds

PBoC = People's Bank of China, SHIBOR = Shanghai Interbank Offered Rate.
Source: People's Bank of China.

(ii) A large portion of bonds in the world—to the tune of at least $10 trillion—were referenced to one of these two rates.

(iii) A significant share of mortgages and other retail loans were linked to them, and the use of these reference rates in derivatives markets was also widespread.

For central banks, the reference rate (such as the overnight rate) also serves as an operational target. Different from the actual policy rate, this operational target is used to guide monetary policy. It is an important component of the monetary policy transmission mechanism because the central bank can influence the financial system through the reference rate and then affect interest rates for loans, money market rates, and interest rate derivatives. Therefore, the PRC's monetary authority should work closely with market participants and review the reference rate setting process.

Before the LIBOR scandal, the SHIBOR was considered a natural candidate for the reference rate for the PRC. As the SHIBOR is an interest rate that participating banks report but do not have to transact using the reported rates, the system could lead to the over fixing or under fixing of the reference rate, especially in a stressed environment. Such problems could lead to a loss of market confidence in the SHIBOR. As a result, the repo rate has become a more viable alternative for the PRC's future reference rate (Table 8).

Looking at major international central banks, the monetary operational target rates used by the US Fed and the Bank of Japan (BOJ) are both overnight rates. The Fed conducts its monetary policy by influencing the federal funds rate (FFR), the rate at which banks lend to each other overnight. After the Federal Open Market Committee (FOMC) sets the FFR target, the Fed then uses tools, such as open market operations, reserve requirements, and the discount window, to change the supply and demand of funds in the market, thus influencing the FFR.

Similarly, the BOJ publishes and controls the uncollateralized overnight call rate, which is the rate charged for overnight loans between banks. The BOJ sets this rate through open market operations to influence banks' current account balances with the BOJ, which in turn affects the overnight call rate.

The ECB meanwhile acts as the calculation agent for the Euro Overnight Index Average (EONIA), which is also an interbank overnight rate. Officially, the EONIA is not a reference rate or operational target for the ECB, but it plays a similar function (BIS 2008).

C. Market Infrastructures

Rapid interest rate liberalization without the necessary market, legal, regulatory, and supervisory infrastructure can lead to failures and crises in the banking system. The conventional interest rate liberalization sequencing, based on these concerns, is to liberalize short-term rates first and then to liberalize long-term interest rates.

In addition to interest rate liberalization, the PRC must deepen and broaden the local-currency bond, foreign exchange, and related derivatives markets to allow firms and investors to diversify the risks; facilitate the use of market-driven prices to price risks; and provide tools for financial institutions and corporations to manage their risk exposures.

Finally, the PRC's monetary authority will also need to make monetary policy forward looking to reflect changes in both domestic and external financial markets and economic conditions. Against this backdrop, the authority should better communicate with the market and adjust the interest rate proactively to anchor market expectations.

VIII. Conclusion

This paper finds that the de facto degree of financial market openness is surprisingly high in the PRC despite the presence of de jure capital controls. Nonetheless, the authority still maintains a tightly managed RMB exchange rate regime and continues to accumulate foreign exchange reserves. As a result, the authority's ability to set autonomous monetary policy has been constrained. This could lead to the accumulation of domestic macroeconomic and financial imbalances, which could eventually lead to financial crises in the future.

To avoid such consequences, the PRC authority faces several options. One is to reverse policies to open financial markets and limit international capital flows. This would allow the authority to achieve both exchange rate stability and monetary policy autonomy, but would require the process of RMB internationalization to slow down. In addition, reversing policy direction could reduce the PRC's growth prospects by sending a negative message to financial markets.

The other more reasonable option would be to increase RMB exchange rate flexibility and thereby restore monetary policy autonomy. Two-way flexibility can be achieved by substantially liberalizing capital outflows, as capital inflows have

already been substantially liberalized and large capital inflows have been pushing up the RMB value. This option presents the risk of excessively large RMB exchange rate volatility, but the authority can contain this through smoothing interventions in the currency market.

However, to continue to pursue financial market opening, the PRC would need to make its financial markets deeper and more liquid and strengthen financial market supervision and regulation. The interest rate needs to be determined in the market through the demand and supply of funds, which would help create stable yield curves and strengthen the transmission mechanism of monetary policy.

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Appendix: Data Description

Variables	Description	Period	Source
Δi_t	7-day Repo	Oct 2003–Oct 2014	CEIC
	7-day CHIBOR	Sep 2000–Oct 2014	
	3-month SHIBOR	Oct 2006–Oct 2014	
Δi_t^*	3-month US dollar LIBOR	Jan 1990–Oct 2014	Bloomberg
$\tilde{y}_t$	Industrial production (real) growth rate	Jan 1995–Oct 2014	CEIC
$\tilde{\pi}_t$	CPI inflation gap	Jan 1990–Oct 2014	CEIC
$\Delta FXR/FXR_t$	Foreign currency assets purchased by PBoC	Dec 1999–Oct 2014	CEIC
$\Delta M/M_t$	M0	Dec 1997–Oct 2014	CEIC
	M1	Mar 1997–Oct 2014	
	M2	Mar 1997–Oct 2014	

CHIBOR = China Interbank Offered Rate, CPI = consumer price index, LIBOR = London Interbank Offered Rate, PBoC = People's Bank of China, SHIBOR = Shanghai Interbank Offered Rate.

How Does Financial Opening Affect Industrial Efficiency? The Case of Foreign Bank Entry in the People's Republic of China

RAN LI AND YIPING HUANG*

This paper analyzes the effects of foreign bank entry on industrial efficiency in the People's Republic of China (PRC) as a case study of financial opening. The study reveals an overall positive impact on the industry. However, the effects vary across ownership groups: negative for state and collective sectors, positive for private enterprises, and insignificant for foreign-invested firms. These findings are incompatible with predictions based on the "cream-skimming effect" and information asymmetry. We investigate two transmission channels of the policy effects—via an easing of financing constraints and through increased competition. Foreign bank entry, like financial liberalization, reverses the effects of repressive financial policy, which protects the state sector but discriminates against private enterprises. While enhancing bank competition can be an effective way to support private sector development, the state sector deserves close attention in order to ensure a smooth transition. This case study should offer some useful lessons for future financial opening.

Keywords: foreign bank entry, financial repression, industrial productivity, People's Republic of China
JEL codes: F36, G21

I. Introduction

In late 2013, authorities of the People's Republic of China (PRC) announced a comprehensive reform program with a strong component of financial reform focusing on reducing entry barriers, liberalizing interest and exchange rates, and achieving capital account convertibility. This could be the PRC's last battles for financial reform, which according to plan should make critical progress by 2020 (Huang, Li, and Wang 2014).

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However, important disagreements remain among scholars and officials about the desired extent, pace, and sequence of reform because of the different assessments of the likely consequences of such reform. Liberalization of the capital account, for instance, could improve the efficiency of financial intermediation as well as increase the volatility of capital flows. Realization of capital account convertibility meanwhile could result in either a more resilient financial system, such as in Chile in the 2000s, or a devastating financial crisis, such as in Indonesia in the 1990s. Understanding the mechanisms by which financial liberalization affects the economy and the financial system is critical for making informed policy decisions.

In this paper, we analyze the effects of foreign bank entry on domestic industrial efficiency as a case study.[1] Many foreign banks entered the PRC during the early years of economic reform, and by the end of the last century, more than 100 foreign banks had established branches or representative offices in the country. At the time, however, they were not allowed to conduct local-currency business with local firms. As part of its commitment to join the World Trade Organization (WTO), the Chinese government agreed to remove that restriction in a number of cities every year during the first 4 years after accession and then in the entire country afterwards. This paced entry of foreign banks provides a unique policy experiment for analyzing the effects of financial opening on the domestic economy. It is worth noting that the term "foreign bank entry" in this study refers to foreign banks being allowed to do local-currency business with domestic firms.

The literature offers various predictions on this subject. Conventional theory suggests that inefficient domestic banks and lack of competition among lenders often result in high borrowing costs and limited financial access in many developing countries. Therefore, introducing foreign banks may enhance bank competition, increase credit supply, and improve economic efficiency. However, banking theory incorporating information asymmetry also demonstrates that greater competition among banks may actually reduce some firms' access to credit (Petersen and Rajan 1995). High information costs may also induce foreign banks to lend only to the most profitable local firms (Dell'Ariccia and Marquez 2004, Sengupta 2007), which may adversely affect both domestic banks and the firms that rely upon them (Detragiache, Tressel, and Gupta 2008).

In a study on foreign bank entry in the PRC, Bonin and Huang (2001) made two predictions based on experiences of some European transitional economies. First, it is unlikely that foreign banks would overwhelm the domestic banking system unless they are allowed to take over major local banks. Rather than worrying about foreign banks destroying the domestic banking system, greater attention should be paid to potential hurdles to foreign banks' business development. Second, because

[1] In another study, Huang and Ji (2014) attempted to draw macroeconomic and financial implications for the PRC by analyzing experiences of financial liberalization in about 60 middle-income economies during the past 4 decades.

of their information disadvantage but more advanced banking products, technology and networks, foreign banks would probably focus on doing business with profitable companies and wealthy households, i.e., the so-called "cream-skimming effect."

Did foreign bank entry, represented by the opening of local-currency business with local firms, help improve industrial efficiency in the PRC? Did it benefit the large and profitable state-owned enterprises (SOEs) disproportionately due to cream skimming? Did it hurt smaller privately owned enterprises (POEs) due to their information disadvantage? What were the possible channels for the above policy effects, if they did exist? This study attempts to address these research questions by using very large datasets of industrial firms over the period 2002–2007 collected by the National Bureau of Statistics (NBS) and by applying difference-in-differences (DID) analysis.

Findings of this study provide some new insights on financial liberalization in the PRC. Foreign bank entry had significant positive effects on industrial efficiency at the aggregate level, which is in line with prior expectations. However, it had significant negative effects on SOEs and collective-owned enterprises (COEs), an insignificant impact on foreign-invested enterprises (FIEs), and a significant positive effect on POEs. The finding that foreign banks benefit POEs but hurt SOEs is actually at variance with our intuitive predictions, as foreign banks deal mostly with large SOEs and FIEs. Further investigation of the channels of policy effects confirm that foreign bank entry eases funding constraints and improves competition. Therefore, it may be regarded as an important step towards financial liberalization, reversing the effects of previous repressive financial policies that favored SOEs and COEs.

This study has important implications for both the literature and policymaking. First, our analysis suggests that in addition to the cream-skimming effect and the impact of information asymmetry problems, foreign bank entry also has an important "financial liberalization effect" as evidenced by the different outcomes for different ownership groups. Second, increasing bank competition could be as important as establishing privately owned financial institutions in improving funding conditions for the private sector, since foreign bank entry asserts the greatest benefit on the private sector. Third, foreign bank entry also causes setbacks among SOEs and COEs which were previously protected by policy, a finding that supports the case for gradual liberalization wherever possible to ensure smooth transition. Finally, given foreign banks' positive contribution to overall efficiency, there is basis for authorities to consider reducing explicit and implicit restrictions imposed on these institutions, which currently account for a tiny share of the PRC's banking assets.

II. Institutional Background

Prior to reform, the PRC had a single financial system. The People's Bank of China (PBC) acted both as a commercial bank and a central bank. At the start of

the economic reform, authorities began to establish various specialized commercial banks. Today, the PRC already has a large financial system dominated by banks (Huang et al. 2013). Therefore, reform of the banking sector is critical for improving overall financial intermediation (Berger, Hasan, and Zhou 2009).

The government started the process of overhauling the banking system after the East Asian financial crisis when non-performing loan (NPL) ratios of domestic banks likely reached 30%–40% (Bonin and Huang 2001). Many of the commercial banks went through the reform process of writing off NPLs, injecting capital, introducing foreign strategic investors, and listing in the capital markets.

Despite all these reforms, the PRC's financial policies remained heavily repressive, with heavily regulated interest rates, state-influenced credit allocation, frequently adjusted reserve requirements, and a tightly controlled capital account (Huang and Wang 2011; Huang, Gou, and Wang 2014). A comprehensive dataset provided by Abiad, Detragiache, and Tressel (2010) suggests that the index of financial liberalization for the PRC was 0.35 in 2001, the year of WTO entry. This number is quite low compared to the average for advanced economies, 0.93, or the average for emerging economies (excluding the PRC), 0.67.

This paper focuses on the narrow phenomenon of financial opening in the PRC following WTO entry. Before 2001, there were already a certain number of foreign bank branches operating in different cities. These branches, however, were only allowed to conduct foreign-currency business with foreign companies and foreign residents. Some foreign banks actually came to the PRC following companies from their home countries that were making direct investments in the country. These banks had very limited business scope. After 1993, the PRC's government gradually lifted geographic restrictions and allowed foreign banks to conduct local-currency business with foreign firms and citizens. Meanwhile, foreign banks were also gradually allowed to conduct foreign currency business with domestic firms (Bonin and Huang 2002).

While finalizing the WTO entry agreement, the Chinese government made a strong commitment to gradually phase out restrictions on foreign banks' local-currency business with local firms, starting with 13 cities (regions) at the end of 2003. The authorities added another five cities to the list at the end of 2004 and seven more cities at the end of 2005. Restrictions on the geographic distribution and clientele of foreign banks' local-currency business were completely lifted by the end of 2006. Beginning 2007, foreign banks were allowed to conduct local-currency business with local firms across the entire country.

III. Literature and Hypotheses

The gradual opening up to foreign banks provides a rare opportunity for researchers to analyze the impact of financial opening, although the overall extent of openness remains quite limited. We raise three research questions:

(i) Did foreign bank entry enhance the overall efficiency of Chinese industry?
(ii) Did the effects on industrial efficiency differ across groups of firms with different ownership types?
(iii) What were the possible channels through which the policy worked?

Analysis of these questions is important for both academic and policy purposes. They not only help achieve better understanding of foreign banks' impact on the Chinese economy but also provide useful lessons with valuable implications for future policy decisions.

The above research questions are related to at least three branches of the economic literature. The first branch examines the spillover effects of foreign direct investment (FDI) (e.g., Hymer 1960, Caves 1974, Dunning 1980 and 1983). Blomström and Kokko (1998) found that in order to overcome the disadvantages that came with operating overseas, such as cultural and language barriers and established local business practices, multinational corporations must possess some firm-specific advantages, including superior production technologies and advanced management skills. They argued that the operation of such multinational corporations can generate productivity spillovers for the local industry through channels such as demonstration, personnel training, and competition.

Some studies applied this spillover argument to the financial sector. For instance, Levine (1996) suggested two possible channels by which FDI can positively affect the domestic banking sector: the first is by directly bringing in new and better skills, management techniques, training procedures, technology, and products to the domestic market; the second is by indirectly stimulating competition in domestic financial markets, which in turn puts pressure on profits and overhead expenses, enhancing domestic banking efficiency. In our study, we will look at the spillover effects of competition in the banking sector when trying to explain changes in industrial efficiency.

The second branch of the literature directly concerns foreign bank entry as a special case of FDI, which can exert influence on domestic firms from both direct and indirect channels. That is, foreign banks may directly provide services to local firms, and they may also indirectly affect firms by changing the domestic banking sector. The latter includes increasing competition in the banking sector and improving local banks' operating efficiency.

Some empirical studies focused on the interest rate spread, cost base, and competition in the banking sector. By analyzing bank-level data from 80 countries, Claessens, Demirgüc-Kunt, and Huizinga (2001) found that foreign bank entry lowered the interest rate spread and management costs of local banks. Several other studies reached very similar conclusions: Unite and Sullivan (2003) for the Philippine case; Clarke et al. (1999) for the Argentine case; and Barajas, Steiner, and Salazar (2000) for the Columbian case. In the meantime, Petersen and Rajan (1995) argued that banking development is critical for alleviating financing constraints.

Shen et al. (2009) pointed out that competition among banks is important for private firms obtaining loans.

Several papers dealt with the direct effect of foreign bank entry on firms. Some confirmed the cream-skimming effect, where foreign banks compete mainly with domestic banks for profitable and wealthy clients. Giannetti and Ongena (2009) found that foreign bank entry was beneficial for capital allocation in Eastern Europe, particularly for younger and larger firms. Sarma and Prashad (2013) provide evidence of the cream-skimming effect in India, arguing that foreign banks actually reduced the possibility of smaller firms from obtaining bank loans.

The third branch of the literature analyzes foreign bank entry in the PRC as a vital component of financial liberalization. Leung and Chan (2006) found that local banks actually improved efficiency in response to foreign bank entry. Berger, Hasan, and Zhou (2009) concluded that foreign capital significantly helped four big state-owned banks improve efficiency. Xu (2011) confirmed the positive effect of the existence of foreign banks on domestic bank competition and efficiency. Mao, Wu, and Liu (2010) estimated the quadratic relationship between credit provided by foreign banks and total credit in the PRC.

A more relevant study to our current research is by Lin (2011) who analyzed the data on listed companies on the Shanghai or Shenzhen stock exchanges during 2001–2005 and found that the more profitable firms and non-SOEs actually benefited more from foreign bank entry in the PRC. Lin's study, however, suffers from some obvious shortcomings. First, private firms listed on stock exchanges are mostly large and profitable and less representative of average POEs. Second, listed POEs are not subject to the usual problem of lack of credit information given the regulatory requirements of the stock exchanges. Third, until recently, the overall share of foreign banks remains very small. This raises questions about foreign banks' overall role in providing so-called non-discriminating loans.

Our study focuses on both aggregate effects and the more specific effects for different ownership groups—SOEs, COEs, FIEs, and POEs. Based on the literature review outlined above, we formulate three tentative hypotheses for empirical tests. One is that foreign bank entry should be beneficial for the Chinese industry as a whole, as it probably intensified competition and increased credit supply. However, since foreign banks' share in the total banking sector did not increase after the PRC's WTO entry, we focus on the competition effect in this study. Another is that foreign bank entry would benefit large and profitable firms, including many of the SOEs and FIEs, by a greater degree due to the cream-skimming effect. Finally, foreign bank entry could further put the smaller firms at a disadvantage, including many in the private sector, given information asymmetry problems. According to Levine (1996), foreign banks are at a disadvantage due to cultural and language barriers (i.e., the "soft information") and tend to choose based on "hard information." SOEs, which are widely considered as being backed up by the Chinese government, are

less risky than private firms from the point of view of foreign banks, which further exacerbates the existing discrimination against POEs.

IV. Data, Empirical Method, and Results

A. Datasets and the Difference-in-Difference Approach

The datasets used in this study were constructed by the NBS and collected through annual surveys of all large-scale industrial firms in the PRC. On average, they cover close to 190,000 enterprises, from 37 two-digit manufacturing industries and 31 provinces every year. Given that the PRC's WTO-accession took place at the end of 2001, we employ post-WTO data for the period 2002–2007.

To obtain clean samples of data, we adopt several strategies to delete outliers and irregular observations.[2] In particular, following Yu (forthcoming) and Feenstra, Li, and Yu (2014), we leave out observations if any of the following are true: liquid assets are greater than total assets, total fixed assets are greater than total assets, the net value of fixed assets is greater than total assets, the firm's identification number is missing, and invalid established time exists (e.g., the opening month is later than December or earlier than January).

The key indicator we analyze in this study is total factor productivity (TFP). In order to avoid possible estimation biases commonly encountered in the Solow residual estimation approach, we adopt the consistent semi-parametric estimation method first developed by Olley and Pakes (1996). Using NBS firm survey data, Lu and Lian (2012) compared different TFP estimates using different approaches—including ordinary least squares and fixed effects regression and methods developed by Olley and Pakes (1996) and Levinsohn and Petrin (2003)—and concluded that the Olley and Pakes approach is relatively better. We also estimate TFP using the Solow residual approach as a robustness check.

The gradual opening up of the PRC to foreign banks is an excellent laboratory to study the impact of foreign bank entry. The exogenous policy plan allows us to construct a counterfactual using the DID approach. As in Lin (2011), firms located in regions where foreign bank credit was unavailable and hence plausibly unaffected by foreign bank entry, comprise the control group. Comparing changes in the productivity of firms with access to foreign bank lending to those of firms without such access provides a causal effect of foreign bank entry.

We formulate the following basic DID fixed effects model:

$$Y_{it} = c + \alpha_i + \mu_t + \beta\ Foreign_{it} + \gamma_0 X_{it} + \varepsilon_{it} \quad (1)$$

[2] Following Cai and Liu (2009), we delete observations with missing information on critical parameters such as total assets, the number of employees, gross value of industrial output, net value of fixed assets, and sales. We also drop firms with fewer than eight workers as they fall under a different legal regime, as mentioned in Brandt, van Biesebroeck, and Zhang (2012).

where $Foreign_{it}$ represents a dummy variable that is equal to 1 when foreign bank loans are available in the region of firm *i* at the beginning of year *t* for local-currency business with domestic enterprises, and 0 otherwise.[3] Y_{it} is the dependent variable, which takes the form of either per capita output, the capital/labor ratio, or TFP (all in logarithms). X_{it} is a vector of control variables that includes the age of the firm and, in log form, total assets, gross domestic product (GDP), and the population of the city where the firm is located. We also control for firm fixed effects μ_t and time fixed effects α_i.

Of these variables, TFP estimates are more subject to criticism, as they often depend on the estimation method applied. In this study, we use the consistent semi-parametric estimator developed by Olley and Pakes (1996). As a robustness check, we also calculate TFP using the Solow residual.

We first estimate Equation (1) with output per worker as the dependent variable, using the full sample as well as subsamples, and by different ownership types as defined by the largest shareholder (Table 1). The Hausman test results suggest that fixed effects estimation is more suitable than random effects estimation.

The coefficient estimate for foreign bank entry is significantly positive for the full sample, confirming that financial opening does improve output per worker or labor productivity (by 2%). However, repeating the same regression for different ownership groups reveals some interesting results: While the impact is positive for POEs (4.52%), it is negative for SOEs and COEs and insignificant for FIEs. The age of the firm has a negative impact on output per worker, while the amount of total assets has a positive impact. These results appear to be consistent with expectations. The control variables at the regional level, local GDP and population, do not have a significant effect.

We then decompose the above dependent variable output per worker into the capital–labor ratio and TFP, and repeat the regression of Equation (1). It turns out that foreign bank entry has no effect on firms' capital–labor ratio, both at the aggregate and at the disaggregated level (Table 2). The effects on TFP, however, have exactly the same signs as those on output per worker (Table 3). Specifically, foreign bank entry increases TFP of POEs by 4.63%, while decreasing TFP of SOEs and COEs by 3.39% and 3.66%, respectively. Comparing the above three sets of regression results shows that foreign bank entry affects output per worker mainly through its influence on productivity.

Clearly, different effects on different ownership groups—i.e., negative on SOEs and COEs, positive on POEs, and insignificant on FIEs—reveal an interesting

[3]There are two main measures of foreign bank entry used in the literature: one is the number of foreign banks and the other is the amount of total assets (or share of assets) of foreign banks (McFadden 1994, Clarke et al. 1999, Unite and Sullivan 2003, Shen et al. 2009). Unfortunately, we were not able to use either of these measures due to unavailable information. Another reason we adopted the second measure is that the first measure includes information about both existence of foreign banks and scale of foreign banks. However, total assets of foreign banks in the PRC are still too small to exert influence through scale, which we call a direct effect. A 0–1 dummy captures the effect of the existence of foreign banks, for example, competition pressure for domestic banks, which we call an indirect effect.

Table 1. **The Basic Model (Output per Worker)**

	Full Sample	SOEs	COEs	POEs	FIEs
Foreign	0.0203*	−0.0358***	−0.0354**	0.0452***	0.000998
	(0.0119)	(0.0131)	(0.0142)	(0.0139)	(0.0234)
Age	−0.00245***	−0.00112	−0.00126*	−0.000836**	−0.000774
	(0.000365)	(0.000677)	(0.000719)	(0.000414)	(0.00129)
Log(Assets)	0.223***	0.227***	0.244***	0.213***	0.289***
	(0.00825)	(0.0142)	(0.0181)	(0.00848)	(0.0169)
Log(GDP)	−0.0535	0.0536	0.00336	−0.00260	−0.0258
	(0.0962)	(0.0556)	(0.0989)	(0.107)	(0.0839)
Log(Population)	−0.0190	−0.155***	−0.0479	−0.0539	0.00344
	(0.0551)	(0.0459)	(0.0558)	(0.0724)	(0.0247)
Constant	3.365***	3.197***	3.514***	3.964***	2.752***
	(0.394)	(0.299)	(0.555)	(0.515)	(0.647)
Observations	1,202,542	68,486	93,810	860,374	179,872
R-squared	0.217	0.219	0.209	0.235	0.140
Number of Firms	318,464	25,450	43,313	252,590	53,536
Clustered at	Region	Region	Region	Region	Region
Year Dummy	Yes	Yes	Yes	Yes	Yes
Industry Dummy	No	No	No	No	No
Firm Specified	Yes	Yes	Yes	Yes	Yes
Hausman Test (p-value)	0.0001	0.0000	0.0002	0.0000	0.0000

COEs = collective-owned enterprises, FIEs = foreign-invested enterprises, GDP = gross domestic product, POEs = privately owned enterprises, SOEs = state-owned enterprises, *** = $p < 0.01$, ** = $p < 0.05$, * = $p < 0.1$.
Notes: The dependent variable is the log of output per worker. Robust standard errors in parentheses. Hausman test (p-value) < 0.05 indicates a fixed effects model is preferred over a random effects model.
Source: Authors' computations.

Table 2. **The Basic Model (Capital–Labor Ratio)**

	Full Sample	SOEs	COEs	POEs	FIEs
Foreign	−0.0119	−0.0117	9.72e-05	−0.00476	−0.000188
	(0.00745)	(0.0105)	(0.0120)	(0.00863)	(0.00888)
Age	−0.00160***	−0.00123*	−0.000526	−0.00126***	−0.00772***
	(0.000294)	(0.000630)	(0.000961)	(0.000295)	(0.00214)
Log(Assets)	0.515***	0.545***	0.497***	0.529***	0.355***
	(0.0124)	(0.0192)	(0.0279)	(0.0120)	(0.0289)
Log(GDP)	−0.0969	0.0320	−0.0188	−0.0404	−0.200***
	(0.0674)	(0.0423)	(0.0662)	(0.0612)	(0.0694)
Log(Population)	0.0668**	0.0308	0.0851	0.0669*	0.0700***
	(0.0263)	(0.0402)	(0.0875)	(0.0360)	(0.0126)
Constant	−1.179***	−1.817***	−1.595**	−1.494***	1.240***
	(0.376)	(0.319)	(0.798)	(0.293)	(0.471)
Observations	1,202,245	68,418	93,784	860,188	179,855
R-squared	0.155	0.127	0.142	0.175	0.058
Number of Firms	318,167	25,382	43,287	252,404	53,519
Clustered at	Region	Region	Region	Region	Region
Year Dummy	Yes	Yes	Yes	Yes	Yes

COEs = collective-owned enterprises, FIEs = foreign-invested enterprises, GDP = gross domestic product, POEs = privately owned enterprises, SOEs = state-owned enterprises, *** = $p < 0.01$, ** = $p < 0.05$, * = $p < 0.1$.
Notes: The dependent variable is the log of the capital–labor ratio. Robust standard errors in parentheses.
Source: Authors' computations.

Table 3. **The Basic Model (Total Factor Productivity)**

	Full Sample	**SOEs**	**COEs**	**POEs**	**FIEs**
Foreign	0.0251**	−0.0339***	−0.0366***	0.0464***	−0.000450
	(0.0116)	(0.0130)	(0.0137)	(0.0132)	(0.0228)
Age	−0.00128***	−0.000398	−0.000855	6.10e-05	0.00312**
	(0.000347)	(0.000681)	(0.000700)	(0.000412)	(0.00140)
Log(Assets)	0.0430***	0.0282*	0.0659***	0.0256**	0.187***
	(0.0115)	(0.0156)	(0.0188)	(0.0114)	(0.0229)
Log(GDP)	−0.0109	0.0391	0.00209	0.0122	0.0517
	(0.0762)	(0.0556)	(0.0834)	(0.0939)	(0.0617)
Log(Population)	−0.0461	−0.177***	−0.0841	−0.0776	−0.0268
	(0.0473)	(0.0501)	(0.0667)	(0.0637)	(0.0211)
Constant	0.956***	0.915***	0.846*	1.077**	−1.288**
	(0.347)	(0.303)	(0.503)	(0.485)	(0.548)
Observations	1,202,245	68,418	93,784	860,188	179,855
R-squared	0.006	0.004	0.007	0.007	0.033
Number of Firms	318,167	25,382	43,287	252,404	53,519
Clustered at	Region	Region	Region	Region	Region
Year Dummy	Yes	Yes	Yes	Yes	Yes

COEs = collective-owned enterprises, FIEs = foreign-invested enterprises, GDP = gross domestic product, POEs = privately owned enterprises, SOEs = state-owned enterprises, *** = $p < 0.01$, ** = $p < 0.05$, * = $p < 0.1$.
Notes: The dependent variable is the log of total factor productivity. Robust standard errors in parentheses.
Source: Authors' computations.

story, with strong policy implications. One way of thinking about these results is that repressive financial policies discriminate against POEs but favor SOEs and COEs. Foreign bank entry may be viewed as a way to reverse the effects of financial repression. Therefore, previously favored firms become worse off as a result of the financial liberalization, while previously discriminated firms become better off.

The specific mechanisms through which such policy effects play out will be investigated later. The insignificant effect on FIEs is a natural consequence since, as we stressed above, foreign entry here refers to the opening up of foreign banks' business with domestic firms, thus affecting FIEs less. Moreover, FIEs are neither too discriminated as POEs nor too favored as SOEs and COEs by financial repression policies.

B. Robustness Checks

Before exploiting detailed channels of policy effects, we take four steps to check the robustness of the result and validate the above findings. First, we repeat regressions of Equation (1) applying an alternative set of TFP estimates and an alternative definition of ownership. Second, we use a two-period estimation method to avoid possible bias caused by correlation in a multi-period DID approach. Third, we perform placebo exercises. Finally, to deal with the concern that there might have been a pre-existing trend in the different areas, we replace the indicator variable

Table 4. **Firm Characteristics and Benefits from Foreign Bank Entry (Total Factor Productivity)**

	Full Sample	SOEs	COEs	POEs	FIEs
Foreign × Large	0.117***	0.0961***	0.0451**	0.129***	0.0992***
	(0.0104)	(0.0214)	(0.0200)	(0.0125)	(0.0132)
Foreign × Old	0.141***	0.0619***	0.0608***	0.152***	0.0756***
	(0.0119)	(0.0199)	(0.0180)	(0.0140)	(0.0135)
Foreign × High-profit	0.0274	−0.0293*	−0.0135	0.0583***	−0.0161
	(0.0180)	(0.0177)	(0.0221)	(0.0207)	(0.0142)
Foreign × High-collateral	0.194***	0.0917***	0.108***	0.204***	0.163***
	(0.0119)	(0.0194)	(0.0183)	(0.0144)	(0.0129)
Year Dummy	Yes	Yes	Yes	Yes	Yes
Industry Dummy	Yes	Yes	Yes	Yes	Yes
Firm Specified	Yes	Yes	Yes	Yes	Yes

COEs = collective-owned enterprises, FIEs = foreign-invested enterprises, POEs = privately owned enterprises, SOEs = state-owned enterprises, *** = $p < 0.01$, ** = $p < 0.05$, * = $p < 0.1$.
Notes: The dependent variable is the log of total factor productivity. Robust standard errors in parentheses.
Source: Authors' computations.

Foreign in Equation (1) with trend indicators (specifically, *Before*3, *Before*2, *Before*1, *Before*0, *After*1, *After*2, and *After*3), which are dummy variables representing the years before or after policy implementation (see Appendix Tables A1–A4).

The robustness checks confirm our findings of the positive effects of foreign bank entry on TFP for the entire sample and for POEs. The effects are not significant for FIEs in all exercises. While the findings for SOEs and COEs vary in some cases, most exercises confirm negative effects of foreign bank entry.

V. Possible Transmission Channels

Before investigating the transmission channels of policy, we carry out a quick exercise to see which features of the firm help increase efficiency benefits from foreign bank entry. To do so, we adopt the following simple model:

$$\log(TFP) = c + \alpha_i + \mu_t + \beta\, Foreign_{it} + \beta_1\, Foreign_{it} \times Z_i + \gamma_0 X_{it} + \varepsilon_{it} \qquad (2)$$

where Z_i is a set of dummy variables reflecting pre-foreign bank entry conditions. We take the averages of the corresponding variables over the period 1998–2001. Z_i is equal to 1 if firm *i*'s variable value is greater than the median value of all firms; otherwise, $Z_i = 0$. We focus on four firm-specific characteristics, including size (large or small), age (old or young), profits (high or low), collateral (high or low).[4]

The results suggest that firms that are larger, older, and with more collateral receive greater benefits from foreign bank entry in terms of efficiency performance,

[4]We define collateral as the ratio between fixed and total assets.

regardless of ownership type (Table 4). The findings on collateral differ from the insignificant result observed by Lin (2011). This may be due to the different samples used. Lin (2011) focused on listed firms, for which collateral was probably a less important screening device.

Results on firm profitability are more interesting. More profitable POEs seem to enjoy greater efficiency improvements, while less profitable SOEs benefit more from foreign bank entry. The latter result probably traced to the fact that profitable SOEs already received sufficient financial services prior to foreign bank entry.

Table 4 provides a preliminary hypothesis of foreign bank entry—succinctly, that foreign bank entry helps improve the efficiency of the domestic banking system. Specifically, bigger and more mature firms and those with higher collateral levels—in other words, those that have hard information—benefit more from foreign bank entry. It seems that foreign bank entry increases transactions-based lending instead of relationship lending.[5] This is consistent with the literature that foreign banks are disadvantaged by language and cultural barriers and thus rely more on efficiency and firms' hard information (Blomström and Kokko 1998).

We now try to provide further empirical evidence to the above hypothesis and offer more detailed explanations for the findings from the basic model by exploiting two possible transmission channels. The first is that foreign bank entry reduces financing constraints, especially of the POEs. The second is that foreign bank entry intensifies competition in the domestic banking sector, which in turn improves POEs' TFP.

A. Easing Financing Constraints

We adapt Equation (1) into the following:[6]

$$\log(TFP)_{ijt} = c + \alpha_i + \mu_t + \beta_0 \, Foreign_{it} + \beta_1 \, Foreign_{it} \times Index_j^{exd} + \beta_2 \, Index_j^{exd} + \gamma_0 X_{it} + \varepsilon_{it} \quad (3)$$

[5]The two terms are defined in Berger and Udell (2002) who state that financial intermediaries lending can be categorized into at least four main distinct lending technologies: financial statement lending, asset-based lending, credit scoring, and relationship lending. According to the authors, the first three lending technologies are often referred to as transactions-based lending, under which the lending decisions are "based on ding, under which."

[6]A large finance and macroeconomics literature interprets greater investment–cash flow sensitivity for firms as evidence that they are indeed financially constrained (e.g., Fazzari, Hubbard, and Petersen 1988). However, the paper by Kaplan and Zingales (1997) questions this interpretation. They pointed out that the underlying assumption behind this approach—the monotonic relationship between financing constraints and investment–cash flow sensitivity—may not be true. Their study was later supported by other economists such as Cleary (1999). Though Kaplan and Zingales (1997, 172) admitted that their results may be "specific to distressed firms that are forced to use cash flow to repay their debt, and may not apply to more 'normal' samples," we doubt that firms in the PRC are qualified enough to be "normal." Another reason why we abandon this approach is that the original dataset does not contain the variable cash flow, which needs to be indirectly calculated from other variables or by proxy. However, as Kaplan and Zingales (1997, 171) pointed out, cash flow itself may already "act as a proxy for investment opportunities not captured by Tobin's Q and do so differentially across firms." The indirect calculation of cash flow might further exacerbate this concern.

Table 5. **Financial Constraints and Foreign Bank Entry (Total Factor Productivity)**

	SOEs	COEs	POEs	FIEs
Foreign × Index	0.107	−0.00472	0.0493**	0.0182
	(0.0668)	(0.0380)	(0.0201)	(0.0232)
Foreign	0.000327	−0.0272*	0.0460***	−0.00534
	(0.0147)	(0.0146)	(0.0131)	(0.0236)
Index	−0.138*	0.0917*	0.0314	−0.0162
	(0.0724)	(0.0470)	(0.0203)	(0.0282)
Age	0.000690	−0.000610	0.000306	0.00223
	(0.000863)	(0.000767)	(0.000415)	(0.00141)
Log(Assets)	−0.101***	−0.0976***	−0.0699***	0.00428
	(0.0156)	(0.0147)	(0.00748)	(0.0138)
Log(GDP)	0.0151	−0.0269	−0.00111	0.0506
	(0.0679)	(0.102)	(0.0948)	(0.0663)
Log(Population)	−0.156**	−0.0771	−0.0640	−0.0314
	(0.0635)	(0.0707)	(0.0612)	(0.0243)
Constant	1.607***	2.086***	1.663***	0.686*
	(0.371)	(0.599)	(0.463)	(0.367)
Observations	41,192	73,705	761,091	164,304
R-squared	0.018	0.012	0.009	0.012
Number of Firms	15,969	33,598	218,458	48,377
Clustered at	Region	Region	Region	Region
Year Dummy	Yes	Yes	Yes	Yes

COEs = collective-owned enterprises, FIEs = foreign-invested enterprises, GDP = gross domestic product, POEs = privately owned enterprises, SOEs = state-owned enterprises, *** = $p < 0.01$, ** = $p < 0.05$, * = $p < 0.1$.
Note: The dependent variable is the log of total factor productivity. Robust standard errors in parentheses.
Source: Authors' computations.

where $Index_j^{exd}$ represents the demand for external funds of industry *j* that firm *i* is part of. Because the actual external financing demand in the PRC is not observable, we follow Rajan and Zingales (1998) in using the dependence of US firms on external financing as a proxy for the demand for external funds in the PRC. There is a detailed discussion on why this is a reasonable approach in Rajan and Zingales (1998), who used this dependency index as a proxy for external financing dependency in developing countries.

In Equation (3), based on our hypothesis above, we expect β_1, the coefficient for the interaction term of $Index_j^{exd}$ and $Foreign_{it}$, to be positive in the regression of private firms. This means that foreign bank entry benefits firms in industries that have high dependency on external financing; in other words, foreign bank entry eases the damage of financing constraints on the efficiency of private firms. This is exactly what the estimation results reveal (Table 5).

B. Increasing Competition in the Banking Sector

To investigate the relationship between the effect of foreign bank entry on banking competition and in turn on firm TFP, we apply a two-step approach to

Table 6. **Foreign Bank Entry, Bank Competition, and Firm TFP (Step 1)**

	Level		Linear Trend	
Foreign	0.857**	0.887**	0.509*	0.508**
	(0.359)	(0.331)	(0.271)	(0.249)
Trend			0.365*	0.399*
			(0.214)	(0.219)
Log(Provincial GDP)		4.515*		4.792**
		(2.37)		(2.168)
Log(Provincial Population)		0.48		−0.269
		(2.923)		(2.921)
Constant	3.253***	−34.23	3.259***	−30.29
	(0.384)	(25.25)	(0.377)	(24.05)
Observations	400	400	400	400
R-squared	0.557	0.584	0.57	0.599
Number of Provinces	31	31	31	31
Year Dummy	Yes	Yes	Yes	Yes

TFP = total factor productivity, GDP = gross domestic product, *** = $p < 0.01$, ** = $p < 0.05$, * = $p < 0.1$.
Note: The dependent variable is the bank competition index (*BankCompt*). Robust standard errors in parentheses.
Source: Authors' computations.

construct the link, following Klein and Olivei (2008) and Acemoglu and Cantoni (2011). First, we use provincial data to regress a bank competition index (*BankCompt*) on foreign bank entry (*Foreign*). Second, we regress TFP on the estimated value of *BankCompt*, which is the calculated change in the bank competition index due to foreign bank entry.

The two-step model consists of the following specifications:

$$BankCompt_{pt} = c + \alpha_p + \mu_t + \gamma_0 Foreign_{pt} + \varepsilon_{pt} \quad \text{(First step)} \qquad (4)$$

$$\log(TFP)_{it} = c + \alpha_i + \mu_t + \beta_0 \widehat{BankCompt}_{pt} + \gamma_0 X_{it} + \varepsilon_{it} \quad \text{(Second step).} \qquad (5)$$

The bank competition index used in this paper is based on Fan, Wang, and Zhu (2003, 2004, 2007, 2010), who compute the NERI Index of Marketization for provinces in the PRC. The index is the share of deposits in non-state-owned financial institutions. Since financial institutions in the PRC are almost all banks, we use this index to reflect the competiveness in the banking sector.

Table 6 summarizes the estimation results for Equation (4). Foreign bank entry actually intensifies banking competition based on the significantly positive coefficient estimates. To check if the conclusion is model-dependent, we also include provincial GDP and provincial population (both in log form) as control variables and add a time trend to the equation. In all these exercises, the main finding remains unchanged.

Empirical results of Equation (5) confirm that increases in bank competition brought about by foreign bank entry positively impact industrial efficiency for POEs but negatively for SOEs. The effects are not significant for COEs and FIEs (Table 7). The result is consistent with literature. The effect of foreign bank entry is often indirect, not affecting accumulation but rather allocative efficiency.

VI. Concluding Remarks

This study finds that foreign bank entry following the WTO accession generally had a positive effect on the efficiency of Chinese industry. At the disaggregated level, however, the impact differed across ownership groups: significantly positive for private enterprises, significantly negative for state and collective industries, and insignificant for foreign companies. While the above overall impact is consistent with predictions based on economic theory, the contrasting effects on state versus private sectors are somewhat surprising.

The general positive effect seems to support the theory in literature that foreign bank entry in emerging markets can improve domestic banking efficiency. However, the negative impact on SOEs is contradictory to the so-called cream-skimming effect and the impact of information asymmetry problems highlighted in the literature, such as Bonin and Huang (2002), and at odds with our hypothesis. Our analysis of transmission channels proves that foreign bank entry does raise competition among banks. POEs, which are recognized as being heavily discriminated against by banks and facing severe financial constraints, are positively affected by foreign bank entry. Our channel analysis suggests that foreign bank entry eased financial constraints faced by POEs, which is in line with predictions that foreign bank entry can improve bank efficiency.

The right framework by which to rationalize the above policy effects is that of financial repression. In an economy with seriously repressive financial policies, which is a reasonable depiction of the current situation in the PRC, the state sector is often strongly favored, while the private sector is discriminated against. Introduction of foreign banks reduces the effect of repressive policies and therefore should reverse previous policy effects. This means hurting state enterprises but benefiting private enterprises, other things being equal.

But how does this work? What are the channels given that foreign banks do not really focus on lending to the private sector? In this study, we identify two potential transmission mechanisms—one through financing constraints and the other through bank competition. The two, however, may be interrelated. Most firms face external financing constraints, particularly in the private sector, which hurts firms' efficiency performance. With foreign bank entry, financing constraints still have a negative impact on efficiency, but the magnitude is significantly reduced. Likewise, foreign bank entry increases competition in the domestic banking

Table 7. **Foreign Bank Entry, Bank Competition, and Firm TFP (Step 2)**

	SOEs	COEs	POEs	FIEs	SOEs	COEs	POEs	FIEs
Estimated *BankCompt*	−0.0561**	−0.0454	0.130***	0.0242	−0.0479*	−0.0391	0.133***	0.0219
	(0.0282)	(0.0319)	(0.0310)	(0.0539)	(0.0280)	(0.0314)	(0.0306)	(0.0521)
Age					−0.000188	−0.000777	0.000164	0.00331**
					(0.000694)	(0.000688)	(0.000393)	(0.00144)
Log(Assets)					0.0313*	0.0605***	0.0236**	0.179***
					(0.0160)	(0.0172)	(0.0111)	(0.0221)
Log(GDP)					0.0585	0.0142	0.0287	0.0446
					(0.0498)	(0.0788)	(0.0916)	(0.0636)
Log(Population)					−0.203***	−0.110	−0.0910	−0.0279
					(0.0477)	(0.0722)	(0.0640)	(0.0219)
Constant	0.962***	1.424***	−0.0849	0.707	1.216***	1.257**	−0.0741	−1.354*
	(0.223)	(0.277)	(0.278)	(0.484)	(0.338)	(0.502)	(0.601)	(0.767)
Observations	65,903	88,422	843,231	170,117	65,903	88,422	843,231	170,117
R-squared	0.003	0.003	0.007	0.010	0.004	0.006	0.008	0.030
Number of Firms	24,364	40,817	247,514	51,315	24,364	40,817	247,514	51,315
Clustered at	Region	Region	Region	Region	Region	Region	Region	Region
Year Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

COEs = collective-owned enterprises, FIEs = foreign-invested enterprises, GDP = gross domestic product, POEs = privately owned enterprises, SOEs = state-owned enterprises, TFP = total factor productivity, *** = $p < 0.01$, ** = $p < 0.05$, * = $p < 0.1$.
Note: The dependent variable is the log of TFP. Robust standard errors in parentheses.
Source: Authors' computations.

sector, which in turn improves industrial efficiency. In practical terms, foreign banks probably still deal mainly with large state and foreign companies. By competing for the same businesses with local banks, especially the large state-owned commercial banks, foreign banks force local banks to extend services to those clients not previously covered. Private enterprises' financing conditions improve as a result.

Our results offer important policy implications. On the one hand, foreign bank entry is generally beneficial for the PRC's economy. This evidence lends some support to the authorities' new initiative to achieve greater financial openness. On the other hand, financial opening, which reverses previous repressive policy, may also cause significant corrections, especially in previously protected sectors. Reform programs should be designed with caution to ensure a smooth transition. While the case of foreign bank entry is useful for thinking about future reform steps to take, it is important to remember that opening up to foreign capital is quite different from opening up to foreign banks. However, the risk–reward framework offers the basis for policy deliberation.

The current study has a number of shortcomings. As the study does not use banking data at the micro level, it fails to reveal any information about changes in bank behavior after foreign bank entry, which could help better explain the mechanism by which foreign bank entry affects industrial efficiency. For instance, did foreign bank entry actually increase or reduce banks' interest rate spread, operating costs, profitability, and credit supply? Meanwhile, as the current policy debate centers around the issue of capital account liberalization, foreign bank entry is probably not the best case study to offer policy advice. Foreign bank entry is akin to direct investment, while capital account liberalization is akin to portfolio investment. These two could be very different in nature but should be the subject of another academic paper.

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*ADB recognizes "China" as the People's Republic of China.

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Appendix

The two most important variables in our analyses are TFP and ownership. In the above analysis, ownership type is defined by the largest shareholder. As a robustness check, we alter the definition of ownership by only recognizing those with more than 50% stake of firms and then repeating the same regressions (Table A.1). TFP estimates are subject to criticism because they are often dependent on the estimation approach applied. In this study, we used the Olley and Pakes method but, as another robustness check, we also calculate TFP estimates using the Solow residual approach (Gary, Rawski, and Zhang 2008) and repeat the same regressions (Table A.2). Both exercises validate findings of the different effects of foreign bank entry on the four groups of firms with different ownership.

According to Bertrand, Duflo, and Mullainathan (2004), using DID that relies on many years of data may ignore the bias in estimated standard errors that serial correlation introduces. To deal with this problem, we adopt the method of Yu and Liang (2014) by only keeping firms that existed in the dataset both before and after foreign bank entry and then taking averages of all variables before and all variables after foreign bank entry. This way, we construct a two-period balanced panel dataset. We re-estimate Equation (1) using this newly constructed dataset. This time, the estimated effects on SOEs and COEs become insignificant, like those on FIEs. However, the effects on the full sample and on POEs remain significantly positive (Table A.3).

Table A.1. **Robustness Check—Alternative Definition of Ownership**

	SOEs	COEs	POEs	FIEs
Foreign	−0.0353***	−0.0366***	0.0466***	2.01e-05
	(0.0130)	(0.0137)	(0.0132)	(0.0229)
Age	−0.000456	−0.000879	6.78e-05	0.00319**
	(0.000687)	(0.000714)	(0.000412)	(0.00140)
Log(Assets)	0.0259*	0.0649***	0.0253**	0.187***
	(0.0157)	(0.0189)	(0.0114)	(0.0229)
Log(GDP)	0.0408	0.00199	0.0124	0.0516
	(0.0559)	(0.0833)	(0.0939)	(0.0614)
Log(Population)	−0.178***	−0.0838	−0.0774	−0.0269
	(0.0506)	(0.0667)	(0.0636)	(0.0211)
Constant	0.933***	0.855*	1.077**	−1.290**
	(0.304)	(0.505)	(0.485)	(0.547)
Observations	67,778	93,288	859,564	179,522
R-squared	0.004	0.007	0.007	0.033
Number of Firms	25,113	43,080	252,275	53,394
Clustered at	Region	Region	Region	Region
Year Dummy	Yes	Yes	Yes	Yes

COEs = collective-owned enterprises, FIEs = foreign-invested enterprises, GDP = gross domestic product, POEs = privately owned enterprises, SOEs = state-owned enterprises, TFP = total factor productivity, *** = $p < 0.01$, ** = $p < 0.05$, * = $p < 0.1$.
Note: The dependent variable is the bank competition index (*BankCompt*). Robust standard errors in parentheses.
Source: Authors' computations.

Table A.2. **Robustness Check—Alternative Estimates of TFP**

	SOEs	COEs	POEs	FIEs
Foreign	−0.0354***	−0.0379***	0.0468***	0.00350
	(0.0127)	(0.0135)	(0.0132)	(0.0219)
Age	−0.000270	−0.000578	0.000165	0.00239*
	(0.000653)	(0.000646)	(0.000404)	(0.00121)
Log(Assets)	0.160***	0.195***	0.165***	0.306***
	(0.0146)	(0.0178)	(0.0107)	(0.0249)
Log(GDP)	0.0367	0.00600	0.00714	0.0286
	(0.0556)	(0.0899)	(0.0950)	(0.0748)
Log(Population)	−0.167***	−0.0657	−0.0661	−0.0166
	(0.0483)	(0.0606)	(0.0643)	(0.0243)
Constant	0.456	0.497	0.785	−1.217*
	(0.300)	(0.499)	(0.483)	(0.651)
Observations	68,418	93,784	860,188	179,855
R-squared	0.112	0.117	0.162	0.129
Number of Firms	25,382	43,287	252,404	53,519
Clustered at	Region	Region	Region	Region
Year Dummy	Yes	Yes	Yes	Yes

COEs = collective-owned enterprises, FIEs = foreign-invested enterprises, GDP = gross domestic product, POEs = privately owned enterprises, SOEs = state-owned enterprises, TFP = total factor productivity, *** = $p < 0.01$, ** = $p < 0.05$, * = $p < 0.1$.
Note: The dependent variable is the bank competition index (*BankCompt*). Robust standard errors in parentheses.
Source: Authors' computations.

Table A.3. **Robustness Check, Two-period DID Approach**

	Full Sample	**SOEs**	**COEs**	**POEs**	**FIEs**
Foreign	0.219***	−0.0225	0.0446	0.315***	−0.0124
	(0.0322)	(0.0341)	(0.0552)	(0.0336)	(0.0382)
Log(Assets_2p)	0.0253*	0.124***	0.0829***	−0.00724	0.193***
	(0.0136)	(0.0228)	(0.0252)	(0.0133)	(0.0287)
Age_2p	−0.000779***	−0.000736*	−0.000874**	−0.000438**	−0.000973***
	(0.000169)	(0.000401)	(0.000348)	(0.000196)	(0.000238)
Log(Population_2p)	0.0946	−0.237**	−0.123	0.238*	0.00321
	(0.103)	(0.0935)	(0.123)	(0.122)	(0.0704)
Log(GDP_2p)	−0.346***	0.133*	−0.0695	−0.515***	−0.174***
	(0.0510)	(0.0708)	(0.0849)	(0.0656)	(0.0532)
Constant	2.291***	−0.286	1.317**	2.841***	0.228
	(0.499)	(0.405)	(0.559)	(0.572)	(0.494)
Observations	354,632	23,538	35,458	247,770	47,866
R-squared	0.025	0.020	0.011	0.047	0.049
Number of Firms	177,316	15,991	27,622	138,781	27,061
Clustered at	Region	Region	Region	Region	Region
Year Dummy	Yes	Yes	Yes	Yes	Yes

COEs = collective-owned enterprises, DID = Difference-in-Difference, FIEs = foreign-invested enterprises, GDP = gross domestic product, POEs = privately owned enterprises, SOEs = state-owned enterprises, TFP = total factor productivity, *** = $p < 0.01$, ** = $p < 0.05$, * = $p < 0.1$.
Note: The dependent variable is the bank competition index (*BankCompt*). Robust standard errors in parentheses.
Source: Authors' computations.

Our analysis exploits time and spatial variations in foreign bank entry. Since the entry process is staged but clustered within just a few years, there are lingering concerns about the extent to which the exact timing of the reform matters for the identified effects. We would also like to rule out the possibility that reform indicators pick up shocks unrelated to foreign bank entry that could be present in some cities. In the placebo exercise, we assign a certain number of foreign bank entries each year to a random selection of cities, with the expectation of the number being equal to the actual value. We repeat this exercise 20 times, finding no absolute t-value and R-squared values of the placebo regression larger than those of the actual regression. This suggests that the special distribution of foreign bank entry indeed drives our results.

There is also concern that although the exogenous gradual policy change can exclude the possibility of reverse causality, there might be a selection bias as there may already be a pre-existing trend in certain areas. Thus, we replaced the indicator variable *Foreign* in Equation (1) with the trend indicators *Before*3, *Before*2, *Before*1, *Before*0, *After*1, *After*2, and *After3,* which are dummy variables representing years before or after the policy implementation. The results reveal our conclusion to be robust—there was no significant difference between control groups and experiment groups prior to foreign bank entry that could have affected our previous results (Table A.4).

Table A.4. **Robustness Check—Pre-existing Trend**

	SOEs	**COEs**	**POEs**	**FIEs**
before3	0.0393	−0.0190	−0.0416	−0.0459
	(0.0259)	(0.0402)	(0.0324)	(0.0372)
before2	0.0205	−0.0618	0.0776*	−0.107
	(0.0358)	(0.0525)	(0.0529)	(0.0983)
before1	−0.00176	−0.127*	0.130	−0.157
	(0.0451)	(0.0703)	(0.298)	(0.1696)
before0	−0.0186	−0.197*	0.225*	−0.238
	(0.0635)	(0.102)	(0.1575)	(0.2941)
after1	−0.0492	−0.312**	0.359**	0.234*
	(0.0778)	(0.137)	(0.1812)	(0.169)
after2	−0.0636	−0.415**	0.497***	0.440
	(0.0949)	(0.169)	(0.1972)	(0.457)
after3	−0.118	−0.547**	0.708***	0.551
	(0.124)	(0.201)	(0.128)	(0.498)
Age	−0.000361	−0.000705	0.000501	0.00335**
	(0.000797)	(0.000610)	(0.000664)	(0.00144)
Log(Asset)	0.0272	0.0553*	0.0235	0.184***
	(0.0235)	(0.0272)	(0.0236)	(0.0189)
Log(GDP)	0.0480	0.0345	0.0941	0.107**
	(0.0659)	(0.0855)	(0.0732)	(0.0448)
Log(Popu)	−0.170***	−0.0990	−0.104**	−0.0354***
	(0.0440)	(0.0744)	(0.0474)	(0.0117)
Constant	0.828**	1.151	1.255**	−1.263***
	(0.390)	(0.698)	(0.610)	(0.301)
Observations	68,418	93,784	860,188	179,855
R-squared	0.005	0.016	0.024	0.036
Number of Firms	25,382	43,287	252,404	53,519
Clustered at	Region	Region	Region	Region
Year Dummy	Yes	Yes	Yes	Yes

COEs = collective-owned enterprises, FIEs = foreign-invested enterprises, GDP = gross domestic product, POEs = privately owned enterprises, SOEs = state-owned enterprises, TFP = total factor productivity, *** = $p < 0.01$, ** = $p < 0.05$, * = $p < 0.1$.

Note: The dependent variable is the bank competition index (*BankCompt*). Robust standard errors in parentheses.

Source: Authors' computations.

Venture Capital Investment and the Post-IPO Performance of Entrepreneurial Firms: Evidence from the People's Republic of China

DI GUO, KUN JIANG, AND XIAOTING MAI*

We examine the effects of venture capital (VC) investment on the performance (measured by return on assets, return on equity, and Tobin's Q) and growth (measured by growth of total sales and total number of employees) of entrepreneurial firms in the People's Republic of China (PRC) after an initial public offering (IPO). Firm-level panel data analysis shows that VC investment contributes to the long-term performance and growth of entrepreneurial firms after an IPO. Meanwhile, we observe a significant and positive relationship between corporate governance of firms and VC investment. However, we do not find that experience or specialization of VC firms influences the effects of venture investment on post-IPO performance or growth of entrepreneurial firms in the PRC.

Keywords: venture capital, post-IPO performance and growth, corporate governance, specialization and experience
JEL codes: G24, G30

I. Introduction

Venture capital (VC) investment has attracted increasing interest from researchers and policymakers since the 1980s. It is widely believed that VC investment is a good way to fill up the funding gaps faced by young R&D-oriented ventures, and consequently, stimulate national innovation and economic growth (Bygrave 1987, Gompers and Lerner 1999). Since the 1980s, many nations in Europe and Asia have begun to initiate public programs to stimulate VC activities.[1] Most countries try to duplicate the "American model" and build up a friendly environment for the VC sector by stimulating both demand and supply sides of the investment (i.e., by providing subsidies and preferential tax policies to both start-up companies and VC

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[1]For example, Yozma in Israel, Beteigungskapital fur Technologieunternehmen (BTU) in Germany, Actions relating to Equity Finance for Innovation (AEFI) in Ireland, and Regional Venture Capital Funds (RVCF) in the UK.

institutions, undertaking regulatory changes in pension funds and insurance funds management, and building up secondary stock markets).[2] Currently, there are over 40 national VC associations around the world.

The People's Republic of China (PRC) numbers among the many countries that have made an effort to develop a vibrant VC industry to stimulate innovation. Starting from the mid-1980s, the government has initiated various programs to promote VC investment including injecting venture funds into government-controlled VC firms (VCFs), encouraging corporate VC arms, and attracting foreign venture funds. Indeed, the country's VC industry has developed dramatically over the past 2 decades.

The PRC has been the second largest VC market in the world since 2001. It has grown from a mere concept in the 1980s to an industry with over 400 domestic and foreign VCFs in 2011, managing over $48.53 billion investible capital. Meanwhile, the annual disbursement of VC investment has increased from $518 million in 2001 to $13 billion in 2011.[3] Moreover, the PRC is now one of the most favored investment destinations of VC funds around the world.[4] More importantly, the impact of the country's VC investment is seen in the global market. From 2000 to 2011, over 600 VC-backed Chinese firms went public. Such firms have become the major driving force in the development of financial and VC markets, supporting the sustainable growth of the PRC and the rest of the world.

Despite the VC industry's rapid growth and growing impact on the global capital market, systematic analysis of the VC market in the PRC remains very limited. Guo and Jiang (2013) examine the role of VC investment in VC-backed firms based on firm-level panel data. However, they mainly focus on the effects of VC investment on the early development stages (i.e., prior to an initial public offering or IPO). Theoretical (Black and Gilson 1998) and empirical (Jeng and Wells 2000) studies suggest that a well-developed capital market is one of the most important factors behind VC investment. However, Chinese stock markets are far less developed, and their regulation has long been criticized (Allen, Qian, and Qian 2005; Wang 2005; Fan, Wong, and Zhang 2007; Kao, Wu, and Yang 2009; Allen et al. 2012; Piotroski and Zhang 2014). A natural question thus arises as to whether and how VC investments play a role in firms listed on such stock markets.

The present study tries to fill the existing gap by exploring the effects of VC investment on the post-IPO performance and growth of VC-backed firms in the PRC. Based on a panel dataset that covers all listed firms in the country's stock markets between 1990 and 2010, our study focuses on the following important questions.

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[2] For example, in the United States (US), the capital gains tax rate was reduced from 49.5% to 28% in 1978. Additionally, the amendment to the "prudent man" rule in 1979 confirmed that pension fund managers are allowed to invest part of the funds in high-risk assets.

[3] *China Venture Capital Annual Report 2011* published by Zero2IPO Research Center.

[4] Information obtained from the *Global Trend in Venture Capital 2012 Survey* conducted by Delloitte & Touche LLP.

First, we ask whether VC affects long-term post-IPO firm performance and growth. Second, we examine whether the experience or specialization of VCFs influences the effects of VC investment on post-IPO performance and growth of firms. Finally, we look at the relationship between VC investment and corporate governance of portfolio companies to further explore the mechanisms by which VC investment affects the long-term performance and growth of VC-backed firms.

We find that VC-backed firms in the PRC demonstrate significantly higher performance and growth than non-VC-backed firms after an IPO. However, different from the findings from the United States (US), we find that neither experience nor specialization of VCFs influences the effects of venture investment on post-IPO performance and growth of VC-backed firms in the PRC. Finally, we find that VC-backed firms have significantly higher probability of allocating ownership to executives than non-VC-backed firms and are able to better align the interests of the executives and the shareholders. Identification concerns are addressed by using instrumental variables.

II. VC Industry in the PRC

A. Institutional Background of VC Investment in the PRC

VC programs were initiated by the central government in the mid-1980s as part of its science and technology reform. The transformation of the centrally planned economy to a market-based system brought tremendous changes to the VC industry. However, the industry was merely a concept within the first 10 years since the reform, with local and central governments serving as major players.

The first breakthrough did not occur until the late 1990s when venture fund sources were enriched. Before 1996, individuals and corporations were prohibited from investing in VC funds. The restriction was removed with the passage of a law promoting the industrialization of technological achievements of the PRC. For the first time, VC investment was recognized as a legal commercial activity and funds were allowed to be raised from diverse sources, including national and local governments, enterprises, organizations, and individuals. Large corporations, universities, and individuals were also allowed to enter the industry for the first time. The number of VCFs increased from 17 in 1994 to 59 in 1998. The amount of annual investment rose to $128 million in 1998 from $27.2 million in 1994.[5] However, the VC market remained small in terms of both fund-raising and investment disbursement.

The second breakthrough came in 2001 when foreign VCFs (FVCFs) finally gained legal recognition in the PRC. Foreign institutional investors have been

[5] *China Venture Capital Annual Report 2002* published by China Venture Capital Research Institute.

struggling for legitimacy in the PRC due to rigorous capital controls and other legal restrictions. In 2001, the Ministry of Foreign Trade and Economic Cooperation, together with the Ministry of Science and Technology and the State Administration for Industry and Commerce, issued provisional regulations on the establishment of foreign-invested VC investment enterprises. By clarifying registration requirements for FVCFs, this set of regulations was the first effort from the government to confirm the legitimacy of FVCFs in the country, although most of the requirements were not really feasible.[6]

FVCFs have been seeking effective vehicles to accommodate their investments in the PRC. Before the mid-1990s, FVCFs mainly worked in joint ventures with domestic investors. However, their performance was far from satisfactory (Zeng 2004). With the benefit of accumulated experience, FVCFs have explored new ways to accommodate their investments in the country. The most popular approach is to invest using an offshore model; that is, FVCFs incorporate overseas and raise funds from international markets. Without registering domestically, they establish representative offices to search, evaluate, and manage their investments in the country. The registration of their portfolio companies meanwhile follows a "round-trip" model, where the holding company is based overseas.[7] Following this pattern, an increasing number of mainstream FVCFs have since entered the PRC and become a dominant player in the country's VC market, which saw record annual investments of $992 million in 2003 and $1.269 billion in 2004. Annual investment by FVCFs was more than 80% of total VC investment in 2003 (Guo and Ding 2010).

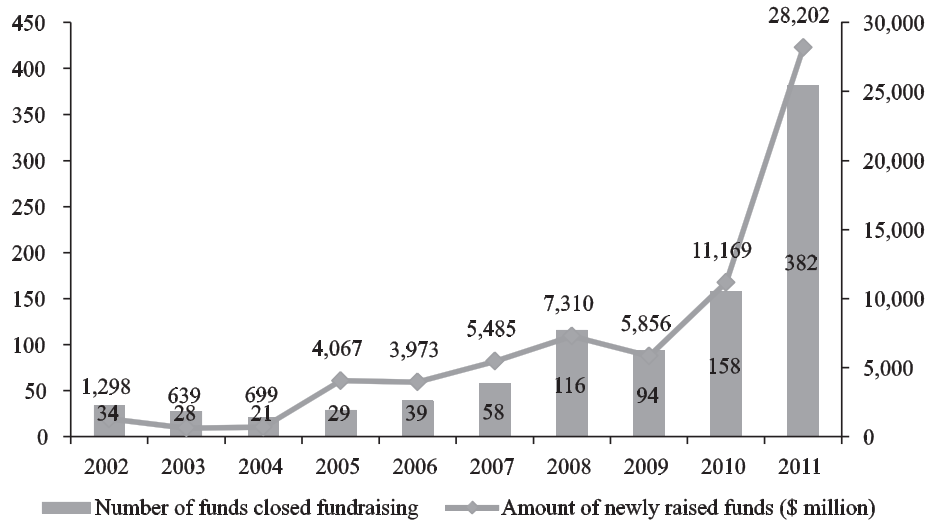
The third wave of development occurred in the second half of the 2000s when the PRC issued a series of laws and policies to relax regulations and saw a rapid growth of domestic VCFs (DVCFs). First, the constitutional rights of the private sector were fully and clearly recognized at the 10th National People's Congress in 2004. In the same year, the Bankruptcy Law came into effect. These legal changes were initiated to provide better protection for external investors.

Meanwhile, in 2008, the central government allowed pension funds to invest in VCFs for the first time. Since then, VC funds have substantially increased. More importantly, after more than 10 years of discussion, ChiNext, a NASDAQ-type exchange for high-growth, high-tech start-ups, launched in October 2009. With

[6] According to the regulations, FVCFs must pass through a strict, time-consuming approval process at various government agencies for registration. In addition, the only legal organizational form for FVCFs in the PRC is the limited company, which is different from the widely-used limited partnership governance structure. Furthermore, the rigid requirements for registered capital (at least $20 million, 15% of which must be paid within 3 months after the issue of the business license, with the remainder paid within 3 years whether or not attractive investments are available) are also constraints for FVCFs. Foreign institutional investors may now legally invest and raise funds in the PRC if they register as qualified foreign investment institutions (QFIIs). However, the threshold of the requirements for registration as QFIIs is too high such that most FVCFs are unqualified.

[7] With this "round-trip" model, when an FVCF decides to invest in a project, it helps the founders to register an overseas holding company. Both the FVCF and the major founders of the company hold the majority shares in the holding company. The holding company then invests back in the original enterprise in the PRC, typically with 100% control.

Figure 1. **Newly-raised Venture Capital Funds in the PRC, 2001–2011**



PRC = People's Republic of China.
Source: China Venture Capital Annual Report 2012 published by Zero2IPO Ltd. Available online: http://zero2ipo.com.cn/f/research/20130509022213368 3M.pdf.

different IPO regulation systems, ChiNext enables VC-backed firms to be listed in the PRC that particularly widens the divesting channels for DVCFs. According to the *China Venture Capital Annual Report*, DVCFs in 2011 outshone their foreign counterparts in terms of capital under management for the first time, representing 50.5% of the yearly total and emerging as the backbone for the country's VC market.

B. VCFs and Investment in the PRC

The PRC, including Hong Kong, China, has been the second largest VC market in the world since 2001, experiencing unparalleled growth in terms of fund-raising in recent years.[8] As shown in Figure 1, the PRC in 2011 saw 382 new VC funds raise $28.2 billion for investment in Chinese companies, or about 25 times the amount raised in 2001. Twenty of these new funds raised $100 million or more in 2011. In comparison, newly raised VC investments amounted to $16.2 billion in the US and US$3 billion in Europe, respectively, during the period.[9] In 2011, Beijing ranked as the fifth hotbed in the world in terms of the amount of newly-raised venture funds, next to Silicon Valley, New England, South California, and New York. According to the statistics of Zero2IPO Research Center, investible VC in the PRC totaled $48.53 billion in 2011.

[8]This ranking was calculated based on data provided by the Asian Venture Capital Journal Database.

[9]All the figures for 2011 are obtained from the *Global Venture Capital Insights and Trends Report 2012* published by Ernst and Young Ltd.

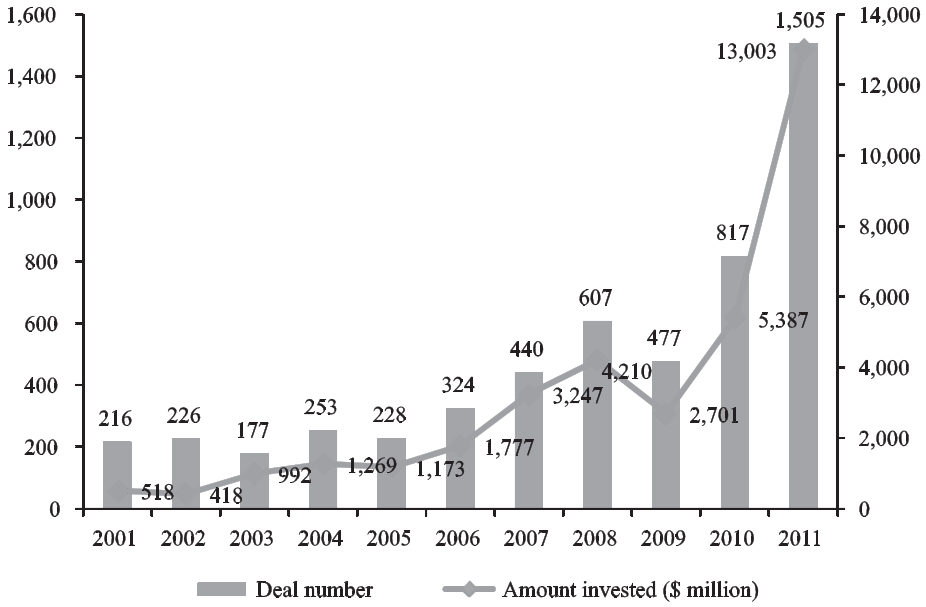
Data provided by the China Venture Capital Research Institute (CVCRI) show that in 2008, out of a total of 402 VCFs, 261 were domestic firms, while 141 were foreign firms. Most of the VCFs have 10 to 20 professional managers on average. The average size of capital under investment per VCF in 2008 was CNY1.32 billion ($190 million). Meanwhile, VCFs, particularly the large ones, were concentrated in a few of the largest cities. By the end of 2008, over 73% of total available VC was being managed by VCFs located in Beijing, Shanghai, and Shenzhen.

DVCFs and FVCFs are different in many aspects because of institutional constraints. DVCFs are mainly established as state-owned subsidiaries or spin-offs of local governments, large corporations, and prestigious universities. In a survey conducted by CVCRI in 2008, government, corporations, and financial institutions accounted for approximately 75.1% of the sources of DVCFs. In comparison, institutional investors, limited partnership funds, and individuals made up approximately 97.3% of the sources of FVCFs. On average, DVCFs are much smaller than FVCFs in terms of capital under management. In 2008, 25.44% of DVCFs managed more than CNY500 million, while the percentage for FVCFs was 66.67%. Most of the prominent VCFs in the world such as Sequoia Capital, Softbank Asia Infrastructure Fund Partners, and Kleiner Perkins Caufield & Byers (KPCB) have entered the PRC. DVCFs and FVCFs are also different in terms of organizational structure. Almost all DVCFs (98%) were structured as limited liability companies before 2007 because limited partnership was not legal in the country as an organizational form until June 2007. In contrast, a majority of FVCFs are structured as limited partnerships.

Figure 2 shows the annual disbursements of VC investment in the PRC from 2001 to 2011. Annual disbursements visibly increased from $518 million in 2001 to $13.003 billion in 2011. Average investment size increased from $2.40 million per deal in 2001 to $8.64 million per deal in 2011. Similar to the fund-raising pattern, the disbursements of VC investment are concentrated in a few major cities and provinces. Although the distribution of VC investment has evened out in recent years and shifted from the eastern to the western side of the country, companies in Beijing and Shanghai still attracted $2.86 billion (22% of the total) and $1.278 billion (9.8% of the total) worth of VC investment in 2011, respectively.

VC investment plays a major role in financing R&D-oriented firms in the PRC. Guo and Ding (2010) report that over 62% of VC investments in the country were in high-tech sectors by the end of 2007. Internet, computer hardware and software, bio-tech and healthcare, and communication industries have attracted the largest VC investment. However, compared to more mature VC markets of the US and Europe, VC investors in the PRC generally prefer later-stage companies. In 2011, less than 10% of VC investments in the country had been in companies at the start-up or product development stages compared to approximately 30% in the US and Europe (Ernst & Young Ltd. 2012).

Figure 2. **Venture Capital Disbursement in the PRC, 2001–2011**



PRC = People's Republic of China.
Source: China Venture Capital Annual Report 2012 published by Zero2IPO Ltd. Available online: http://zero2ipo.com.cn/f/research/20130509022213368 3M.pdf.

Similar to other emerging markets (e.g., India and Brazil), IPOs represent the bulk of exits of VC investment from the PRC, as they do in Japan, the Republic of Korea, and Taipei,China. From 2000 to 2010, over 600 VC-backed firms in the country went public. In 2011, 432 of 1,225 new IPOs in the global exchange markets were Chinese firms, 171 of which were VC-backed companies. These figures suggest that the development of the VC market affects not only the PRC's sustainable growth, but also the world's economic growth. However, systematic analysis on this market remains very limited.

III. VC Investment, IPOs, and Post-IPO Performance of Firms

The impact of VC investment on entrepreneurship and innovation has attracted immense interest from scholars. While studies have provided solid evidence on the positive relationship between VC investment and entrepreneurial firms' productivity and innovation in the US, the development and impact of VC markets outside the US are mixed. For instance, Bottazzi and Da Rin (2002a) find that although the European Commission has made numerous efforts to stimulate the VC

industry, the gap between Europe and the US has widened over the years. Meanwhile, there seems to be no evidence that VC investment stimulates innovation in Europe. Similar observations are made with regard to the VC market in Germany and Japan (Mayer, Schoors, and Yafeh 2005). On the other hand, studies document sustainable growth of VC markets and its positive influences on entrepreneurial firms in Israel (Mayer, Schoors, and Yafeh 2005); Taipei,China (Saxenian and Li 2003); and the PRC (Guo and Jiang 2013).

IPOs of entrepreneurial firms are the favorite type of exit by VCFs because they bring great return and builds the reputation of VCFs. Studies document that VCFs not only play an important role in deciding when and how portfolio companies execute IPOs, but they also continue to be involved afterwards (Megginson and Weiss 1991). In particular, studies find that VCFs tend to hold equity stakes in the firms they previously backed beyond the lock-up period (normally 180 days) (Baker and Gompers 1998). Furthermore, some VC-backed firms are associated with more independent boards and board chairmen who are not CEOs (Baker and Gompers 2003).

Given the active involvement of VCFs in the IPO of portfolio firms, a natural question arises as to whether these efforts influence IPO performance and the long-term performance of the firms after an IPO. However, answers to these questions remain inconclusive. Most US-based studies suggest a positive relationship between VC investment and IPO performance of firms. Supporting the VC certification and monitoring assumptions, Barry et al. (1990), Megginson and Weiss (1991), and Brav and Gompers (1997) find that in the US, VC-backed firms are normally less underpriced at IPOs than non-VC-backed firms. Wang, Wang, and Lu (2003) arrive at similar results for Singapore. However, Gompers (1996) hypothesizes the "grandstanding" of young VCFs, which are more likely to push entrepreneurial firms to prematurely undertake an IPO in order to falsely signal their reputation and performance. At the same time, Francis and Hasan (2001) find that although VC-backed IPOs are managed by more reputable underwriters and are generally associated with lower underwriter compensation, they are more underpriced than non-VC-backed ones. Lee and Wahal (2004) provide further evidence that VC-backed IPOs experience larger first-day returns than comparable non-VC-backed IPOs after controlling for endogeneity issues.

Findings on the effects of VC investment on long-term performance of firms after an IPO are also inconclusive. Jain and Kini (1995), for example, observe that VC-backed companies exhibit superior post-IPO operating performance compared to non-VC-backed IPO companies. Brav and Gompers (1997) note higher long-term returns for VC-backed companies, suggesting that VCFs tend to put effective management structures in place, enabling firms to perform better in the long run. Recent studies further confirm the management structure explanation. For instance, Nahata (2008) finds that the better reputation of the lead VCF, the more likely the VC-backed firm would experience better long-term performance and market

recognition post-IPO. Moreover, Krishnan et al. (2011) provide evidence on positive relationships among the reputation of VCFs, corporate governance of VC-backed firms, and long-term post-IPO performance. Overall, the abovementioned studies indicate that VCFs improve IPO and post-IPO performance of issuing companies in the US.

Studies on the effects of VC investment on post-IPO performance in markets outside the US are scarce, and the results are more complicated. Based on firm-level panel data in Europe, Bottazzi and Da Rin (2002a, 2002b) find that VCFs have a limited effect on a firm's ability to raise equity capital and to grow and create jobs. Hamao, Packer, and Ritter (2000) find that firms in Japan with venture backing from subsidiaries of securities companies perform significantly worse over a 3-year period than other firms after an IPO. Wang, Wang, and Lu (2003) report that the post-IPO operational performance of VC-backed companies in Singapore is inferior to that of non-VC-backed companies, and that such gap widens over time, with operating returns on assets and sales being significantly lower.

The contradictory findings on the effects of VC on the IPO and post-IPO performance of firms remind us of the heterogeneity of the quality and impact of VC investment and associated institutions. Hence, it is necessary to further explore the role of VC investment on the performance of innovative entrepreneurial firms in markets in which economic and institutional systems differ from developed economies. Moreover, it is important to explore ultimately under what circumstances VC investment works more efficiently to help entrepreneurial firms grow faster and improve long-term performance, and what the mechanisms are for the outperformance.

The present study tries to extend existing literature by exploring the effects of VC investment on the post-IPO performance of VC-backed firms in the PRC. The country we have chosen to study is of special interest for several reasons. Most previous studies on VC investment are based on data from developed economies. Whether VC investment also contributes to the performance and growth of entrepreneurial firms in developing countries, such as the PRC, has undergone less scrutiny. Among the very few studies on Chinese VC markets, Guo and Jiang (2013) focus on the effects of VC investment on financial performance of privately held firms, while Wang and Wang (2011) and Humphery-Jenner and Suchard (2013) focus on the effects of foreign VC investment.

How VC investment affects post-IPO performance of firms has not been examined yet, even though VC-backed firms in the PRC have already become a major driving force in the development of financial and VC markets. Both theoretical (Black and Gilson 1998) and empirical (Jeng and Wells 2000) studies in existence suggest that a well-developed capital market is one of the most important factors for VC investment. However, Chinese stock markets are far less developed, and their regulation has long been criticized (Allen, Qian, and Qian 2005; Wang 2005; Fan, Wong, and Zhang 2007; Kao, Wu, and Yang 2009; Allen et al. 2012; Piotroski and Zhang 2014).

IV. Data

A. Sample

Our sample consists of IPOs in the PRC from 1990 to 2010. IPO and post-IPO data are taken from China Stock Market & Accounting Research (CSMAR). CSMAR covers daily market transactions and stores financial and corporate governance data of all listed firms in the country. We delete firms in the financial industry and those listed in both A and B boards.[10]

VCF data of IPO issuers are taken from the VentureXpert database. The dataset includes, among others, the name, location, and industry (in four digits) of each VC-backed firm; the total VC investment gained by the company; the name of the VCFs involved in each deal; data on each VCF, including age, location, and funds under management; and investment preference. Initially, we extract from the VentureXpert database a list of 2,527 VC-backed firms receiving their first VC investment prior to January 2011. The names are in English. We confirm their Chinese names through websites and other online sources, allowing us to obtain the Chinese names of 2,518 firms. We then match the list of Chinese names with CSMAR data to identify the listed VC-backed firms.

Out of the 2,518 VC-backed firms listed on Chinese stock markets by end-2010, we identify 195 of which 137 are listed on the primary boards (i.e., the Shanghai Exchange and the Shenzhen Exchange), and 58 are listed on the secondary board (i.e., ChiNext). Only a small portion of VC-backed firms have a chance to undertake an IPO. In particular, it is hard for entrepreneurial firms to be listed on stock markets in the PRC due to institutional restrictions.

We then build a panel dataset for the period 1990–2012 to calculate post-IPO performance and obtain 621 firm-year observations for the 195 VC-backed firms and 17,689 firm-year observations for the 1,881 non-VC-backed listed firms. Table 1 shows the distribution of VC-backed and non-VC-backed firms by IPO year. Most VC-backed firms initiated an IPO after 2006, while the number of non-VC-backed IPOs dropped after 2006.

[10]The shares of listed companies in the PRC are divided into A and B shares according to target investors. A-shares are officially called renminbi common stock. These shares are issued by Chinese companies for institutions, organizations, and individuals in the PRC (excluding investors from Taipei,China; Hong Kong, China; and Macau, China) and subscribed to and traded in the official domestic currency. B-shares are officially called renminbi special shares. In the early 1990s, the PRC was short on foreign exchange reserves and exercised foreign exchange control. Against this backdrop, the country allowed domestic enterprises to issue B-shares, which are denominated in the official domestic currency, on a trial basis at the end of 1991 in order to absorb international capital. Before 2001, only foreign investors could subscribe to and trade B-shares in US dollars or Hong Kong dollars. After 2001, even individual Chinese investors were allowed to do so. In the PRC, some firms are simultaneously listed on A and B boards.

Table 1. **Distribution of IPOs by Year for the Sampled Firms**

Time of IPO	Non-VC-backed Firms	% of Total	VC-backed Firms	% of Total	Total
1990–1995	277	98.93%	3	1.07%	280
1996–2000	694	98.30%	12	1.70%	706
2001–2005	312	96.59%	11	3.41%	323
2006	57	89.06%	7	10.94%	64
2007	84	73.68%	30	26.32%	114
2008	65	84.42%	12	15.58%	77
2009	63	64.95%	34	35.05%	97
2010	259	75.07%	86	24.93%	345
1990–2010	1,811	90.28%	195	9.72%	2,006

IPO = initial public offering, VC = venture capital.
Source: Authors' computations.

B. Variables

We study the difference between VC-backed and non-VC-backed firms in two aspects, namely post-IPO performance and growth. Post-IPO performance and growth are measured in terms of profitability, market recognition, and firm growth. Profitability is measured by return on assets (*ROA*) and return on equity (*ROE*), while market recognition is captured by Tobin's Q. We focus on two aspects of growth—annual sales growth rate (*G_Sales*) and growth rate in the number of employees (*G_Emp*). The key explanatory variable is whether or not the firm is backed by VC. We assign *VC_Dummy* the value of 1 if the firm is backed by VCFs and 0 otherwise. A significantly positive coefficient implies that VC-backed firms generally enjoy better post-IPO performance and growth.

We are also interested in how the experience and specialization of VCFs affect the post-IPO performance of VC-backed firms. VCFs typically syndicate investment, with the lead VCF intensively involved in governing portfolio companies. Following the literature (Lee and Wahal 2004, Nahata 2008), we define the lead VC investor as the one making the largest total investment across all rounds of funding in an entrepreneurial firm. We measure the experience of VCFs by the age of the lead VCF at the time of investment in the entrepreneurial firm. Each VC fund managed by VCFs normally lasts 7 to 10 years. VCFs need to constantly raise new funds based on their reputation. Hence, the older the firm, the more the VCF can accumulate investment experience (Gompers 1996, Lee and Wahal 2004, Gompers and Lerner 1999). Therefore, age is a good indicator for the experience of a VCF. Dummy variable *VC_Age1* equals 1 if the lead VCF is younger than 10 years old at the time the VC-backed firm launched an IPO and 0 otherwise. Similarly, dummy variable *VC_Age2* equals 1 if the lead VCF is older than 10 years at the time the VC-backed firm launched an IPO and 0 otherwise. The chosen cutoff for the age of VCFs is

based on the average life span of VC funds. Normally, a VCF that is older than 10 years has at least had more than twice the experience in raising VC funds.

In terms of the specialization of VCFs, we focus on their industry preferences. Information on VCF specialization is obtained from VentureXpert. Normally, VCFs disclose whether they are interested in particular industries. We construct two dummy variables, *VC_Ind1* and *VC_Ind2*, to measure the industry specialization of VCFs. *VC_Ind1* is a dummy variable that equals 1 if the lead VCF is a generalist and does not have any specific industry preference and 0 otherwise. *VC_Ind2* is a dummy variable that equals 1 if the lead VCF specializes in a particular industry and 0 otherwise.

Moreover, we look at the relationship between VC investment and corporate governance of VC-backed firms. We focus on two aspects of corporate governance—the interest alignment of shareholders and managers, and institutional ownership. In our study, we measure the alignment of interests in two ways, focusing on the stake holdings of executives and management teams. *Xcuhldn_D* is a dummy variable that equals 1 if the firm allocates equities to executives as incentives and 0 otherwise. Similarly, *Mgnhldn_D* is a dummy variable that equals 1 if the firm allocates equities to the management team as incentives and 0 otherwise. We measure institutional ownership by looking at the ratio of the shares held by the top 10 (*InsnShare10*) institutional shareholders of the firm.

Six control variables are included in the analysis. *Firm Age* is the age of the firm at the time of examination. *Firm size* is measured by the logarithm of total assets of the firm in a given year. We also include the leverage ratio (*LVRG*) in the estimates as this may affect the IPO or post-IPO performance of a firm. *LVRG* is defined as the total liability of a firm divided by total assets in a given year. Furthermore, we control for the ownership of the firm. *SOE* is a dummy variable assigned a value of 1 if more than 50% of the firm is controlled by the state and 0 otherwise. Being heavily involved in governing their portfolio companies, VCFs are concerned with the ownership structure of firms. Major institutional shareholders affect the extent to which VCFs may influence decision making in portfolio companies, consequently affecting IPO and post-IPO firm performance.

We further control for the length of time the firm has been listed. Firm performance and growth may be related to the maturity of the listed firm and the ability to access public capital. As shown in Table 1, the panel data is unbalanced with many VC-backed firms appearing in recent years. To address this concern, we add a control variable, *IPO_Age*, which measures the number of years the firm has been listed in a stock exchange. Finally, to control for cross-market effects, we add a control variable to distinguish whether the firm is listed on main boards of exchange markets or the secondary board. *ChiNext* is a dummy variable that equals 1 if the firm is listed on ChiNext and 0 otherwise.

Table 2 presents the t-test results on the differences between VC-backed and non-VC-backed firms in all variables of interest for the subject period. VC-backed

Table 2. **Summary Statistics**

Panel A. Features of VC-backed and Non-VC-backed Firms

	Non-VC-backed Firms						VC-backed Firms						
Variables	**Observations**	**Mean**	**S.D.**	**Var.**	**Skewness**	**Kurtosis**	**Observations**	**Mean**	**S.D.**	**Var.**	**Skewness**	**Kurtosis**	**t-stat**
ROA	16,622	0.033	0.082	0.007	−2.048	15.919	603	0.073	0.061	0.004	−1.615	14.774	15.816
ROE	16,161	0.063	0.191	0.037	−2.634	40.895	597	0.123	0.091	0.008	−0.29	9.46	14.709
G_Emp	12,878	0.022	0.487	0.237	−0.371	32.507	490	0.162	0.279	0.078	0.889	9.028	10.473
G_Sales	16,601	0.125	0.603	0.364	−0.464	66.959	603	0.226	0.255	0.065	1.675	14.929	8.841
Tobin's Q	16,549	2.665	1.835	3.369	2.9	15.182	604	3.621	2.114	4.47	1.926	8.338	10.966
InsnShare5	10,515	0.54	0.153	0.023	−0.178	2.656	523	0.579	0.129	0.017	−0.297	2.714	6.857
InsnShare10	10,515	0.574	0.151	0.023	−0.295	2.732	526	0.646	0.121	0.015	−0.72	3.591	13.185
Xcuhldn_D	10,512	0.502	0.5	0.25	−0.008	1	526	0.679	0.467	0.218	−0.765	1.586	8.437
Mgnhldn_D	10,514	0.645	0.479	0.229	−0.606	1.368	526	0.766	0.424	0.18	−1.258	2.582	6.357
Total assets	16,858	3827.37	17192.11	2.96E+08	19.80	506.88	608	2955.33	5835.90	3.41E+07	5.48	40.85	3.216
SOE	17,068	0.275	0.446	0.199	1.01	2.019	621	0.137	0.344	0.118	2.113	5.464	9.69
LVRG	16,619	2.411	1.997	3.989	4.955	41.319	603	1.789	0.909	0.826	4.725	56.943	15.518
Firm Age	17,067	8.807	4.893	23.944	0.381	2.658	621	7.454	4.201	17.648	0.732	3.393	7.837

Panel B. Features of VCFs

	Freq.	***Percent***		***Freq.***	***Percent***
VC_Ind1	18	13.43	***VC_Age1***	106	60.23
VC_Ind2	116	86.57	***VC_Age2***	70	39.77
Total	134	100	***Total***	176	100

Panel C. Unit Root Tests for Dependent Variables

	Statistic for Fisher-type Unit Root Test	**p-value**
ROA	9361.8	0.000
ROE	9409.2	0.000
G_Emp	1.59E+04	0.000
G_Sales	1.44E+04	0.000
Tobin's Q	1.26E+04	0.000

VC = venture capital, VCFs = venture capital firms.
Source: Authors' computations.

firms outperform non-VC-backed firms in almost all performance and growth measures. For instance, average ROA and ROE of VC-backed firms are both about twice those of non-VC-backed firms. VC-backed firms have significantly higher average Tobin's Q than non-VC-backed ones. On average, the growth of employees of VC-backed firms is almost eight times that of non-VC-backed ones, while the average growth of total sales of VC-backed firms is approximately twice that of non-VC-backed ones.

The two groups have significantly different levels of corporate governance. On average, the top 10 institutional investors hold 27% of the total shares of VC-backed firms, while the figure for non-VC-backed firms is 21%. More VC-backed firms allocate equity incentives to executives and management teams than non-VC-backed firms. On average, 67.9% and 76.6% of VC-backed firms allocate equity incentives to executives and management teams, respectively; the respective figures for non-VC-backed firms are 50.2% and 64.5%.

The two groups are also significantly different in other aspects. For instance, the average size of non-VC-backed firms as measured by total assets is larger than that of VC-backed ones by 22.3%. Over 27% of non-VC-backed firms are state-owned, while only less than 14% of VC-backed firms are. At the time that they receive venture investment, 46.7% of VC-backed firms have lead VCFs that are older than 10 years. Meanwhile, 56.25% of VCFs specialize in particular industries.

We apply the Wilcoxon test on the median to ensure that our results are not affected by outliers. We use the two-tailed Wilcoxon rank-sum test to determine whether the difference in performance between VC-backed and non-VC-backed firms from the start of VC investment until after 2 years of the investment (Kazmier and Pohl 1984). The results are robust to outliers.

Finally, the dependent variables we are interested in are the performance and growth of firms. Whether firms' performance persists over time is hence of concern. If there is indeed persistence in the series, then the lagged performance measure is likely to be a significant explanatory variable of future performance. This concern is particularly important for short panel unbalanced data such as that used in this paper. To test the persistence of our dependent variables, we perform Fisher-type (Choi 2001) tests in Panel C of Table 2. The results show that all statistics for Fisher-type unit-root tests are statistically significant, suggesting it is safe to reject the null hypothesis that the dependent variables persist over time.

V. Empirical Findings

A. VC Investment and Post-IPO Performance and Growth of Firms

The first research question that we aim to address is whether VC-backed firms exhibit different levels of post-IPO performance and growth compared with

Table 3. **VC Investment and Post-IPO Performance and Growth of Firms**
(Full sample)

	(1) *ROA*	(2) *ROE*	(3) *Tobin's Q*	(4) *G_Emp*	(5) *G_Sales*
VC_Dummy	0.018***	0.028***	0.393***	0.063***	0.059***
	(0.005)	(0.007)	(0.134)	(0.012)	(0.012)
SOE	0.003	0.008**	0.157***	−0.037***	−0.019**
	(0.002)	(0.004)	(0.043)	(0.010)	(0.009)
Firm Age	−0.001**	−0.000	−0.018**	−0.002	−0.004***
	(0.000)	(0.001)	(0.009)	(0.001)	(0.001)
IPO_Age	−0.003***	−0.005***	0.009	−0.009***	−0.007***
	(0.000)	(0.001)	(0.010)	(0.001)	(0.001)
L_Assets	0.013***	0.029***	−0.998***	0.060***	0.067***
	(0.001)	(0.002)	(0.050)	(0.005)	(0.007)
LVRG	−0.005***	−0.015***	−0.057***	−0.007**	0.007
	(0.001)	(0.003)	(0.011)	(0.003)	(0.005)
ChiNext	0.011***	−0.022***	−0.099	0.123***	0.031
	(0.004)	(0.006)	(0.139)	(0.022)	(0.021)
Constant	0.082***	0.154***	7.804***	−0.104	−1.786***
	(0.005)	(0.010)	(0.372)	(0.122)	(0.030)
Industry effect	Y	Y	Y	Y	Y
Year effect	Y	Y	Y	Y	Y
No. of observations	17,222	16,758	16,921	13,307	17,189
Adj. R-square	0.133	0.083	0.385	0.034	0.035
p-value	0.000	0.000	0.000	0.000	0.000

* = p < 0.1, ** = p < 0.05, *** = p < 0.01.
IPO = initial public offering, VC = venture capital.
Note: Standard errors in parentheses.
Source: Authors' computations.

non-VC-backed firms. Table 3 presents the results of panel regressions for performance and growth. *VC_Dummy* is constantly significant and positively associated with all performance and growth measures, which suggests that VC-backed firms exhibit significantly higher financial returns, market recognition, and growth in size than non-VC-backed firms post-IPO. On average, the *ROA* and *ROE* of VC-backed firms are higher than those of non-VC-backed firms (by 0.018 and 0.028, respectively). Correspondingly, the return on assets (ROA) and return on equity (ROE) of non-VC-backed firms are roughly 35.6% and 29.5% of the average values of VC-backed firms.

Meanwhile, Model 3 shows that on average, VC-backed firms enjoy a higher Tobin's Q than non-VC-backed firms (by 0.39). The difference in Tobin's Q is approximately 11% of that for VC-backed firms. Similarly, we find that VC-backed firms exhibit significantly higher growth in employee number and sales, as shown in Models 4 and 5. On average, growth in the number of employees and total sales of VC-backed firms are higher by 0.063 and 0.059, respectively, than those of non-VC-backed firms, and these differences comprise roughly 55.6% of the growth of employees and 34.1% of the growth of total sales of VC-backed firms.

We also find ownership to be correlated with the performance and growth of a firm. Models 2 and 3 in Table 3 show that *SOE* is significantly and positively correlated with *ROE* and Tobin's Q, indicating that state-owned enterprises (SOEs) outperform non-SOEs in terms of financial performance and market recognition. However, *SOE* is significantly and negatively correlated with the growth of employee number and sales, as shown in Models 4 and 5, respectively. This finding suggests that SOEs grew more slowly than non-SOEs.

Meanwhile, firm size is significantly and positively related to financial performance and growth measures. These results suggest that larger firms are more likely to outperform smaller firms in terms of financial returns and growth in scale. However, firm size is significantly and negatively correlated with Tobin's Q, indicating that the value of large firms may generally be discounted by investors. Additionally, *LVRG* is significantly and negatively associated with all aspects of performance and growth in the number of employees.

The relationships between *ChiNext* and the performance measures are also notable. *ChiNext* is significantly and positively correlated with *ROA* and growth in the number of employees, but significantly and negatively associated with *ROE*. The results seem puzzling, with the potential explanation being that most firms listed on ChiNext are normally young and growing firms and may thus have limited access to loans as compared with those listed on the main boards of stock markets, such that these young firms often use equity investment for fund-raising.

Finally, we find that *IPO_Age* is significantly and negatively correlated with most performance and growth measures. This implies that the performance and growth of a firm decrease over time post-IPO.

Overall, we find a significant and positive relationship between VC investment and post-IPO performance and growth of Chinese firms. However, some identification challenges remain. Given that VC investments were made before the IPO of firms, we are not concerned about reverse causality issues. Instead, we focus on the effects of missing variables or biases driven by our empirical strategies.

For one, the panel data used in our basic estimations are unbalanced, with many firms appearing in later years. In particular, we find that *IPO_Age* has significant and negative effects on firm performance and growth. We are therefore concerned about whether the results are driven by unbalanced data. Moreover, most VC-backed firms were listed in recent years, whereas the majority of non-VC-backed firms were listed earlier. A natural question therefore is whether the significant and positive relationship between VC investment and firm performance and growth that we have found can be attributed to the IPO maturity of firms. VC investment and firm performance and growth may be difficult to link for a long post-IPO period.

To address all these concerns, we employ two different approaches. First, we build a balanced sample that restricts the post-IPO performance of firms within the first 3 years after an IPO for both VC-backed and non-VC-backed firms, similar to the strategy used by Krishnan et al. (2011). We present the results in the Appendix.

As shown in Table A.1, when considering only the performance and growth measures of firms within 3 years post-IPO, the effects of VC investment remain robust. These results suggest that the significant relationships between VC investment and firm performance and growth we observe in Table 3 are not driven by IPO maturity.

The second approach we use to address the concerns with the unbalanced data is to conduct a simple cross-sectional analysis of firm performance and growth in the first, second, and third year post-IPO, similar to the approach used by the study of Krishnan et al. (2011). Once again, the significant and positive effects of VC investment remain robust. Owing to space limitations, we do not present the results in this study, but the results can be provided by request.

Aside from IPO maturity, we are also concerned about selection issues and unobservable variables. First, VCFs may invest in better performing companies ex ante. Selected companies are more likely to take advantage of external opportunities than non-VC-backed firms; thus, they grow and perform at an improved pace, particularly after IPO when they have better access to public capital. Meanwhile, several missing variables, which coincidentally coexist with VC investment, may contribute to the superior performance of VC-backed firms post-IPO. Thus, the effects of VC investment in Table 3 may be inflated.

We address the above identification concerns with two approaches. First, we address the selection biases using propensity score matching (PSM) methodology to match VC-backed firms with non-VC-backed firms by industry, time of IPO, and firm age at the time of IPO to reduce potential selection issues. As shown in Table 4, the significant relationship between VC investment and all firm performance and growth measures remains robust.

Second, we address the identification concerns by employing a two-stage estimation procedure to identify the effects of VC investment (Li and Wooldridge 2002). We employ an instrumental variable called *IPO_CN* which refers to the number of IPOs in Chinese stock markets in the city in which the firm is located 1 year before the VC investment is made. This is to predict the probability of a firm being backed by VC investment in the first-stage estimation. *IPO_CN* is a qualified instrumental variable because it is correlated with the demand and supply of VC investment in the city but is independent of the performance of VC-backed firms. The probability of whether a firm will undertake an IPO may predict whether a firm may be selected by VCFs. An IPO is evidently the most successful exit approach for VC investment. Thus, firms with a higher chance to be listed soon appear more attractive to potential VCFs.

Chinese institutions determine the number of IPO cases across regions. The equity share issuance of firms has been heavily governed and influenced by the central government in the PRC. Under a quota system, the government determines the total number of shares to be issued locally and then allocates stock issuance quotas to regions and ministries. Regional governments, in turn, allocate quotas to selected companies that plan to go public through IPOs. Even after 2003, when

Table 4. **VC Investment and Post-IPO Performance and Growth of Firms**
(PSM sample)

	(1) *ROA*	(2) *ROE*	(3) *Tobin's Q*	(4) *G_Emp*	(5) *G_Sales*
VC_Dummy	0.015***	0.027***	0.401***	0.051***	0.049***
	(0.005)	(0.007)	(0.129)	(0.012)	(0.012)
SOE	−0.002	−0.001	0.118*	−0.022	−0.024*
	(0.003)	(0.005)	(0.063)	(0.015)	(0.014)
Firm Age	−0.001**	−0.002*	−0.044***	−0.003	−0.003
	(0.001)	(0.001)	(0.012)	(0.002)	(0.002)
IPO_Age	−0.004***	−0.005***	0.026*	−0.012***	−0.010***
	(0.001)	(0.001)	(0.016)	(0.002)	(0.002)
L_Assets	0.014***	0.034***	−0.860***	0.055***	0.069***
	(0.002)	(0.004)	(0.080)	(0.009)	(0.010)
LVRG	−0.008***	−0.023***	−0.069***	−0.013	0.002
	(0.002)	(0.007)	(0.025)	(0.008)	(0.011)
ChiNext	0.009**	−0.018***	0.022	0.097***	0.021
	(0.004)	(0.007)	(0.153)	(0.023)	(0.021)
Constant	0.017	−0.046*	8.209***	0.187***	−0.262***
	(0.015)	(0.025)	(0.646)	(0.047)	(0.085)
Industry effect	Y	Y	Y	Y	Y
Year effect	Y	Y	Y	Y	Y
No. of observations	6,896	6,791	6,791	5,508	6,882
Adj. R-square	0.195	0.136	0.365	0.048	0.046
p-value	0.000	0.000	0.000	0.000	0.000

* = p < 0.1, ** = p < 0.05, *** = p < 0.01.
IPO = initial public offering, PSM = propensity score matching, VC = venture capital.
Note: Standard errors in parentheses.
Source: Authors' computations.

the quota system was abandoned, IPOs continued to be tightly controlled by the central government (i.e., China Securities Regulatory Commission [CSEC]). Thus, the number of annual IPOs indicated the ease of obtaining IPO approval from the government for the following year (Du and Xu 2009).

A number of VC-backed firms, particularly foreign ones, choose to be listed on foreign stock exchange markets. Nonetheless, even for IPOs abroad, a firm should gain approval from the Ministry of Foreign Trade and Commerce prior to 2005 and register with them after 2005. Stated differently, firms still need to undergo complicated approval procedures for IPO listing in overseas stock markets. IPO cases in the previous year have a significant implication on IPO cases for the subsequent year. Hence, we suggest that VCFs prefer investing in companies located in areas with higher quotas or that have better chances to list more firms in stock markets. The number of IPOs is not directly correlated with the performance of individual firms. Thus, we suggest that *IPO_CN* could serve as a good instrumental variable.

Table 5 presents the two-stage estimations. Panel A shows first-stage estimations where we regress *VC_Dummy* on the set of independent variables, including

Table 5. **Two-stage Estimations for VC Investment Effects**

Panel A. First-stage Estimations of the Two-stage Regressions

	(1) *VC_Dummy*	(2) *VC_Dummy*	(3) *VC_Dummy*	(4) *VC_Dummy*	(5) *VC_Dummy*
IPO_CN	0.029***	0.030***	0.029***	0.031***	0.029***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Constant	−1.436***	−1.388***	−1.378***	−1.339***	−1.427***
	(0.204)	(0.210)	(0.206)	(0.224)	(0.205)
Pseudo R-square	0.205	0.209	0.204	0.203	0.205

Panel B. Second-stage Estimations of the Two-stage Regressions

	(1) *ROA*	(2) *ROE*	(3) *Tobin's Q*	(4) *G_Emp*	(5) *G_Sales*
VC_Dummy	0.130***	0.072	5.744***	0.272**	−0.180
	(0.023)	(0.060)	(0.717)	(0.129)	(0.150)
SOE	0.004***	0.007*	0.266***	−0.030**	−0.025**
	(0.002)	(0.004)	(0.033)	(0.013)	(0.011)
Firm Age	−0.001*	0.000	0.012*	−0.001	−0.005**
	(0.000)	(0.001)	(0.006)	(0.002)	(0.002)
IPO_Age	−0.002***	−0.005***	0.052***	−0.008***	−0.010***
	(0.000)	(0.001)	(0.008)	(0.002)	(0.002)
L_Assets	0.014***	0.031***	−0.832***	0.065***	0.075***
	(0.001)	(0.002)	(0.022)	(0.006)	(0.008)
LVRG	−0.005***	−0.013***	−0.051***	−0.006*	0.007
	(0.001)	(0.004)	(0.009)	(0.003)	(0.006)
ChiNext	−0.013	−0.032***	−0.939***	0.079**	0.086**
	(0.008)	(0.011)	(0.309)	(0.035)	(0.035)
Constant	0.013	−0.028**	7.727***	−0.403***	−0.272***
	(0.009)	(0.013)	(0.178)	(0.044)	(0.062)
Industry effect	Y	Y	Y	Y	Y
Year effect	Y	Y	Y	Y	Y
No. of observations	15,264	14,824	14,996	11,448	15,237
Adj. R-square	0.073	0.075	0.145	0.027	0.028
p-value	0.000	0.000	0.000	0.000	0.000

* = p < 0.1, ** = p < 0.05, *** = p < 0.01.
VC = venture capital.
Note: Standard errors in parentheses. The first stage regressions are full estimations with all control variables included, but we do not show them to save space.
Source: Authors' computations.

our instrumental variable. First-stage regressions in Panel A confirm that *IPO_CN* is a statistically qualified instrumental variable that is both significantly and positively correlated with *VC_Dummy* for all estimates.

Panel B of Table 5 shows the results of second-stage regressions, in which *VC_Dummy* is instrumented by *IPO_CN*. *VC_Dummy* is significantly and positively correlated with profitability measured by *ROA* and *ROE*, market recognition measured by *Tobin's Q*, and growth in the number of employees. The results are generally consistent with those shown in Table 3, suggesting that firm differences in terms of profitability, market performance, and growth are driven by VC investment.

We also conduct two-stage estimations for the PSM sample and find that the effects of VC investment on firm performance and growth remain robust (the results are provided by request). Overall, using two-stage Heckman estimation enables us to identify the likelihood of a firm being selected by VC investment. The results of the two-stage regressions confirm the post-IPO effects of VCFs on the performance and growth of firms.

B. Do Experience and Specialization of VCFs Matter?

We determine whether VCF investment experience and specialization vary in their effects on post-IPO performance and growth. As previously discussed, the post-IPO effect of venture investment is mainly focused on two mechanisms, the certification and value-added effects of VCFs. VC backing may be a signal to investors that a firm has more potential than its peers. This attracts more investments and leads to better performance and faster growth. Meanwhile, the outperformance and faster growth of VC-backed firms after IPO may relate to the monitoring efforts of VCFs before exit or the effective corporate governance structures implemented before exit (Brav and Gompers 1997, Krishnan et al. 2011). The arguments suggest two major requirements—reputation and expertise—that enable VCFs to certify or add value to efficiently monitor and guide the firms they support. Logic implies that if venture investment can certify and add value to portfolio companies, companies backed by VCFs with greater experience and expertise should outperform those backed by VCFs with less experience and expertise.

Table 6 reports the regression results of the relationship between VCF experience and post-IPO performance and growth of firms. As mentioned earlier, we use age to measure VCF experience. The results show that *VC_Age1* is significantly and positively correlated with all the post-IPO performance and growth measures of firms. Similar results are found with *VC_Age2*. The only exception is that no statistically significant relationship exists between *VC_Age2* and *Tobin's Q*. Overall, the results suggest that VC-backed firms enjoy higher profitability, better market recognition, and faster growth than non-VC-backed ones regardless of the experience of the lead VCF. Meanwhile, we observe that the coefficients of *VC_Age1* are larger than those of *VC_Age 2* in most cases, with *ROE* as the only exception. In order to determine whether the effects of the two types of VCFs are significantly different, we further conduct Lincom tests for the coefficients of *VC_Age1* and *VC_Age2*. As shown in Table 6, none of the p-values of the Lincom tests is smaller than 10%, which suggests that the coefficients of *VC_Age1* and *VC_Age2* are not significantly different. The results indicate that the experience of VCFs does not significantly influence performance or growth of entrepreneurial firms in the PRC.

Next, we focus on the specialization of VCFs and its effects on post-IPO performance and growth of firms. While some VCFs focus on investing within

Table 6. **Experience of VCFs and Post-IPO Performance and Growth of Firms**

	(1) *ROA*	(2) *ROE*	(3) *Tobin's Q*	(4) *G_Emp*	(5) *G_Sales*
VC_Age1	0.019***	0.025**	0.556***	0.080***	0.062***
	(0.006)	(0.011)	(0.173)	(0.019)	(0.016)
VC_Age2	0.016**	0.029***	0.219	0.054***	0.057***
	(0.006)	(0.010)	(0.214)	(0.014)	(0.014)
SOE	0.003	0.008**	0.156***	−0.037***	−0.018**
	(0.002)	(0.004)	(0.043)	(0.010)	(0.009)
Firm Age	−0.001**	0.000	−0.019**	−0.002	−0.004***
	(0.000)	(0.001)	(0.009)	(0.001)	(0.001)
IPO_Age	−0.003***	−0.005***	0.009	−0.009***	−0.007***
	(0.000)	(0.001)	(0.010)	(0.001)	(0.001)
L_Assets	0.013***	0.030***	−1.000***	0.060***	0.067***
	(0.001)	(0.002)	(0.050)	(0.005)	(0.007)
LVRG	−0.005***	−0.015***	−0.057***	−0.007**	0.007
	(0.001)	(0.003)	(0.011)	(0.003)	(0.005)
ChiNext	0.011***	−0.021***	−0.084	0.118***	0.028
	(0.004)	(0.006)	(0.149)	(0.023)	(0.022)
Constant	0.082***	0.154***	7.820***	−0.105	−1.787***
	(0.005)	(0.010)	(0.374)	(0.122)	(0.030)
Industry effect	Y	Y	Y	Y	Y
Year effect	Y	Y	Y	Y	Y
Lincom Tests	−0.003	0.004	−0.337	−0.025	−0.005
VC_Age2–VC_Age1	(0.009)	(0.014)	(0.269)	(0.22)	(0.019)
No. of observations	17,175	16,711	16,874	13,281	17,142
Adj. R-square	0.133	0.083	0.386	0.034	0.035
p-value	0.000	0.000	0.000	0.000	0.000

* = p < 0.1, ** = p < 0.05, *** = p < 0.01.
IPO = initial public offering, VCFs = venture capital firms.
Note: Standard errors in parentheses.
Source: Authors' computations.

particular industries, others apply more generalist approaches and diversify investments across industries. Theories suggest different predictions on the relationship between specialization and performance. Some studies argue that organizational diversification (i.e., generalist investors) is an important element of efficient capital allocation. However, Rajan, Servaes, and Zingales (2000), Scharfstein (1998), and Scharfstein and Stein (2000) suggest that diversified firms may have difficulty redeploying capital into sectors with better investment opportunities. Empirically, Gompers, Kovner, and Lerner (2009) find that firms backed by more specialized VCFs enjoy higher profitability after IPO than those backed by generalist VCFs. The authors mainly attribute the success of specialized VCFs to their better judgment of the quality of potential portfolio companies and better implementation of monitoring functions than non-specialized VCFs.

Table 7 presents the results pertaining to the relationship between VCF specialization and firm performance and growth. It shows that *VC_Ind1* is significantly

Table 7. **Specialization of VCFs and Post-IPO Performance and Growth of Firms**

	(1) *ROA*	(2) *ROE*	(3) *Tobin's Q*	(4) *G_Emp*	(5) *G_Sales*
VC_Ind1	0.015**	0.023**	0.092	0.050***	0.051***
	(0.006)	(0.010)	(0.183)	(0.013)	(0.012)
VC_Ind2	0.019***	0.032***	0.644***	0.086***	0.068***
	(0.006)	(0.010)	(0.179)	(0.020)	(0.018)
SOE	0.003	0.008**	0.156***	−0.037***	−0.019**
	(0.002)	(0.004)	(0.043)	(0.010)	(0.009)
Firm Age	−0.001**	−0.000	−0.018**	−0.002	−0.004***
	(0.000)	(0.001)	(0.009)	(0.001)	(0.001)
IPO_Age	−0.003***	−0.005***	0.008	−0.009***	−0.007***
	(0.000)	(0.001)	(0.010)	(0.001)	(0.001)
L_Assets	0.013***	0.030***	−0.999***	0.060***	0.067***
	(0.001)	(0.002)	(0.050)	(0.005)	(0.007)
LVRG	−0.005***	−0.015***	−0.057***	−0.007**	0.007
	(0.001)	(0.003)	(0.011)	(0.003)	(0.005)
ChiNext	0.011***	−0.023***	−0.151	0.118***	0.030
	(0.004)	(0.006)	(0.139)	(0.022)	(0.021)
Constant	0.082***	0.154***	7.814***	−0.105	−1.786***
	(0.005)	(0.010)	(0.372)	(0.122)	(0.030)
Industry effect	Y	Y	Y	Y	Y
Year effect	Y	Y	Y	Y	Y
Lincom Tests	0.004	0.009	0.552**	0.036	0.017
VC_Ind2–VC_Ind1	(0.008)	(0.013)	(0.244)	(0.023)	(0.02)
No. of observations	17,191	16,727	16,890	13,291	17,158
Adj. R-square	0.133	0.083	0.386	0.034	0.035
p-value	0.000	0.000	0.000	0.000	0.000

* = p < 0.1, ** = p < 0.05, *** = p < 0.01.
IPO = initial public offering, VCFs = venture capital firms.
Note: Standard errors in parentheses.
Source: Authors' computations.

and positively correlated to almost all measures of post-IPO performance and growth, with Tobin's Q as the only exception. Nonetheless, *VC_Ind2* shows a significant and positive correlation with all performance and growth measures across Models 1 to 5. These results indicate that VC-backed firms outperform non-VC-backed firms in performance and growth no matter whether the lead VCF has a specific industry preference or not. Meanwhile, we observe that the coefficients of *VC_Ind2* are constantly larger than those of *VC_Ind1* for all performance and growth measures. Once again, we conduct Lincom tests for the coefficients of *VC_Ind1* and *VC_Ind2*. As shown in Table 7, almost all the p-values for the Lincom tests are larger than 10%, with Tobin's Q as the only exception. The results of Lincom tests suggest that whether a firm is backed by VCFs with specific industry preference or not does not affect the post-IPO financial performance or growth of the firm. However, the Lincom tests show that the coefficients of *VC_Ind1* and *VC_Ind2* are significantly different for Tobin's Q, indicating that firms backed by specialized VCFs normally

enjoy significantly higher market recognition than those backed by VCFs without specific industry preference.

Overall, we do not find experience or specialization of VCFs significantly affecting the post-IPO performance or growth of entrepreneurial firms in the PRC. The only exceptional case is that firms backed by VCFs with specific industry preference are better recognized by investors than those backed by generalist VCFs. In general, these results are consistent with findings in Japan (Hamao, Packer, and Ritter 2000), Europe (Bottazzi and Da Rin 2002a, 2002b), and Singapore (Wang, Wang, and Lu 2003). However, the results contrast with the findings in the US (Lerner 1994, Brav and Gompers 1997, Nahata 2008, Krishnan et al. 2011) where experience of VCFs is found to be positively correlated with firm performance.

C. Corporate Governance and VC Investment

We have provided evidence on the positive effects of VC investment on firm performance and growth post-IPO. However, a challenging question left unanswered is why VC-backed firms outperform non-VC-backed ones. In particular, we try to determine why outperformance continues in the long-term, even after an IPO, when VCFs normally exit soon afterward.

Existing studies try to link the monitoring function of VCFs and the outperformance of VC-backed firms. Brav and Gompers (1997), for example, suggest that VCFs tend to place effective management structures that may affect long-term performance. However, little evidence differentiates the management structures of VC-backed firms from those of others. Among the few studies that consider the corporate governance of VC-backed firms, Krishnan et al. (2011) provide evidence on positive relationships among VC investment, corporate governance, and VC-backed firm performance based on the US data.

We also link VC investment and corporate governance to explore further the factors that explain the post-IPO performance of VC-backed firms in the PRC. We first focus on the alignment of interests between shareholders and managers. Conflict of interest between executives and shareholders is a classic issue that results in principal-agent problems. A compensation plan that aligns the interests of the two parties may give managers the incentive to maximize shareholder return and improve performance (Jensen and Murphy 1990). Meanwhile, Kaplan and Strömberg (2003) find that the more a project is associated with information asymmetry issues and higher uncertainty in the US, the more likely executives and management teams are allocated equity stock. As previously mentioned, we measure the alignment of interests in two ways, with a focus on the stockholdings of executives and management teams.

We also consider institutional ownership of firms. Aghion, Van Reenen, and Zingales (2013) find that institutional ownership is positively associated with R&D productivity, indicating that institutional investors are more likely to be focused on long-term performance. Given that VCFs themselves are institutional investors, we

Table 8. **VC Investment and Corporate Governance of Firms after IPO**

	(1) *Mgnhldn_D*	(2) *Xcuhldn_D*	(3) *InsnShare10*
VC_Dummy	1.302***	1.166***	−0.004
	(0.318)	(0.353)	(0.007)
SOE	−0.346***	−0.311***	0.039***
	(0.080)	(0.086)	(0.004)
Firm Age	0.140***	0.120***	−0.004***
	(0.027)	(0.033)	(0.001)
IPO_Age	−0.065***	−0.129***	−0.014***
	(0.024)	(0.028)	(0.001)
L_Assets	0.214***	0.291***	0.029***
	(0.037)	(0.048)	(0.003)
LVRG	−0.030***	−0.011	−0.001**
	(0.011)	(0.012)	(0.001)
ChiNext	3.562***	3.304***	0.029***
	(0.571)	(0.460)	(0.008)
Constant	2.413***	2.639***	0.514***
	(0.084)	(0.086)	(0.022)
Industry effect	Y	Y	Y
Year effect	Y	Y	Y
No. of observations	10,927	10,925	10,927
Adj. R-square			0.329
p-value	0.000	0.000	0.000

* = p < 0.1, ** = p < 0.05, *** = p < 0.01.
IPO = initial public offering, VC = venture capital.
Note: Standard errors in parentheses.
Source: Authors' computations.

explore whether VC-backed firms may constantly attract institutional investors even after the exit of VCFs and consequently perform better in the long-term.

Table 8 presents the estimates on the corporate governance of firms. Models 1 and 2 show that *VC_Dummy* has a significant and positive association with *Mgnhldn_D and Xcuhldn_D*, suggesting that VC-backed firms are more likely to allocate equity incentives to executives and management teams than non-VC-backed firms. Meanwhile, Model 3 shows that *InsnShare10* is also positively associated with *VC_Dummy*, although the relationship is not statistically significant. These results suggest that compared with non-VC-backed firms, VC-backed firms seem more likely to give higher incentives to executives and management teams by aligning interests among investors, executives, and management teams.

To address potential identification concerns, we conduct two-stage Heckman estimations with the instrumental variable, *IPO_CN*, to identify whether the difference in corporate governance shown in Table 8 is driven by VC investment. Our findings remain robust, as shown in Table 9.

In sum, we find positive relations among VC investment, ownership concentration, and the alignment of interests between shareholders and investors in the PRC. Our findings are consistent with those of Brav and Gompers (1997), and

Table 9. **Two-stage Estimations for VC Effects on Corporate Governance**

Panel A. First-stage Estimations of the Two-stage Regressions

	(1) *VC_Dummy*	(2) *VC_Dummy*	(3) *VC_Dummy*
IPO_CN	0.028***	0.028***	0.028***
	(0.008)	(0.008)	(0.008)
Constant	−1.426***	−1.425***	−1.426***
	(0.224)	(0.224)	(0.224)
Pseudo R-square	0.219	0.219	0.219

Panel B. Second-stage Estimations of the Two-stage Regressions

	(1) *Mgnhldn_D*	(2) *Xcuhldn_D*	(3) *InsnShare10*
VC_Dummy	1.607***	1.518***	0.655***
	(0.209)	(0.207)	(0.076)
SOE	−0.108***	−0.127***	0.122***
	(0.016)	(0.016)	(0.005)
Firm Age	0.013***	0.013***	−0.005***
	(0.002)	(0.002)	(0.001)
IPO_Age	0.016***	0.007***	−0.004***
	(0.003)	(0.003)	(0.001)
L_Assets	0.056***	0.069***	0.013***
	(0.005)	(0.005)	(0.002)
LVRG	−0.009***	−0.011***	0.001**
	(0.003)	(0.002)	(0.001)
ChiNext	0.071	0.106	−0.086**
	(0.086)	(0.087)	(0.034)
Constant	−0.048	−0.217***	0.496***
	(0.051)	(0.050)	(0.017)
Industry effect	Y	Y	Y
Year effect	Y	Y	Y
No. of observations	9,595	9,593	9,595
p-value	0.000	0.000	0.000

* = p < 0.1, ** = p < 0.05, *** = p < 0.01.
VC = venture capital.
Note: Standard errors in parentheses. The first stage regressions are full estimations with all control variables included, but we do not show them to save space.
Source: Authors' computations.

Krishnan et al. (2011), and may thus help explain the outperformance of VC-backed firms after IPO in the long-term. However, we cannot claim the explanation as conclusive given the nature of the estimates. We suggest that our results can help gain insights into the mechanisms through which VC investment affects long-term firm performance and growth.

VI. Conclusion

This study examines the effects of VC investment on the post-IPO performance and growth of Chinese entrepreneurial firms. To the best of our knowledge,

this study is the first to provide related evidence in the PRC. Our firm-level panel data analysis finds that VCFs contribute to the long-term performance and growth of entrepreneurial firms post-IPO. Moreover, a significant and positive relationship exists between firm corporate governance and VC investment. However, we do not find that experience and specialization of VCFs matter in terms of their effects on post-IPO performance and growth of entrepreneurial firms in the PRC.

We contribute to the VC investment literature in four aspects. First, following Brav and Gompers (1997) and Krishnan et al. (2011), this study is among the first attempts to link the features of VCFs, corporate governance, and post-IPO performance and growth of VC-backed firms. We gain an insightful understanding of the mechanisms through which VC investments affect the performance and growth of entrepreneurial firms. Second, this study contributes to the existing literature on the effects of diversification on investment performance with the focus on private equity investment. Third, this work is among the first systematic estimations of the contribution of VC investment to entrepreneurial firms post-IPO in the PRC, where capital markets are distinct from those of Western countries (Allen, Qian, and Qian 2005; Wang 2005; Fan, Wong, and Zhang 2007; Kao, Wu, and Yang 2009; Allen et al. 2012; Piotroski and Zhang 2014). Hence, we contribute to the literature on corporate finance in emerging markets by examining the influence of institutions (Hu, Jefferson, and Qian 2005; Jefferson et al. 2006; Cull, Xu, and Zhu 2009).

This research also contributes to policymaking. The PRC has exerted numerous efforts to encourage VC investment with the expectation of stimulating entrepreneurship, especially R&D entrepreneurship activities. However, without a solid empirical evaluation of the effects of VC investment, no foundation exists on which to direct further development of the VC market. This study confirms a positive relationship between VC investment and the long-term performance of VC-backed companies in the PRC. In particular, this work shows the influences of VC investment on the corporate governance of companies. Moreover, by reviewing the development of the VC market in the past 3 decades, this study suggests that the VC market achieved rapid development in the PRC with the relaxation of restrictions on corporate structure and fund-raising of institutional investors over the past few years.

This study clearly has implications for business practitioners. Those operating in this market and those wishing to enter into this market may gain insight into the institutional issues they might encounter as well as the associated opportunities and threats. This study contributes to the business practice of entrepreneurs by showing that VCFs not only provide capital for entrepreneurial firms but also deeply engage in the management of firms and add value to the firms. Moreover, it highlights how different types of VCFs may vary in terms of their effects on entrepreneurial firms.

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* ADB recognizes "China" as the People's Republic of China.

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Appendix

Table A.1. **VC Investment and Post-IPO Performance and Growth of Firms within 3 Years after IPO**

	(1) *ROA*	(2) *ROE*	(3) *Tobin's Q*	(4) *G_Emp*	(5) *G_Sales*
VC_Dummy	0.008**	0.010*	0.405***	0.041***	0.053***
	(0.003)	(0.006)	(0.138)	(0.015)	(0.013)
SOE	−0.004**	−0.004	0.024	−0.043***	−0.013
	(0.002)	(0.004)	(0.046)	(0.013)	(0.012)
Firm Age	−0.001***	−0.002**	−0.024***	−0.003**	−0.004***
	(0.000)	(0.001)	(0.009)	(0.002)	(0.002)
IPO_Age	−0.012***	−0.022***	−0.109***	−0.023***	−0.012***
	(0.001)	(0.001)	(0.017)	(0.005)	(0.004)
L_Assets	0.007***	0.033***	−0.589***	0.019***	0.026***
	(0.001)	(0.005)	(0.039)	(0.006)	(0.006)
LVRG	−0.014***	−0.052***	−0.078**	−0.011*	−0.014
	(0.002)	(0.011)	(0.034)	(0.006)	(0.011)
ChiNext	0.000	−0.031***	0.026	0.061***	0.011
	(0.003)	(0.006)	(0.141)	(0.023)	(0.021)
Constant	0.148***	0.226***	8.372***	0.174	−1.548***
	(0.007)	(0.015)	(0.232)	(0.115)	(0.029)
Industry effect	Y	Y	Y	Y	Y
Year effect	Y	Y	Y	Y	Y
No. observations	6,322	6,313	6,284	3,701	6,317
Adj. R-square	0.223	0.209	0.372	0.047	0.048
p-value	0.000	0.000	0.000	0.000	0.000

* = p < 0.1, ** = p < 0.05, *** = p < 0.01.
IPO = initial public offering, VC = venture capital.
Note: Standard errors in parentheses.
Source: Authors' computations.

Export Destination and Export Market Penetration of the People's Republic of China—Past and Future

Rui Mao and Bin Zhang*

Growth in the aggregate market penetration rate (MPR) of the People's Republic of China (PRC) slowed during the period 2002–2014. Closer examination of the destinations and product levels reveals a simultaneous weakening in various markets. Production and trade costs were found to be the main determinants of these changes, while productivity growth and real exchange rate appreciation had either insignificant or limited effects. Predicting trends until 2016, we expect the MPR in almost all destinations and product markets to increase in the optimistic case. However, in a more realistic case, the MPR will likely plateau or fall in most markets. To stabilize exports, the PRC must actively facilitate structural transition in destinations and products. Meanwhile, macro policies to boost domestic demand are also urgently needed to maintain the country's high economic growth.

Keywords: market penetration rates (MPR), determinants of MPR, prediction of MPR
JEL codes: E66, F13, F14, F17, O53

I. Introduction

The People's Republic of China (PRC) has implemented a highly successful export-led growth over the past decade. Its total export value increased from $326 billion in 2002 to $2.21 trillion in 2013, implying an average annual growth rate of about 17%. However, the global financial crisis halted export growth. In 2008, export grew by only 16% from the previous year. In 2009, export even shrank by 17%. As this engine sputtered, the PRC's overall economy lost steam. The country's gross domestic product (GDP) growth rate was 9.6% in 2008, only about two-thirds of that a year ago. Contribution of net exports was merely 9%, falling by more than half in a year. It further went down to –38.9% in 2009, the first negative contribution

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recorded this century. Consequently, the GDP growth rate reached a new low of 9.2%.

The slowdown of the PRC's export growth could have resulted from either contracting external demand or a declining market share in external markets. This can be seen from the following equation:

$$\textit{Export growth} = \textit{Growth of other countries' imports} + \textit{Growth of market shares in other countries}. \quad (1)$$

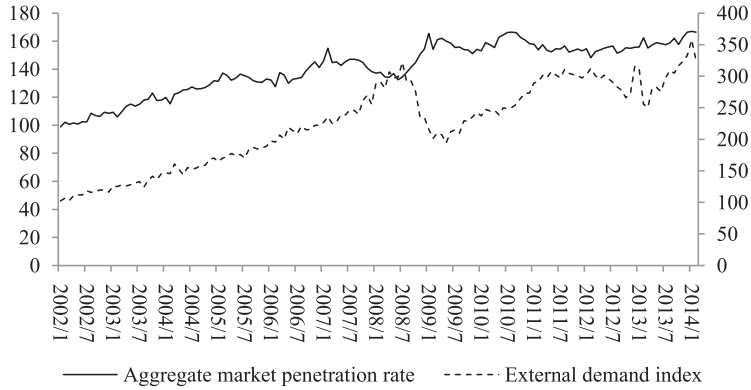
Whereas the contraction of external demand had been mainly a cyclical change caused by the financial crisis, changes in market shares were less volatile and indicative of a downward trend. The PRC's market shares remained depressed and stumbled for a long time, but external demand picked up shortly after the crisis broke out. In short, the country's shrinking market shares were not merely a consequence of its falling external demand. In another study, we decomposed the PRC's export growth to changes in its external demand and market shares based on Equation (1) and found that market shares could explain over 60% of the change in export growth (Zhang 2014). Since a decline in market shares implies a falling status relative to other exporters in the world market, this result implies that our recent observations of the PRC's export market were not merely cyclical symptoms caused by the global recession, but signs of a waning trend in relative strength.

Of course, market share measured by the market penetration rate (MPR) is only one of several measures of export competitiveness, a term that represents the relative strength of a particular exporter versus a number of other competitors. We also summarize five indices of export competitiveness that have been frequently used in the literature and compare their applicability and limitations. Among them, the MPR not only stands out for its simplicity and robustness to aggregation biases, but also serves as the only measure that can distinguish substantial differences across destinations and product markets at the same time. Moreover, according to Equation (1), the MPR has a direct link with export growth, so it could serve as a desirable measure to understand the change in observed aggregate export data.

As both export competitiveness and its determinants were often examined at the aggregate level in the literature (e.g., Zhang 2001, Eaton and Kortum 2002), this paper fills a gap by providing a closer examination of destinations and product levels in the discussion of the MPR index. Moreover, the destination and product structure of the PRC's exports have been rapidly changing such that the nature of the transformation has become an increasingly important policy question. Therefore, we adopt the MPR as an indicator of the relative strength of the PRC's exports.

Focusing on the PRC's 14 major trading partners, we find that the growth rate of the PRC's aggregate MPR had been slowing during 2002–2014. As Figure 1 below shows, the aggregate MPR maintained a growth uptrend until mid-2010, and

Figure 1. **Aggregate Market Penetration Rate of the People's Republic of China**
(2002–2014)



Source: Authors' computations.

only then started to decline. However, it gradually regained its pre-crisis level from 2012 to early 2014.

It is worth noting that the PRC's aggregate MPR did not always move in line with its external demand. In particular, while average demand for the country's exports sharply fell at the height of the global financial crisis in late 2008 and kept declining until May 2009, aggregate MPR even increased during the period. However, while external demand recovered between mid-2009 and early 2012, aggregate MPR was on a decline. This simple observation suggests that external demand is apparently not the only determinant of the MPR.

At a more detailed level, signs of weakening of the PRC's MPR have been observed for different destination and product markets. The country's MPR in Japan has plateaued since mid-2003, while that in the European Union (EU), India, the Russian Federation, and the Republic of Korea has stopped growing since 2008. The measure meanwhile saw a slowdown in the context of the United States (US); Canada; and Taipei,China. Only in the Association of Southeast Asian Nations (ASEAN), Australia, Brazil, Saudi Arabia, and South Africa has the PRC maintained a rising trend in its MPR.

As regards product markets, the PRC's MPR has stopped growing and has even begun to fall in the markets for food, live animals, beverages, tobacco, oils, and fats; petroleum, coal, and gas; and furniture, clothing, and other products. MPR growth has also slowed and showed signs of plateauing in the markets for chemicals, pharmaceuticals, and plastic products; leather, rubber, metal, and textile manufactures; and machinery and transport equipment.

We find production costs, trade costs, productivity, and the real exchange rate to be the four fundamental causes behind these changes. In our regression results, production and trade costs are significantly and negatively correlated with the MPR.

Before 2009, the PRC's production costs were rising, but its trade costs were falling. The positive effect of falling trade costs outweighed the negative effect of rising production costs, leading to an increase in the MPR. However, the negative effect of production costs predominated since 2009, as production costs grew constantly while trade costs declined more slowly. After a short period of stalemate, the MPR therefore began to fall. The MPR was able to recover in 2012, thanks to a slowdown in the growth of production costs.

The effect of productivity on the PRC's MPR is also significantly positive in our regressions, but the impact of late seems limited. Considering that productivity of most sectors in the PRC hardly changed in the past decade, productivity has not been an essential determinant of the MPR. On the whole, the effect of the real exchange rate on the MPR is not significant, although it is important in some markets.

Finally, we predict the PRC's MPR in various destinations and product markets according to trends in the four determinants. Our results reveal that if the optimistic scenario occurs where pre-crisis upward yearly trends are maintained, then the MPR will increase in all destination markets except Japan, and in four out of six product markets except for petroleum, coal, and gas; and food, live animals, beverages, tobacco, oils, and fats. Otherwise, the said measure of competitiveness will either reach a plateau or fall in most destinations, except ASEAN and the Republic of Korea, and in terms of products, in the market for leather, rubber, metal, and textile manufactures.

II. The Market Penetration Rate and Other Measurements of Export Competitiveness

A. Five Frequently Used Indices

The MPR is an index that is frequently used in the literature to measure export competitiveness. Equation (1) demonstrates that it is a desirable measure to understand observed export data owing to the direct link between the two. Compared to other indices of export competitiveness often used, the MPR is preferred because of its simplicity and robustness to aggregation biases as well as its capability to allow for distinctions in destinations and product markets.

To see this, we compare the MPR with four other well-known measures of export competitiveness: (i) international market share, (ii) revealed comparative advantage, (iii) the trade specification coefficient, and (iv) revealed competitive advantage. Table 1 summarizes the results.

International market share is defined as X_{ik}/X_{wk}, where X_{ik} is country i's exports of good k, and X_{wk} is the world's total exports of good k; that is, it represents country i's share in the global export market of good k. When k refers to all goods, it

Table 1. **Measurements of Export Competitiveness**

	Measurement	Calculation	Application	Features
	Market share	X_{ik}/X_{wk}	Between countries/ products	Easy, but cannot distinguish destinations
	MPR	X_{ijk}/M_{jk}	Between countries/ products	Needs importer information
Index	Revealed comparative advantage	$(X_{ik}/X_k)/(X_{wk}/X_w)$	Between countries/ products	Excludes scale effects, but biased to 1
	Trade specification	$(X_{ik} - M_{ik})/(X_{ik} + M_{ik})$	Between products	Excludes import effects
	Revealed competitive advantage	$RCA_{ik} - (M_{ik}/M_i)/(M_{wk}/M_w)$	Between countries/ products	Most extensive, but biased to 0

MPR = market penetration rate.
Source: Authors' compilations.

measures a country's aggregate export competitiveness. However, this index cannot distinguish a country's competitiveness in different destinations. The MPR does not have this problem. Defined as X_{ijk}/M_{jk}, it measures the share of country i's exports of good k to country j, X_{ijk}, in country j's total imports of good k, M_{jk}. However, both the MPR and international market share are subject to the influence of the relative economic size of countries and thus may not reflect real competitiveness.

To take economic scale into account and make cross-country comparisons reasonable, Balassa (1965) proposed the concept of revealed comparative advantage, calculated as $(X_{ik}/X_i)/(X_{wk}/X_w)$, where X_{ik} and X_{wk} are again exports of good k of country i and the world as a whole, and X_i and X_w are total exports of country i and the world, respectively. Nevertheless, like international market share, it cannot be applied to destination-specific studies. In addition, if we sum up a country's revealed comparative advantage in all product markets using export shares as weights, the aggregation tends to bias toward unity when deviations of export intensities from world average levels are smoothed out.

Besides scale effects, another challenge to the MPR and international market share is that they do not consider re-exports. As a result, for a country that concentrates on transit trades such as a "hub port," its MPR and international market share, which only use export data, can both be large, even if it runs a trade deficit.

In contrast, the trade specification coefficient adopted by Liu (2002) takes into account import information. It is calculated as $(X_{ik} - M_{ik})/(X_{ik} + M_{ik})$, where X_{ik} and M_{ik} are, respectively, country i's exports and imports of good k. However, if the coefficient is around 0, it may suggest either weak competitiveness or a large share of intra-industry trade. In addition, this index uses a country's domestic information, so it cannot compare competitiveness relative to other countries. Also, like international market share and revealed comparative advantage, this index cannot distinguish export competitiveness across destinations.

Defined as $(X_{ik}/X_i)/(X_{wk}/X_w)-(M_{ik}/M_i)/(M_{wk}/M_w)$, the revealed competitive advantage index is a hybrid of the revealed comparative advantage index and the trade specification coefficient, and takes both economic scale effects and re-exports into account. However, it also has the disadvantages of these indices.

To sum up, the MPR stands out as a relatively ideal index to measure export competitiveness by destination and product. Nevertheless, it also requires several modifications prior to application.

B. Modifications to the Market Penetration Rate

Both economic scale effects and re-exports tend to impair the MPR's ability to represent the relative strength of Chinese exports. First, because the PRC's economic size continued to expand even if the relative strength of its exports remained constant, the MPR still increased. That is, the MPR may have exaggerated the country's gain in the relative strength of its exports because of economic size effects. Second, most economies recorded imports from the PRC and Hong Kong, China separately. However, most imports from Hong Kong, China were actually re-exported products from the PRC. Therefore, failing to take the products exported through the PRC's main "hub port" into account tends to underestimate the relative strength of the PRC's exports.

To deal with economic size effects, we exclude changes caused by the PRC's expanding economic size from the MPR directly. In particular, if we let $y_c\%$ be the PRC's GDP growth rate over a particular period and $y_r\%$ be the GDP growth rate of the rest of the world (i.e., the world excluding the PRC and the destination economy), then $(y_c\% - y_r\%)$ measures the rate of relative expansion of the PRC's economy in that period. As a result, if the PRC's MPR in the previous period was $x\%$, then it would grow by $(y_c\% - y_r\%)x\%$ in this period simply due to the effect of the PRC's relatively expanding economic size. Hence, in order to accurately represent the relative strength of the PRC's exports, an amount of $(y_c\% - y_r\%)x\%$ must be excluded from the MPR.

To take into account the PRC's transit exports through Hong Kong, China, we prefer to add all products re-exported by Hong Kong, China back to the PRC's direct exports of these products to each destination market. Unfortunately, while we have access to the PRC's export destination and product-level export data, we could not obtain such detailed information on transit exports. As an alternative, we have to assume that the PRC's transit exports of any product through Hong Kong, China were eventually allocated to each destination in a share that is identical to the PRC's direct exports of that product to the destination.

Mathematically, let X_{Hk} be the PRC's exports of good k to Hong Kong, China and let X_{jk} be the PRC's exports to destination j, other than Hong Kong, China. Supposing we calculate the PRC's transit exports of good k through Hong Kong, China to destination j as $X_{Hk}(X_{jk}/\Sigma_j X_{jk})$, we can then add transit exports to the

PRC's direct exports to destination *j* to get its total imports from the PRC, X_{ijk}, and calculate the MPR correspondingly. This allows us to take the PRC's transit exports through Hong Kong, China back into account.

III. Measuring the Market Penetration Rate of the People's Republic of China

A. Data and Method

The MPR is defined as X_{ijk}/M_{jk}, where X_{ijk} is the PRC's exports of good k to country j (including transit exports through Hong Kong, China), and M_{jk} is country j's total imports of good k. As mentioned earlier, the ratio is then adjusted for economic size effects. To calculate these ratios, we need export destination data and product-level export data of the PRC as well as each destination market's product-level total imports and product-level imports specifically from the PRC. These data are available from the CEIC database at a monthly frequency from January 2002 to June 2014.

Once these ratios—i.e., the PRC's MPR in each destination–product market—are calculated, they can be further aggregated across two dimensions. By summing them over all products according to $\Sigma_k(\alpha_{jk}X_{ijk})$, we get the PRC's MPR in a specific destination j. The aggregation weight here, α_{jk}, is the share of destination j's imports of good k in its total imports, M_{jk}/M_j. By summing them over all destinations according to $\Sigma_j(\beta_{jk}X_{ijk})$, we get the PRC's MPR in a specific product market k. The aggregation weight here, β_{jk}, is the share of the PRC's exports of good k to destination j in its total exports of good k, X_{jk}/X_k.

Finally, we can sum up the PRC's MPR on both dimensions according to $\Sigma_j\gamma_j[\Sigma_k(\alpha_{jk}X_{ijk})]$, where $\alpha_{jk} = M_{jk}/M_j$ is the same as before and $\gamma_j = X_j/X$ is the share of the PRC's total exports to destination j in its total exports to the world. This weighted sum measures the PRC's aggregate MPR.

In this paper, we consider 14 major destinations of Chinese exports. They are the US; the EU; Hong Kong, China; ASEAN countries; Japan; the Republic of Korea; India; the Russian Federation; Australia; Taipei,China; Brazil; Canada; Saudi Arabia; and South Africa. Together they account for more than 80% of the PRC's total exports. However, Hong Kong, China is regarded as a hub port through which the PRC's products are re-exported to other destinations. Therefore, we examine how the PRC's MPR changed over time in just the remaining 13 destinations.

With regard to the PRC's MPR in different product markets, we notice that products have been categorized under the various data standards for data of different sources. In particular, import data reported by most destination markets adopted the SITC classification standard, whereas the PRC's customs data for exports adopted the HS classification standard. To match the two standards, we aggregate the nine product categories under the SITC classification into the six product categories of

Table 2. **Transformation of Product Categories**

SITC Nine Product Categories	HS Six Product Categories
Food and live animals, beverage and tobaccos, oil, and wax	Food, live animals, beverages, tobacco, oils, and fats
Mineral fuels, lubricants, and raw materials	Petroleum, coal, and gas
Chemical and related products	Chemicals, pharmaceuticals, and plastic products
Nonedible raw materials, products classified by raw materials	Leather, rubber, metal, and textile manufactures
Machinery equipment	Machinery and transport equipment
Miscellaneous products	Furniture, clothing, and other products

SITC = Standard International Trade Classification, HS = Harmonized System.
Source: Authors' compilations.

the HS classification as shown in Table 2. Hence, we eventually examine the PRC's MPR in six product markets: (i) food, live animals, beverages, tobacco, oils, and fats; (ii) petroleum, coal, and gas; (iii) chemicals, pharmaceuticals, and plastic products; (iv) leather, rubber, metal, and textile manufactures; (v) machinery and transport equipment; (vi) furniture, clothing, and other products.

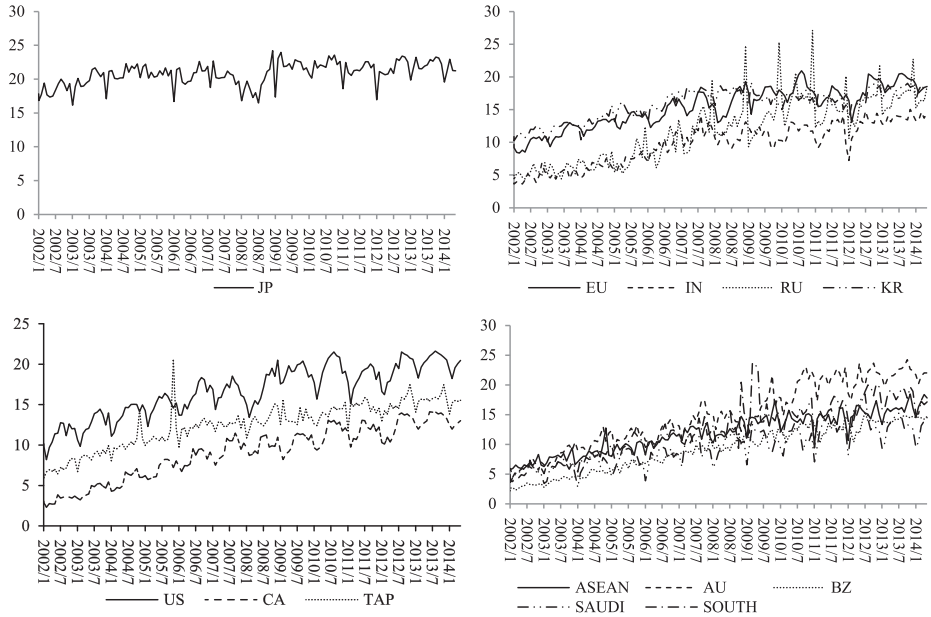
B. Aggregate Market Penetration Rate

Figure 1 shows the PRC's aggregate MPR (solid line and the left axis) during 2002–2014 against its average external demand (dashed line and the right axis). The aggregate MPR—i.e., the weighted average of its MPRs for different destinations and product markets—was 9.7% in January 2002 but normalized to 100 in the figure. According to the solid line, the PRC's aggregate MPR had been generally increasing during the sample period, indicating enhanced relative strength of Chinese exports, but its growth rate had been slowing overall. The measure dipped abruptly at the onset of the global financial crisis then shortly recovered. It plateaued afterwards but declined again in mid-2010 because of the prolonged global crisis. It was in 2012 when the MPR started a gradual recovery. Overall, it is obvious from Figure 1 that the growth rate of the PRC's aggregate MPR has been slowing.

Using shares of the PRC's exports to each destination in its total exports, γ_j, as weights, the dashed line in Figure 1 shows the weighted average of the PRC's external demand. The external demand for each destination is measured by its total imports, M_j. Therefore, average external demand is calculated as $\Sigma_j(\gamma_j M_j)$. It was \$67.7 billion in January 2002 (also normalized to 100 in the graph). According to the dashed line, the PRC's average external demand had been rapidly growing before the financial crisis. However, it suddenly shrank by a third with the shock of the crisis. It later began to recover and recently approached its previous peak.

Figure 1 also reveals that the PRC's aggregate MPR is not completely driven by external demand. In particular, while average demand for the PRC's exports

Figure 2. **Market Penetration Rate of the People's Republic of China, by Destination Market**
(2002–2014)



AU = Australia; BZ = Brazil; CA = Canada; EU = European Union; IN = India; JP = Japan; KR = Republic of Korea; RU = Russian Federation; SAUDI = Saudi Arabia; SOUTH = South Africa; TAP = Taipei,China; US = United States.
Note: ASEAN includes Brunei Darussalam, Cambodia, Indonesia, the Lao People's Democratic Republic, Malaysia, Myanmar, the Philippines, Singapore, Thailand, and Viet Nam.
Source: Authors' computations.

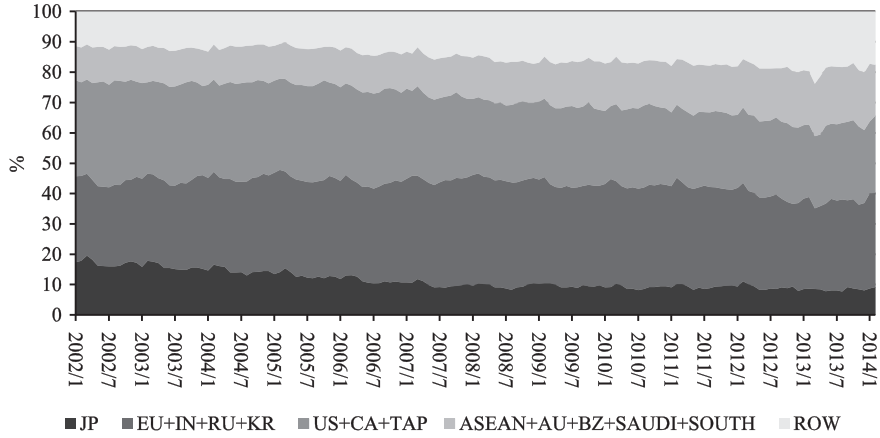
sharply contracted by a third from the pre-crisis peak between August 2008 and May 2009, its aggregate MPR increased within the same period. On the other hand, while external demand was in clear recovery between mid-2009 and early-2012, aggregate MPR was declining. Thus, Figure 1 demonstrates that the PRC's MPR must have been driven by fundamental factors other than external demand.

C. Destination-level Market Penetration Rate

In Figure 2, the MPR indicates the relative strength of the PRC's exports in each destination market. As mentioned earlier, an increase in the MPR is equivalent to a gain in the relative strength of Chinese exports.

The PRC's MPR in different destinations exhibits rather diverse patterns. In particular, despite a slowdown in growth prior to 2004, the PRC's MPR in Japan subsequently remained almost flat. In the EU, India, the Russian Federation, and the Republic of Korea, the MPR had been increasing before the financial crisis, but

Figure 3. **Export Destinations of the People's Republic of China**
(2002–2014)



AU = Australia; BZ = Brazil; CA = Canada; EU = European Union; IN = India; JP = Japan; KR = Republic of Korea; RU = Russian Federation; SAUDI = Saudi Arabia; SOUTH = South Africa; TAP = Taipei,China; US = United States; ROW = rest of the world.
Note: ASEAN includes Brunei Darussalam, Cambodia, Indonesia, the Lao People's Democratic Republic, Malaysia, Myanmar, the Philippines, Singapore, Thailand, and Viet Nam.
Source: The General Administration of Customs of the PRC.

plateaued as well afterwards. The range of fluctuation of the measure in the Russian Federation also widened at the same time. The PRC's MPR maintained an uptrend throughout the period, but the measure's growth rate also slowed. After the financial crisis, there was an apparent slowdown in the growth of the MPR in these markets. The PRC maintained a constantly rising MPR only in ASEAN, Australia, Brazil, Saudi Arabia, and South Africa.

Figure 3 shows the dynamics of the PRC's export destination structure from 2002 to 2014. The 13 economies shown in Figure 2 are the PRC's major export partners, accounting for over 80% of the PRC's total export value.

The share of these economies in the PRC's exports has been declining over time. On closer examination, the share of exports that went to Japan shrank from close to 20% in early-2002 to less than 10% in mid-2014. This was a reasonable change given the stagnation of the PRC's MPR in that market. The combined export share accounted for by the EU, India, the Russian Federation, and the Republic of Korea swelled prior to the financial crisis and contracted subsequently, but did not change much overall. Since the PRC's MPR was increasing in these markets in the first half of the period and decreasing in the second half, the change of this share also makes sense.

The share of the PRC's exports that went to ASEAN, Australia, Brazil, Saudi Arabia, and South Africa expanded during the period, from merely 11% in 2002 to about 20% in 2014. This, coupled with the country's constantly growing MPR in these markets, helped to strengthen the PRC's aggregate MPR.

Meanwhile, the combined export share of the US; Canada; and Taipei,China quickly declined, from almost 35% in 2002 to less than 25% in 2014, despite the slowing but still positive growth of the PRC's MPR in these economies. Figure 3 thus implies that a prompt shift to other destination markets where the PRC's MPR remained on the rise can be a quick way to support the relative strength of the PRC's exports.

D. Product-level Market Penetration Rate

In Figure 4, the MPR indicates the relative strength of the PRC's exports in each product market. Similar to the example earlier, an increase in the MPR is equivalent to a gain in the relative strength of the PRC's exports. The PRC's MPR also varies in different product markets. Solid lines in Figure 4 characterize the PRC's MPR in the six main product markets. Dashed lines are year-on-year growth rates of the MPR, while dotted lines are linear fits of the growth rates.

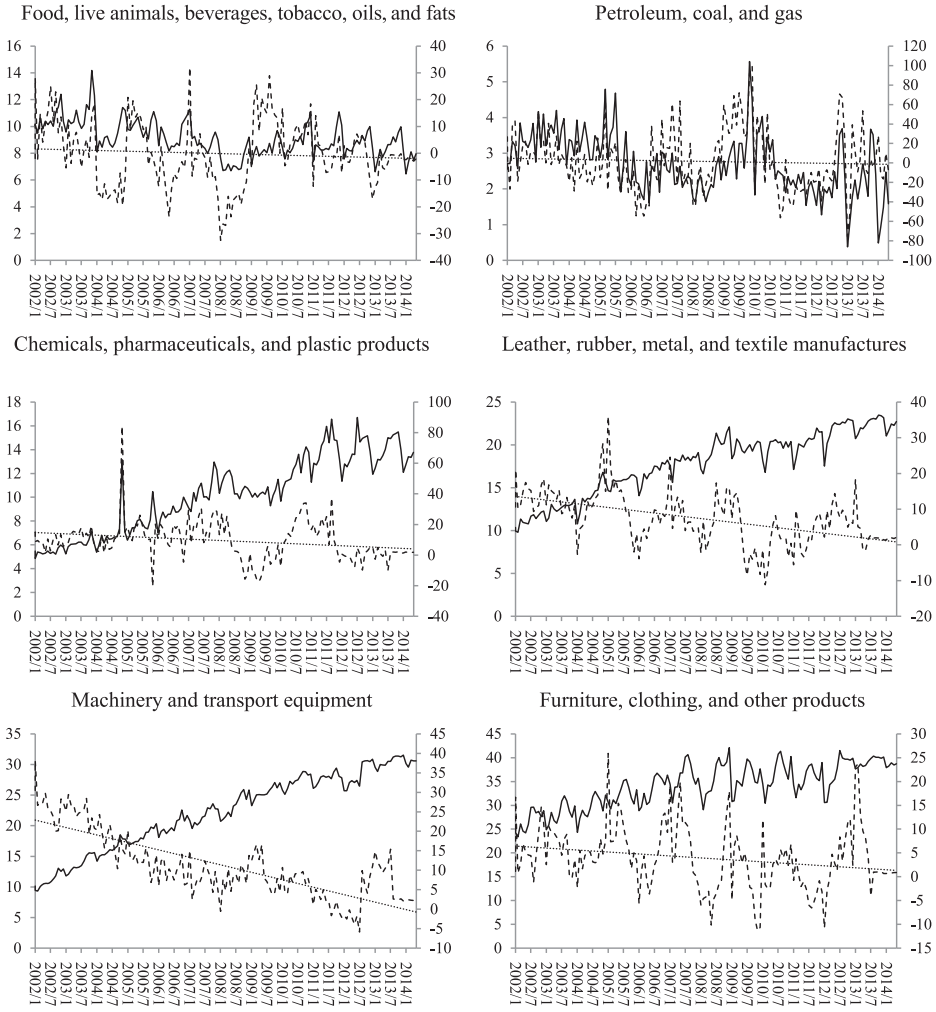
In the market for food, live animals, beverages, tobacco, oils, and fats, the PRC's MPR remained almost steady at around 9%, but the linear trend, though close to zero, sloped downward slightly, suggesting a gradual weakening. In the market for petroleum, coal, and gas, the measure was stable prior to 2010 but experienced a decline afterwards.

The PRC's MPR in the market for chemicals, pharmaceuticals, and plastic products had been growing constantly before 2011, with the linear trend of the growth rate almost flat at around 10% during the sample period. However, the measure plateaued afterwards. The case was similar for furniture, clothing, and other products, except that the MPR in that market stopped growing since 2008. As for leather, rubber, metal, and textile manufactures, and machinery and transport equipment, the growth rate of the PRC's MPR in those markets had been positive but slowing.

Figure 5 shows the dynamics of the PRC's product structure during the 10-year sample period. Three kinds of products—leather, rubber, metal, and textile manufactures; machinery and transport equipment; and furniture, clothing, and other products—constantly made up the bulk of the PRC's exports. In particular, the sum of their export shares was always above 90%. The share of machinery and transport equipment had been gradually rising; while that of furniture, clothing, and other products had been gradually falling. The share of leather, rubber, metal, and textile manufactures did not change much. Whereas the export share of chemicals, pharmaceuticals, and plastic products was expanding, the shares of the remaining products (other two products) slightly shrank.

In a nutshell, the PRC's MPR has largely improved since the country's access to the World Trade Organization (WTO), but the growth rate of the competitive measure has been slowing. After August 2010, the country's MPR even started to fall. Only after 2012 was a slight recovery observed. In the meantime, signs of a weakening MPR have occurred in various destinations and product markets.

Figure 4. **Market Penetration Rate of the People's Republic of China, by Product Market** (2002–2014)



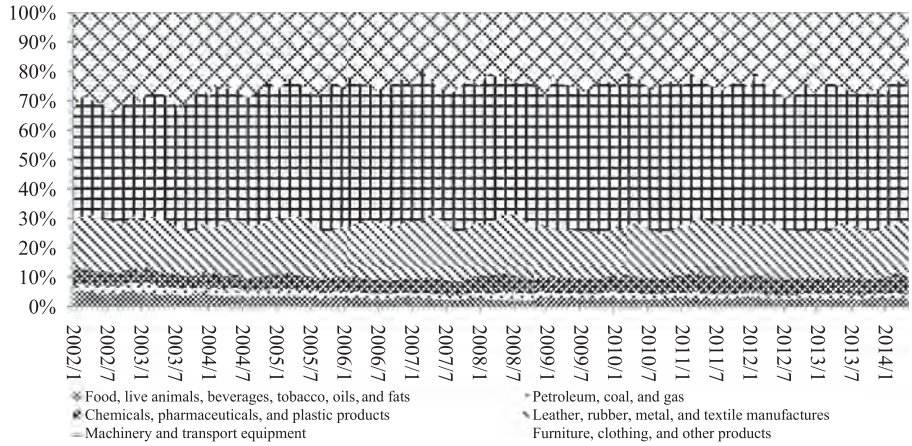
Note: The solid line represents the PRC's MPR (left axis), while the dashed line represents its growth rate (right axis). The dotted line is the linear fit of the MPR growth rate's trend.
Source: Authors' computations.

IV. Determining Export Competitiveness of the People's Republic of China

A. Empirical Specification

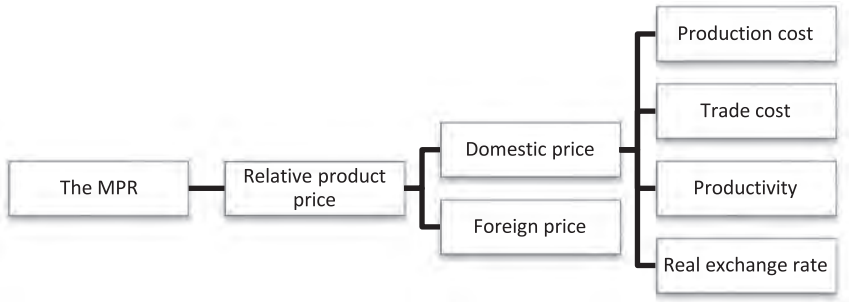
The MPR is higher if exports are cheaper. According to the gravity equation of Eaton and Kortum (2002), export prices are determined by production costs, trade costs, and productivity. In particular, the price of good *k* that country *i* exports to

Figure 5. **Product Composition of Exports of the People's Republic of China**
(2002–2014)



Source: The General Administration of Customs of the PRC.

Figure 6. **Determinants of the Market Penetration Rate**



MPR = market penetration rate.
Source: Authors' compilations.

country j is $p_{ij}(k) = c_i d_{ij}/z_i(k)$, where c_i is country i's production cost, d_{ij} is the trade cost between these countries, and $z_i(k)$ is country i's productivity in producing good k. In addition, the MPR is also affected by the yuan's exchange rate. When the yuan is cheaper, the PRC's exports tend to be favored in price competition with other exporters. Of course, the PRC's MPR is still directly subject to price pressures from competitors. That is, to have a high MPR, the price of the PRC's exports not only needs to be low, but also needs to be lower than that of other exporters. Although prices of other exporters are not generally available, Anderson and van Wincoop (2004), and Baldwin and Taglioni (2006) argue that these effects of third countries can be totally accounted for by multilateral resistance terms, which are essentially destination dummies. MPR determinants are summarized in Figure 6.

Accordingly, a parsimonious determination equation of the MPR can be specified as

$$P_{jkt} = \alpha_j + \alpha_k + \alpha_t + W_t + \tau_{jt} + ULC_{kt} + RER_{jt} + \varepsilon_{jkt}, \tag{2}$$

where P_{jkt} is the MPR of the PRC in destination j and product market k at time t, while α_j, α_k, and α_t are fixed effects of destinations, product markets, and time, respectively. The destination fixed effects also control for multilateral resistance effects as in Anderson and van Wincoop (2004)—i.e., the effects of a third country on the PRC's MPR in the same destination.

W_t is the PRC's real wage rate at time t. As labor is the most important non-tradable input, the wage rate is often used as a proxy variable for production costs (Turner and Van't dack 1993). The PRC's manufactures have been mainly labor-intensive. As the unit labor cost shows, wage costs accounted for about 40% on average of the PRC's total manufacturing output. Hence, the wage rate captures a large portion of the domestic component of production costs.

Meanwhile, τ_{jt} denotes the PRC's trade costs with destination j at time t. It can be indirectly estimated using the gravity model and captures a wide range of factors that we discussed previously. ULC_{kt} is the PRC's unit labor cost in product market k at time t and represents productivity. In particular, a high unit labor cost implies low profits, which further suggests low productivity.

To take into account price effects, we calculate the growth rate of the real exchange rate of the yuan against partner j's currency and denote it by RER_{jt}. Finally, ε_{jkt} represents the error term.

B. Data

Our empirical analysis covers the period from January 2002 to June 2014.The dependent variable, MPR (denoted by P_{jkt}) is calculated from the monthly imports of each destination in each product market. We still consider the PRC's 13 major trading partners and the six product markets categorized under the SITC classification. The real wage rate, W_t, is represented by annual nationwide data obtained from WIND. It measures average labor costs across all industries in real terms and is normalized to 100 in 2002. The Conference Board reports the PRC's unit labor cost, ULC_{kt}, in the manufacturing sector and its 19 industries annually. The problem, however, is how to establish a match between these 19 industries and the six product categories under the SITC classification. Table 3 presents a simple rule. By summing up each industry's unit labor cost under a specific category using its monthly output share as weights, we can estimate the productivity of the PRC in that product market. Because weights change month to month with output share, this measure of productivity features monthly variations.

Table 3. **Transformation between the 19 Manufacturing Industries and Six Product Categories of the People's Republic of China**

19 Manufacturing Industries	Six Product Categories
Food, beverage, and tobacco processing	Food, live animals, beverages, tobacco, oils, and fats
Petroleum refining	Petroleum, coal, and gas
Chemical and pharmaceutical manufacturing	Chemicals, pharmaceuticals, and plastic products
Textile, paper and printing, metal and nonmetallic mineral manufacturing, nonferrous refining	Leather, rubber, metal, and textile manufactures
General machinery, transportation equipment making, electronic machinery making, communication equipment making, other cultural and office products	Machinery and transport equipment
Garment, leather, and fur products, wood processing and furniture making, other products	Furniture, clothing, and other products

Source: Authors' compilations.

The rate of the yuan's real appreciation relative to destination j's currency, RER_{jt}, is calculated using monthly inflation rates in the PRC and destination j, and the nominal exchange rate between the two currencies. In particular, we compute $RER_{jt} = \ln(e_{jt}/e_{jt-1}) - \ln(e_t/e_{t-1}) + \ln(\text{CPI}_t/\text{CPI}_{t-1}) - \ln(\text{CPI}_{jt}/\text{CPI}_{jt-1})$, where $\ln(e_{jt}/e_{jt-1})$ is the monthly average depreciation rate of destination j's currency relative to the US dollar, $\ln(e_t/e_{t-1})$ is the monthly average depreciation rate of the yuan against the US dollar, and $\ln(\text{CPI}_t/\text{CPI}_{t-1})$ and $\ln(\text{CPI}_{jt}/\text{CPI}_{jt-1})$ are, respectively, monthly inflation rates in the PRC and destination j.

As to ASEAN countries, we first calculate their RER_{jt} based on this equation and then aggregate the rates using the PRC's exports to each of these countries as weights. This aggregated variable therefore approximates the appreciation rate of the yuan's real effective exchange rate to ASEAN countries.

Trade costs, however, include too much information to be directly calculated. We have to compromise by estimating these costs in an indirect way via the gravity model. Xu, Liang, and Zhang (2010) proposed a modified gravity equation that can infer trade costs annually from trade values and GDP as follows:

$$\tau_{jt} = 1 - \left[\frac{EXP_{cjt} EXP_{jct}}{s^2 (GDP_{ct} - EXP_{ct})(GDP_{jt} - EXP_{jt})} \right]^{\frac{1}{2(\rho-1)}}. \tag{3}$$

In Equation (3), EXP_{cjt} and EXP_{jct} are, respectively, the PRC's exports to destination j and its exports to the PRC at time t, while EXP_{ct} and EXP_{jt} are, correspondingly, their total exports. GDP_{ct} and GDP_{jt} refer to the gross domestic product. Trade costs are additionally determined by two parameters, s and ρ. In particular, s represents the share of tradable goods in all products. When the share of tradable goods is low, countries trade less not only because of trade costs but also

because of nontradability. Therefore, the estimate of real trade costs from exports and GDP must be adjusted downwards. That is why τ is positively correlated with s.

On the other hand, ρ measures the elasticity of substitution across products. When products are highly substitutable, countries automatically trade less with any given level of trade costs. Hence, the estimate of real trade costs from exports and GDP must be adjusted downwards as well. That is why τ is negatively correlated with ρ. Xu, Liang, and Zhang (2010) set $\rho = 8$ and $s = 0.8$ following the literature. These are the values that we use as well.

Finally, in order to avoid the potential threat of endogeneity, all explanatory variables are lagged by 1 year. However, it should be noted that the regression results are not qualitatively different even if we do not lag these variables.

C. Estimation and Results

A problem one encounters with directly estimating Equation (2) is that dependent and independent variables may share common trends. In this case, estimates tend to include positive biases, where results are larger than the unbiased estimates. Although we introduced year and month dummies, common trends still cannot be completely teased out. In fact, we experimented by estimating Equation (2) directly and found that most coefficients expected to be negative turned out to be positive, contrary to the theory. Hence, in order to correct the results of our empirical analyses, we have to detrend all variables.

In particular, we assume that there are common annual trends between the dependent variable and independent variables. Month on month, however, we assume there are only cyclical variations. To detrend the dependent and independent variables, we therefore only need to regress each variable on the calendar year denoted by *year*. The residual in this regression will then be the detrended portion of the variable. Mathematically, let y represent the dependent variable or any of the four independent variables. It can thus be detrended according to the following equation:

$$y_{jkt} = const_{jk} + \beta_{jk} \cdot year + \delta_{jkt}. \tag{4}$$

In Equation (4), *const* is the constant term, *year* is a continuous variable of calendar years, and β measures the annual trend. As usual, δ is the error term, but its fitted value is also the estimate of the detrended portion of variable y. Note that to detrend variable y, we take its values in each product market k in each destination j as an individual time series. That is, we assume that in each "destination–product group," variable y has a different trend.

Note also that although we address common trends among variables, we do not necessarily need to restrict their trends to be exactly "common." That is, in Equation (4), we allow for the case that each variable has a different trend. However,

Table 4. **Determinants of Export Competitiveness of the People's Republic of China**

	Share of Imports from the PRC (%)						
	All	**Australia**	**Brazil**	**ASEAN**	**Russian Federation**	**Republic of Korea**	**Canada**
Unit labor cost (%)	−0.024***	−0.014***	−0.063***	−0.003	−0.333***	−0.037	−0.052***
	(0.008)	(0.004)	(0.016)	(0.020)	(0.066)	(0.024)	(0.014)
Real wage index	−0.067***	−0.008	−0.002	−0.010	−0.241***	−0.080***	−0.081***
	(0.005)	(0.012)	(0.010)	(0.014)	(0.042)	(0.013)	(0.008)
Trade cost (%)	−0.304***	−0.421	−0.713***	−0.262	−0.945	−0.481*	−0.321
	(0.084)	(0.331)	(0.136)	(0.181)	(0.966)	(0.253)	(0.213)
REER appreciation (%)	−0.010	−2.575***	−0.049	−0.028	−0.956	−1.563***	−1.701***
	(0.026)	(0.514)	(0.284)	(0.020)	(1.796)	(0.514)	(0.458)
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Destination FE	Yes	No	No	No	No	No	No
Observations	13,650	1,050	1,050	1,050	1,050	1,050	1,050
R-squared	0.110	0.238	0.165	0.273	0.166	0.210	0.383
Adjusted R-squared	0.108	0.222	0.148	0.258	0.149	0.194	0.370

	Share of Imports from the PRC (%) (continued)						
	US	**South Africa**	**Europe**	**Japan**	**Saudi Arabia**	**TAP**	**India**
Unit labor cost (%)	**−0.016****	**−0.120****	**−0.037****	**−0.004**	−0.019	−0.027	−0.074***
	(0.004)	(0.053)	(0.017)	(0.018)	(0.034)	(0.017)	(0.025)
Real wage index	−0.073***	−0.131***	−0.095***	−0.030***	−0.017	−0.055***	−0.030**
	(0.007)	(0.026)	(0.009)	(0.011)	(0.018)	(0.009)	(0.012)
Trade cost (%)	−0.943***	−1.823***	−0.474**	−0.746***	−0.066	0.069	−0.463**
	(0.288)	(0.686)	(0.222)	(0.255)	(0.289)	(0.122)	(0.195)
REER appreciation (%)	−0.987	−1.247	−0.420	−3.252***	−9.642*	−2.149**	−0.294
	(3.822)	(0.882)	(0.574)	(0.613)	(5.041)	(1.050)	(0.780)
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Destination FE	Yes	No	No	No	No	No	No
Observations	1,050	1,050	1,050	1,050	1,050	1,050	1,050
R-squared	0.467	0.110	0.384	0.305	0.257	0.287	0.140
Adjusted R-squared	0.456	0.091	0.371	0.291	0.242	0.272	0.123

ASEAN = Association of Southeast Asian Nations, FE = fixed effects, PRC = People's Republic of China, REER = real effective exchange rate, TAP = Taipei,China, US = United States, * = $p < 0.1$, ** = $p < 0.05$, *** = $p < 0.01$.
Source: Authors' computations.

for as long as these trends are positively correlated, regression results will be biased upwards, and detrending with Equation (4) will be necessary.

Table 4 summarizes our empirical results. Since annual trends have already been taken out, year dummies are unnecessary after detrending. Month dummies, however, are still needed to control cyclical variations. The first column is the result of the three-way fixed-effects model that pools the PRC's MPR in all destinations

and product markets, and includes destination dummies, product market dummies, and time (month) dummies. With detrended variables, the signs of all coefficients are now consistent with theoretical predictions. In addition, except for the appreciation of the yuan's real exchange rate, the other three coefficients are all significant. The results shown in this column imply the following:

(i) A fall in the unit labor cost by 1 percentage point, which improves productivity, raises the PRC's MPR by 0.024 percentage point on average. The PRC's unit labor cost was largely stable for almost all products except for petroleum, coal, and gas. Thus, the small coefficient and the general stability of the variable together imply that productivity was not an important driver of the PRC's MPR in terms of economic magnitude.

(ii) A rise in the real wage index by 1 unit depresses the PRC's MPR by 0.067 percentage point on average. Although the number also seems small, the economic magnitude is not. In the PRC, average annual growth of the nationwide real wage was maintained above 10% from 2002 to 2009, sometimes reaching 15%. Thus, because of the growth of the real wage index alone, the PRC's MPR would fall by 0.7 or even 1 percentage point per year on average. In other words, the soaring real wage index was a main negative contributor to the MPR. However, beginning in 2010, the annual growth rate of the real wage index declined to about 8% such that the negative effect imposed by wage growth on the MPR became smaller.

(iii) A rise in trade costs by 1 percentage point hurts the PRC's MPR by 0.304 percentage point on average. According to inferences of the gravity model, the PRC's trade costs with its 13 major partners were declining by 2.3% per year on average. Thus, the improvement in trade costs alone could raise the PRC's MPR by more than 0.7 percentage point each year. In other words, trade costs were the main positive contributor to the MPR. However, trade costs overall improved at a slower rate over time. Before 2010, its annual rate of decline was above 2.5%. Hence, the positive effect it generated on the MPR was able to outweigh the negative effect of a rising wage rate. However, the rate of decline fell below 2% beginning in 2010. Consequently, the MPR declined. This situation reversed again in 2012 when the growth of the real wage index slowed. Hence, the MPR began to recover.

(iv) Real appreciation of the yuan by 1% brings down the PRC's MPR by 0.01 percentage point on average. Quantitatively speaking, its effect is negligible. Statistically, the coefficient is insignificant as well. Therefore, the change in relative value of the yuan does not seem to be an important driver of the PRC's MPR.

The other 13 columns of Table 4 are destination-by-destination results. We make several important observations. First, the coefficient of the variable representing unit labor cost is positive for all destinations and significant for eight destinations, with large magnitudes appearing in the context of the Russian Federation and South Africa. Second, the coefficient of the real wage index is always negative and is significant in nine destinations, with large magnitudes likewise appearing in the Russian Federation and South Africa. Third, the coefficient of trade costs is negative in almost all destinations except Taipei,China, where it is positive but insignificant. The coefficient is negative and significant in seven economies, with large magnitudes appearing in South Africa and the US. Lastly, the coefficient of the variable representing real exchange rate appreciation is negative in all destinations, but significant in only six (less than half of the sample). Large magnitudes appear in the context of Australia and Taipei,China. In a nutshell, regression results based on the whole sample and on each destination market are all largely in line with theoretical expectations.

V. The Outlook of the People's Republic of China's Market Penetration Rate

A. Prediction Method

According to Equation (2), the dependent variable, the PRC's MPR, can be forecast based on reasonable predictions of the independent variables. In particular, if we assume that all determination coefficients remain the same as estimated in Table 4, then according to Equation (2), the MPR can be directly obtained using these estimated coefficients and the predicted values of the variables on the right-hand side.

In this study, the prediction window is set from July 2014 to end-2016.The specific forecasting procedure is as follows:

(i) Predict the four independent variables. For each variable, we estimate an AR(1) model using observed values during 2002–2014. Supposing that the estimated autocorrelation coefficient remains constant until end-2016, we can then iterate the variable forward, and predict its value into the future. It is worth noting that production and trade costs are annual data. The real wage index of the PRC and its trade costs for any destination are taken as individual time series. Unit labor costs meanwhile are of monthly frequency but exhibit clear patterns across months. We thus take the unit labor cost in each product category at any specific month as an individual time series. For example, with regard to the unit labor cost of chemicals, pharmaceuticals, and plastic products, there are 12 sets of time series, each corresponding to a specific

month. This enables us to impose different autocorrelation coefficients for different months. Finally, although data on the appreciation of the yuan's real exchange rate are also of monthly frequency, the monthly patterns are not significant. Hence, we can take the yuan's appreciation against each destination's currency as an individual time series. In addition, only the time series on the appreciation of the yuan against the US dollar and the Saudi riyal have unit roots that must be first-differenced before performing the autoregressions.

(ii) Predict the detrended MPR. We first detrend the predicted values of the four independent variables obtained in the previous step by Equation (4). We then assume that the coefficients in Table 4 remain constant within the prediction window and use the detrended predictions of the four independent variables to forecast the detrended MPR according to the linear relationship. Note that during the prediction, we also assume that destination fixed effects, product market fixed effects, and month fixed effects remain constant at levels that we estimated before.

(iii) Add back yearly trends. To obtain the final prediction of the MPR, yearly trends must be added back to the detrended MPR calculated in the previous step. We predict the yearly trends in the future against two different scenarios. In the first scenario, which we call the "status quo," we assume that the yearly trends stop growing with calendar years and remain unchanged beginning 2014. That is, the PRC's MPR immediately loses its pre-crisis momentum of growth, such that it will remain stable over time if production costs, trade costs, productivity, and real exchange rates all do not change. In the second scenario, which we call the "optimistic case," we assume that yearly trends still grow along with calendar years throughout the prediction window. In other words, we assume in this case that the pre-crisis momentum will be immediately regained in the future, such that even if production costs, trade costs, productivity, and real exchange rates all do not change, the MPR will still grow over time simply due to the momentum of growth as it did before the crisis.

B. Results

Figure 7 presents our forecast of the PRC's MPR in various destinations. In each panel, the solid line represents the real or observed value. It starts from January 2002 and ends in June 2014. The dashed line represents the predicted MPR in the status quo scenario, while the dotted line represents the predicted MPR in the optimistic case. Both lines range from July 2014 to end-2016. There is also a vertical line in each panel specifically in July 2014, indicating the start of the prediction window.

Figure 7. **Prediction of the Market Penetration Rate of the People's Republic of China by Destination Market**
(2002–2016)

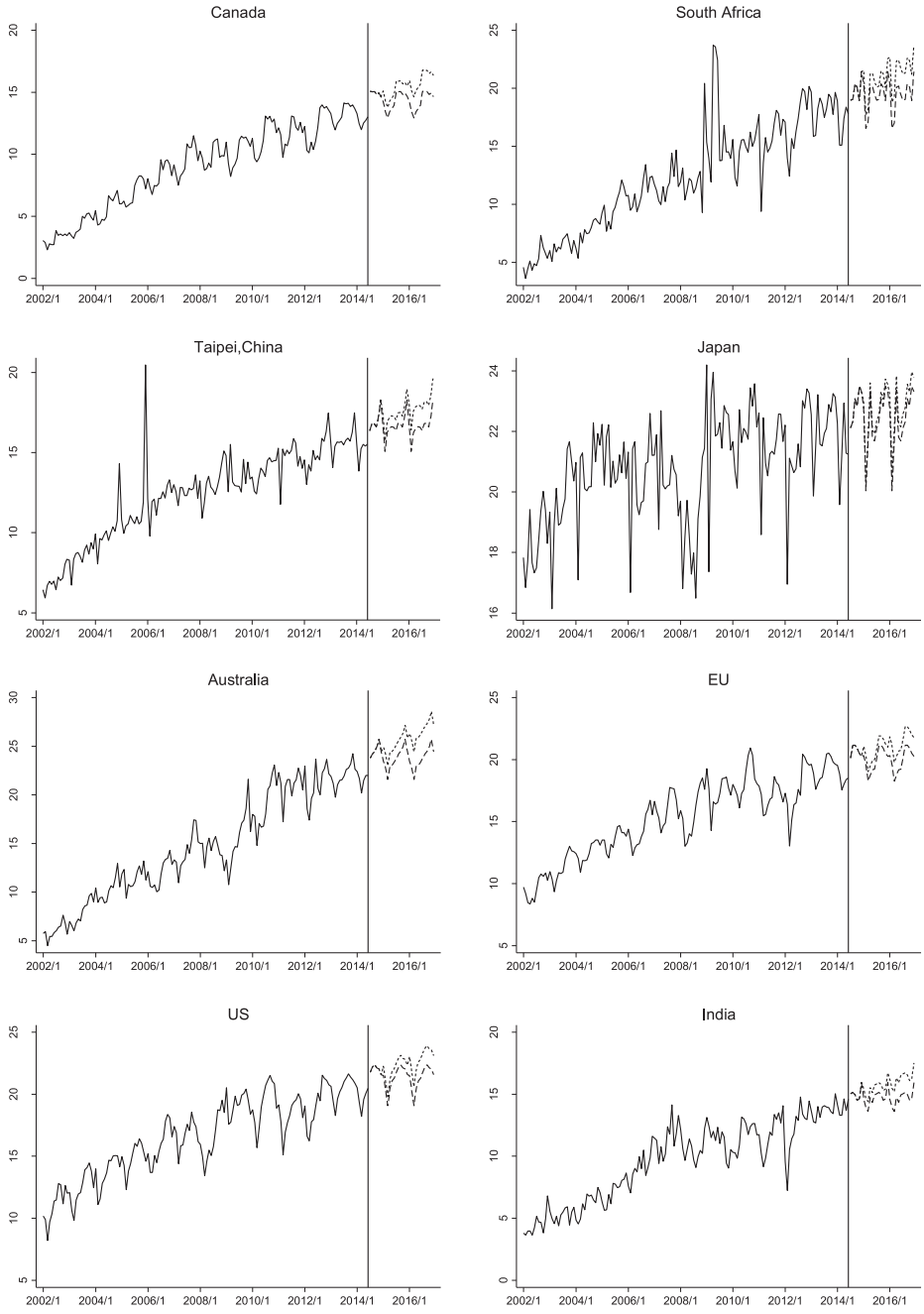
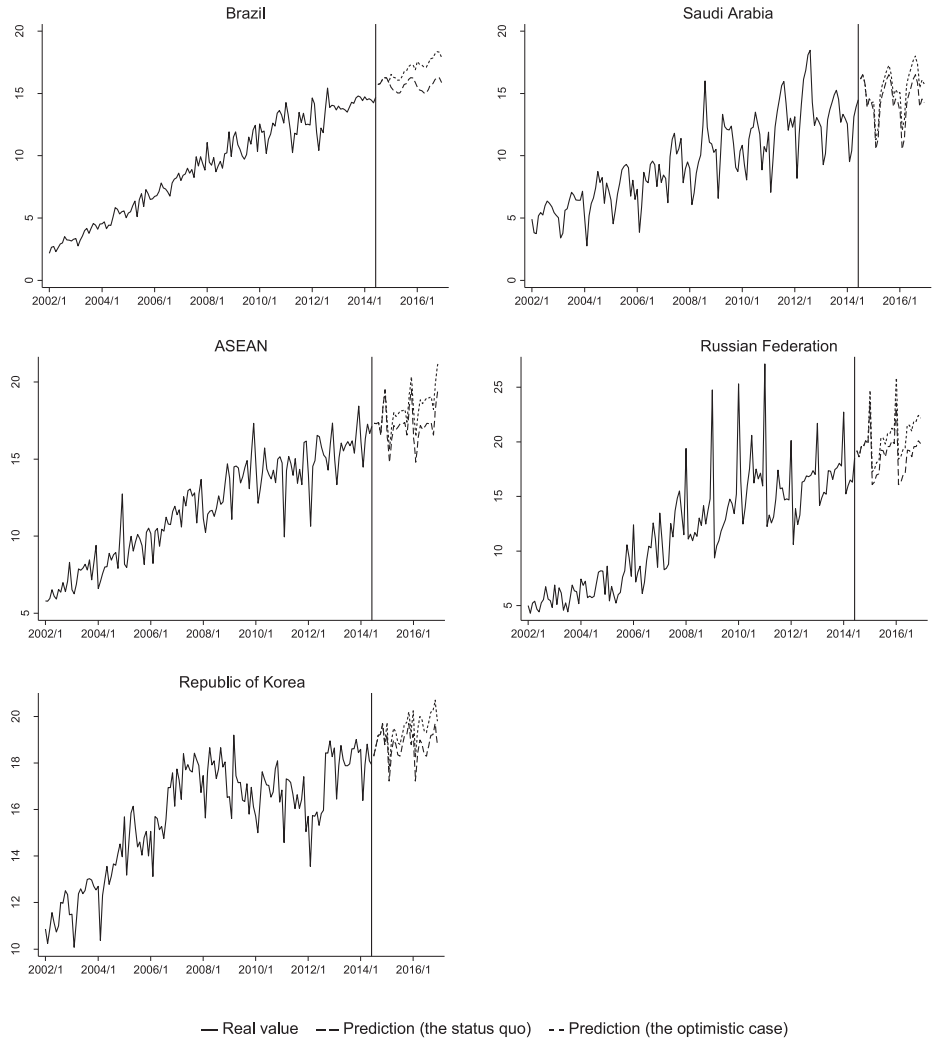


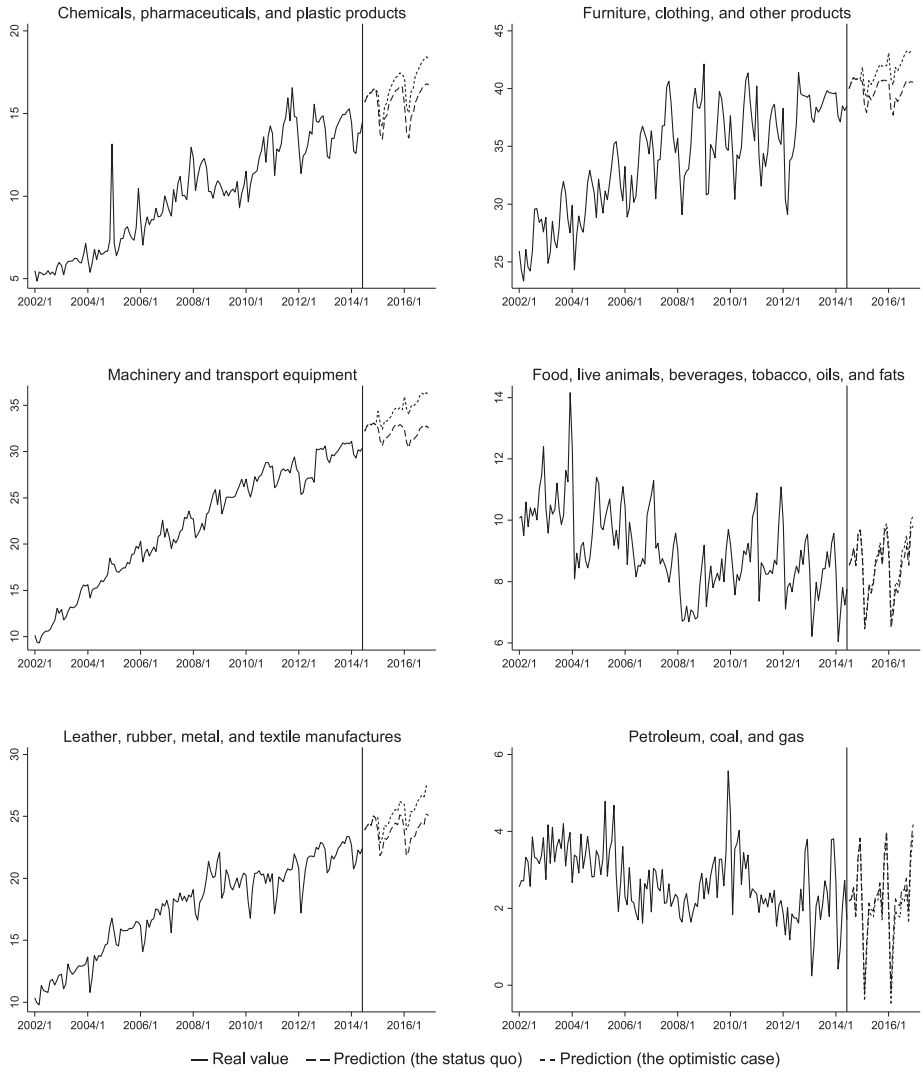
Figure 7. *Continued.*



ASEAN = Association of Southeast Asian Nations, EU = European Union, US = United States.
Source: Authors' computations.

The outlook for the PRC's MPR offers relief if the optimistic scenario happens. An enhancement of the MPR, which indicates a gain in the relative strength of the Chinese exports, can be expected in all destination markets except Japan. Nevertheless, it should be remembered that the optimistic case assumes the pre-crisis momentum will be immediately regained in all destinations, which is hardly realistic. In the status quo scenario, however, the outlook of the MPR appears gloomy. In particular, the MPR will flatten out or fall in most markets, although it will keep growing in ASEAN and the Republic of Korea.

Figure 8. **Prediction of the Market Penetration Rate of the People's Republic of China by Product Market**
(2002–2016)



Source: Authors' computations.

These findings at the destination level suggest that the PRC's aggregate MPR is likely to stop increasing in the near future unless the optimistic case happens. However, the constant uptrend of the MPR in ASEAN and the Republic of Korea still brightens the outlook. This suggests that an adaptive shift of export shares to these markets can be an effective strategy to support the PRC's overall exports.

Figure 8 showcases our forecast of the PRC's MPR in various product markets. The graphed variable is the weighted average of the PRC's MPR in each product

market across all destinations, where the weights are the shares of the PRC's exports to each destination in its total exports of that product. We assume that the weights do not change beginning 2014. In particular, we let the weights in any month of the prediction window be exactly identical to those in the same month for the year 2013. This implies that we assume away composition effects resulting from destination shifts in this prediction. As before, the solid line in each panel represents the revealed (observed) MPR, the dashed line represents the predicted MPR in the status quo scenario, and the dotted line represents the predicted MPR in the optimistic case. The vertical line indicates the start of prediction.

Figure 8 reveals that if the optimistic case happens, then the MPR will keep on increasing, indicating a gain in the relative strength in four product markets: the market for chemicals, pharmaceuticals, and plastic products; furniture, clothing, and other products; machinery and export equipment; and leather, rubber, metal, and textile manufactures. However, if the status quo scenario occurs, the MPR will plateau or fall in all product markets except for leather, rubber, metal, and textile manufactures.

VI. Conclusions

Since the global financial crisis, the PRC's export growth has significantly slowed. This paper examined if this is simply caused by the shock of the crisis or if it reflects fundamental changes in the relative strength of the country's products. We used the MPR as a measure of competitiveness and found that it generally increased during 2002–2014. Despite this overall growth, however, the rate of growth of the MPR has slowed. In particular, an abrupt decline was observed immediately after the breakout of the financial crisis in 2008 and a gradual but longer decline seen between mid-2010 and 2012. Aggregate MPR underwent a gradual recovery afterwards. Weakening signs of the PRC's MPR could also be perceived at more detailed destination and product markets.

With investigations into four underlying determinants of MPR, we identified production and trade costs as the two main drivers. In particular, the PRC's quickly increasing labor costs has a significantly negative impact on the MPR, which is partly offset by the country's decreasing trade costs with most of its trading partners. However, as the rate of decline in trade costs slows, the negative effect of rising production costs begins to dominate. The effects of productivity growth and the real exchange rate appreciation are generally insignificant or small in economic magnitude.

Finally, we predicted the PRC's MPR in different destinations and product markets until 2016. In the optimistic scenario, the MPR will increase in all destination markets except Japan and in four out of six product markets except for petroleum, coal, and gas; and food, live animals, beverages, tobacco, oils, and fats.

While this outlook is comforting, the optimistic case assumes that yearly trends will immediately regain the pre-crisis momentum, which seems unrealistic. In the "status quo" scenario, however, the MPR will plateau or fall in most markets except in ASEAN and the Republic of Korea in terms of destinations; and for leather, rubber, metal, and textile manufactures in terms of products.

Seeing this gloomy outlook, adaptive policies are urgently needed. In particular, trade and industrial policies that can facilitate structural change toward destinations and product markets where the MPR is growing will be crucial in order to stabilize export growth and avoid any severe harm to the export sector. In addition, as the MPR declines, macro policies that can stimulate domestic demand—e.g., increasing the wage income and reducing income inequalities, improving the social security system, and facilitating infrastructure building—are also essential to maintain the PRC's high economic growth.

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*ADB recognizes "China" as the People's Republic of China.

Health Care Expenditure over Life Cycle in the People's Republic of China

JIN FENG, PINGYI LOU, AND YANGYANG YU*

We use individual level data from eight waves of the China Health and Nutrition Survey during 1991–2011 to investigate age profiles of health expenditure for rural and urban residents in the People's Republic of China (PRC). Employing a two-part model, we find that health expenditure of rural residents is averagely 33% lower than that of urban residents and age–expenditure profile is much steeper in urban areas than in rural areas. However, there is no evidence that the health status of the rural elderly is better than that of the urban elderly. The findings imply that health spending of the rural elderly may increase more during the process of rural–urban integration. In addition, we find a significant difference in age–expenditure profiles across time. Compared with expenditure during 1991–2000, the estimated age-expenditure profile becomes steeper during 2004–2011 in both urban and rural areas.

Keywords: health expenditure, age-expenditure profile, rural–urban integration
JEL codes: I10, J11

I. Introduction

With rapid population aging, there is growing concern about its impact on health care expenditure in the People's Republic of China (Peng 2011; Chen, Eggleston, and Li 2011). Since people tend to use more health care as they age, many people are concerned that an aging population will accelerate growth in health care spending. The share of the population age 65 and over is a common indicator used to measure population aging. Data from the Chinese national census show that the share of this age group was 5.9% in 1990 and 7% in 2000, increasing to 8.4% in 2010. According to projections of the United Nations (medium variant), the population age 65 and over will be around 230 million, or about 16.2% of the total.[1]

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[1]United Nations, Department of Economic and Social Affairs. World Population Prospects: The 2012 Revision. Available online: http://esa.un.org/unpd/wpp/index.htm.

In order to have a correct judgment of the growth in aggregate health spending during population aging, we need to understand how age influences the demand for health care. Constructing life-cycle profiles of health expenditure is a primary step towards this goal.

There are only a few studies in the literature analyzing life-cycle health expenditure in the PRC. It is reported that per capita health spending for people age 65 and over was 2.56 times the amount for that under age 65 in 2002 (Li and Chen 2006). For public health care spending per capita, Shen and Lee (2014) using micro data find that the age profile has a J-shape curve in both urban and rural areas. The peak value occurs at around age 80.

Most studies on the United States (US) and other Organisation for Economic Co-operation and Development (OECD) countries conclude that population aging has not been a significant driver of health spending in contrast to growing demand for health care and rising costs due to technology progress in the health care sector, which have had a more significant influence (Newhouse 1992, Getzen 1992, Gerdtham and Jönsson 2000, Baltagi and Moscone 2010). Another line of studies states that health expenditures are mainly driven by time to death, not only age per se (Zweifel, Felder, and Meiers 1999; Seshamani and Gray 2004).

The findings in developed countries may not directly apply to the PRC. First of all, health expenditure in the PRC lags far behind OECD countries and many countries with comparable gross domestic product (GDP) per capita, though it has been increasing for decades. One of the important reasons for low health spending in the PRC is the lack of rural health care consumption. For example, per capita health expenditure of rural residents was only one-third of that of urban residents in 2012. Rural–urban integration during urbanization increases the demand for health care generally, but expenditures by elderly people may increase more than other groups. Whether population aging accompanied by urbanization leads to larger age effects in the PRC than in OECD countries is an unanswered question.

Another remarkable fact is that the Chinese economy and health care system have gone through fundamental reforms in the past years. The reforms have exerted various influences on people born in different times, with diverse life experiences due to "the timing of lives." For example, compared with people of the same age 20 years ago, individuals nowadays have greater access to health care and enjoy more advanced technologies in health care. Furthermore, since the elderly have the highest demand for health care, improving accessibility favors them the most. Hence, the age–expenditure profile today may be steeper than it was before. Testing whether age effects vary across periods in the PRC is a way to illustrate the so-called cohort effect.

We use data from eight waves of the China and Health Nutrition Survey (CHNS) during 1991–2011. The data include information on the health care of individuals of all age ranges across different periods. Employing a two-part model, we find that health care expenditure of rural residents is lower than that of urban

residents in all age groups. We also find the age–expenditure profile to be much steeper in urban areas than in rural areas. However, there is no evidence that the health status of the rural elderly is significantly better than that of the urban elderly. The findings imply that health spending of the rural elderly may increase more during the process of rural–urban integration compared with the urban elderly. We also find a significant difference in age–expenditure profiles across time in both urban and rural areas.

Based on the above estimation, we estimate the contribution of population aging to growth of aggregate health spending and show that the growth rate accounted for by population aging during the urbanization period between 1990 and 2010 is about 2.8%. This accounts for about a fifth of total real annual growth.

In the future, population aging and urbanization will likely continue to drive health expenditure. It is worth noting, however, that the growth of health spending has different meanings in the PRC than in OECD countries. While developed nations struggle with rising health spending, increased expenditure in the PRC during urbanization is encouraging to a large extent, as more people receive much-needed health care.

II. Literature Review

Our paper is related to empirical studies on the life cycle aspect of demand for health care. On average, health care spending is higher for older people than for younger people. Studies on OECD countries show that per capita health spending for people age 65 and over was 2.7 to 4.8 times the amount of those under age 65 in the mid-1990s (Anderson and Hussey 2000). In developing countries, the ratio was 2.9 in Sri Lanka during the same period (Reinharde 2003) and 2.56 in the PRC in 2002 (Li and Chen 2006). More detailed information on the PRC is presented by Meng and Yeo (2006) using household survey data from the China Household Income Project in 2002. They show that, in urban areas of the PRC, an individual in her 60s spends 50% to 100% more on health care than a 40-year old, while an individual in her 80s spends 100% to 170% more than a 40-year old. Shen and Lee (2014) use China Family Panel Studies data to show that per capita public health care spending is high in infancy, decreases for the teenage years, then increases again at middle age. The peak of public health spending occurs at around age 80.

However, several studies find that in rural areas of the PRC, age–expenditure profiles are different from normal patterns, as the elderly spend less on health care. According to a survey done in the 1990s covering 8,414 individuals and 1,428 households in 8 provinces, the 2-week hospitalizing probability and expenditure of people age 65 and over are lower than those of middle-age people (Gao and Yao 2006). A more recent survey comprising 50,357 observations in 4 counties in Hubei and Sichuan provinces finds that self-reported morbidity of the elderly is 30

points higher than for the non-elderly, while inpatient admission is 5 points lower. In addition, per capita inpatient and outpatient spending for the elderly are lower than for the non-elderly, by CNY775 and CNY328, respectively (Yan and Chen 2010).

While per capita spending for health care is consistently higher for older people in most countries, a set of studies indicate that population aging is a relatively minor factor in the growth of national spending for health care. Other factors, including rising per capita income, the availability of new health care products and services, health insurance coverage, and characteristics of the health care system play much bigger roles (Newhouse 1992, Gerdtham and Jönsson 2000, White 2007, Baltagi and Moscone 2010). Population changes occur gradually, while health care spending has grown rapidly.[2]

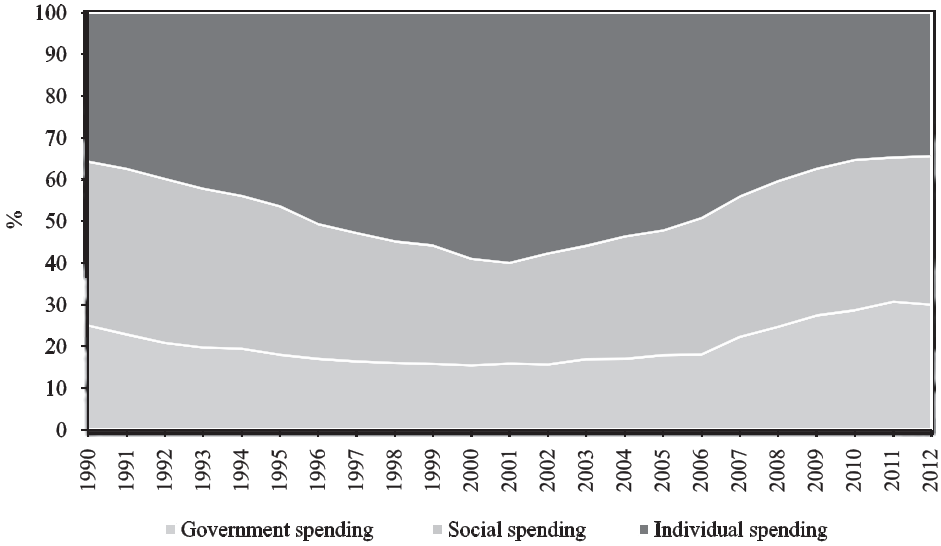
Newhouse (1992) argues that population aging can only explain 2% of the growth of national spending during 1940–1990 in the US. During 1970–2002, real growth of per capita health spending averaged 4.3% per year in the US and 3.8% in a subset of OECD countries. Population aging accounts for 0.3 percentage points of growth in health spending in the US and 0.5 percentage points in OECD countries, about a tenth of total annual growth (White 2007). Cross-country analyses find that age structure (e.g., proportion of the population age 75 and older, and proportion of the population under 4 years old) has no significant effect on national health spending (Gerdtham and Jönsson 2000). Baltagi and Moscone (2010) use a panel of 20 OECD countries over the period 1971–2004 to show that average annual growth rate of health spending is 11.5%, but do not find aging to be the most important contributing factor.[3]

There is also evidence that health expenditure for the elderly may be increasing at a different rate than that for the non-elderly. The ratio of per capita spending of the elderly to the non-elderly in the US was 3.0 in 1987, climbing to 3.9 in the mid-1990s (Anderson and Hussey 2000). Cutler and Meara (1997) find that during 1953–1987, annual growth of per capita spending on the elderly was about 8%, significantly higher than the estimated 4.7% annual growth for those age 1 to 64 years, but the trend reversed after 1996. Other researchers have shown that elderly spending rose at about the same rate as non-elderly spending on health care in the 1960s to the 1990s (Boccuti and Moon 2003). The annual growth rate of per capita spending for the elderly was lower than other age groups in the more recent period in the US, partly because of the reform in Medicare, which aimed to control the growth of spending for the elderly (Meara, White, and Cutler 2004). In the PRC, public health insurance has been proven to be a valid policy to increase the demand for

[2] According to *World Population Prospects*, the share of the population age 65 and over was 8.26%, increasing to 9.76% in 1970, 12.47% in 1990, and 13.06% in 2010. In most developed countries, the population has been aging for many decades, while in developing countries, population aging has taken place relatively recently (United Nations 2013).

[3] Baltagi and Moscone (2010) reconsider the long-run economic relationship between health care expenditure and income, and suggest that health care is a necessity rather than a luxury, with an elasticity much smaller than that estimated in previous studies.

Figure 1. **Structure of Health Care Spending in the People's Republic of China** (1990–2012)



Source: Ministry of Health of the People's Republic of China. 2013. China Health Statistics Yearbook.

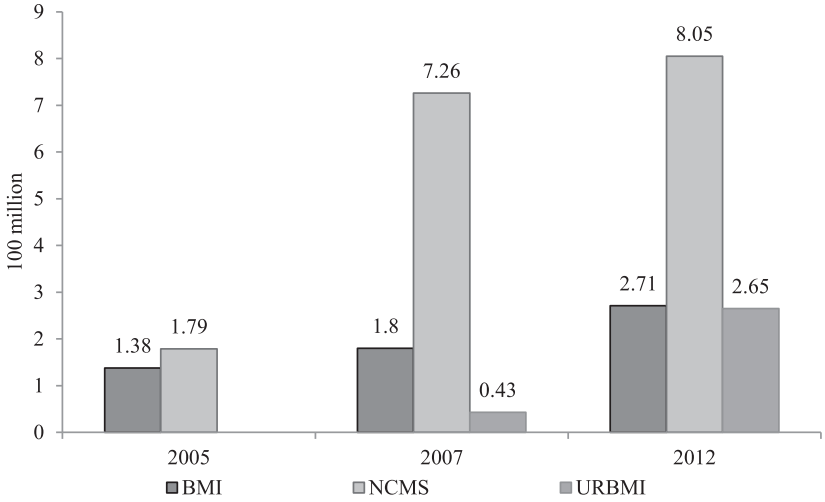
health care of the elderly. Liu, Cai, and Li (2011) find that health insurance coverage significantly increases the utilization of health care of the elderly in both rural and urban areas.

III. The Health Care System in the People's Republic of China

Health care spending as a share of GDP has been increasing in the PRC, from 4% in 1990 to 5.36% in 2012. Three parties are involved in the determination of health care spending in the country. They are government, the social insurance programs, and the individual. The spending driven by each party has been increasing over time but at different speeds. As a result, the structure of the three parties has changed over time (Figure 1). Government and social spending increased gradually prior to 2003. During 1990–2003, individuals' share increased continuously. In the peak year, individual out-of-pocket spending accounted for 60% of total health care spending. In 1990, individual health care spending was 1.4 times the amount spent by government, with the ratio increasing to 3.8 in 2003. After 2003, the growth of government spending and social spending started to exceed the growth of individual spending. The share of individual out-of-pocket spending fell to 34% in 2012. During the same period, government's share rose from 16% to 30%.

The changing pattern has been widely discussed in literature (e.g., Hu et al. 2008, Yip and Hsiao 2008). The evolving role of government in health care financing

Figure 2. **Number of Participants in Health Insurance Programs**

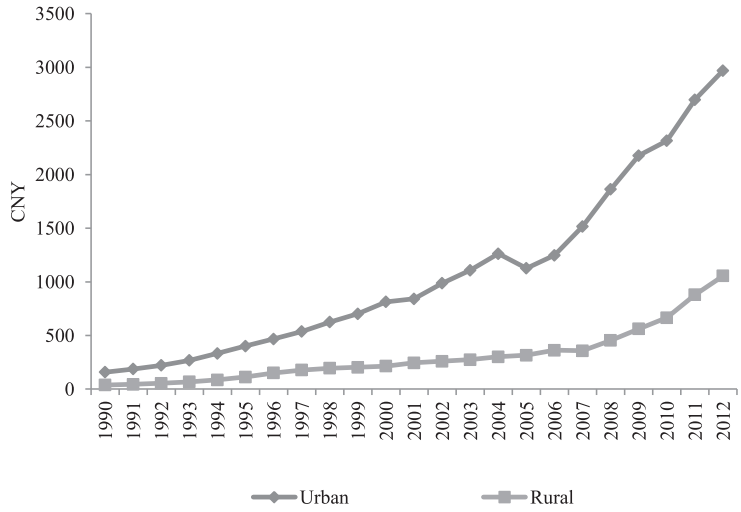


BMI = basic medical insurance, NCMS = new cooperative medical system, URBMI = urban residents basic medical insurance.
Source: Ministry of Health of the People's Republic of China. 2013. China Health Statistics Yearbook.

reflects the direction of health care reform of the PRC. Since the middle of the 1980s, the main reform in the health care sector has been to reduce the state subsidy to public hospitals and encourage hospitals to raise their own funds to cover costs. In the 1990s, hospitals were allowed to generate profit from selling medicines and providing high-tech examinations. The direction of reform was reversed after 2003. Government inputs to health care increased significantly, and new social insurance programs were introduced in 2003 and 2007. A nationwide systemic reform was launched in 2009, supported by substantial public funding. The reform reinstated the government's role in the financing of health care and the provision of public goods.

Social health care expenditure mainly refers to spending paid from social insurance programs. Since the end of the 1990s, public health care has been reformed to favor health insurance programs, and the number of participants therefore expanded dramatically (Figure 2). There is now a variety of health insurance for different population groups. The government introduced the basic medical insurance scheme (BMI) for urban employees in 1998 and the new cooperative medical system (NCMS) for farmers in 2003. In 2007, another health insurance program known as the Urban Resident Basic Medical Insurance scheme (URBMI), which covers urban residents not included in the BMI, was introduced. This new scheme covers children, the elderly, the disabled, and other non-working urban residents. As in the NCMS, there is a government subsidy for the premium payment in the URBMI. By 2012, out of the total population of 1.35 billion, 805 million people were covered by the NCMS, 271 million by the BMI, and 265 million by the URBMI.

Figure 3. **Urban and Rural Per Capita Health Spending**



Source: Ministry of Health of the People's Republic of China. 2013. China Health Statistics Yearbook.

It is worth mentioning that benefit packages differ substantially among the three programs. The BMI is more generous than the other two programs. For example, while the average inpatient reimbursement rate was only 41% in 2009 under the NCMS, the rate was 65% for urban employees in 2008 and 45% for urban residents in 2007 (Shen and Lee 2014).

An important characteristic of the PRC is the large urban and rural disparity—per capita health spending of rural residents has been much lower than that of urban residents. Data in Figure 3 show that the gap has continued to widen. In 2010, per capita health care expenditure of urban residents was 3.79 times as much as that of rural residents.[4] However, there is no evidence that the health status of rural residents is better. On the contrary, the 2008 *China National Maternal and Child Surveillance* reports that the 2007 rates for maternal, infant, and under-5 mortality in rural areas were twice as high as those in urban areas (0.04%, 1.9%, and 2.2% vs. 0.02%, 0.8%, and 0.9%, respectively).[5] The disparity is a consequence of insufficient health care supply, poor health care insurance, and low household income in rural areas. According to Shen and Lee (2014), urban residents benefit more from public health care funding than rural residents at all ages, especially after age 60. According to the *China Health Statistics Yearbook* (2013), the number of professional health staff for every 1,000 persons is 3 times lower in rural areas than in urban areas during the 2000s.

[4]Data on urban and rural health spending available since 1990 in the *China Health Statistics Yearbook* (2013).

[5]"China National Maternal and Child Surveillance" is a national database that includes newborn, infant, and under-5 mortality rates by sex and urban or rural areas.

IV. Data and Summary Statistics

A. Data

We use eight waves of the CHNS survey during 1991–2011. These were conducted in 1991, 1993, 1997, 2000, 2004, 2006, 2009, and 2011. Adopting the multi-stage stratified cluster sampling method, the survey obtains random samples from nine provinces: Guangxi, Guizhou, Heilongjiang, Henan, Hubei, Hunan, Jiangsu, Liaoning, and Shandong.[6] The survey contains comprehensive information on households and individuals, including demographic and socioeconomic information of family members, health status, utilization of health facilities, health care expenditure, and insurance participation of each family member. To reduce noise due to outliers, we drop the 0.5% lowest and highest expenditures for each year. This leaves a total of 94,271 observations for the eight waves.

The observations are evenly distributed among the waves. Urban and rural observations on average account for 32.4% and 67.6%, respectively.[7] We divide the observations into eight age groups (i.e., according to the age in the survey year): 0–9 years, 10–19 years, 20–29 years, 30–39 years, 40–49 years, 50–59 years, 60–69 years, and 70 and over. In the PRC, the share of population age 60 and over also measures population aging, as the retirement age is 60 for men and 55 or 50 for women. The share of observations for age 60 and over increased from 11% in 1991 to 26% in 2011, while that for age 70 and over increased from 4% to 10% during the same period.

Each interviewee reported whether he or she had been ill in the past 4 weeks. If he was ill, the survey asked whether he went to a hospital, how much he spent, and how much was covered by health insurance. Expenditure here includes fees for outpatient care, cost of inpatient care in various levels of health care facilities, and consumption of drugs. We sum up all spending items paid out-of-pocket and by insurance of each interviewee who had been sick during the last 4 weeks and adjust the spending to 2011 prices using the price index provided by the CHNS dataset.[8]

Table 1 summarizes the relevant variables for the full sample by waves of the survey.

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[6] Available online: http://www.cpc.unc.edu/projects/china. The survey is jointly implemented by the Carolina Population Center at the University of North Carolina at Chapel Hill, the National Institute of Nutrition and Food Safety of the US, and the Chinese Center for Disease Control and Prevention.

[7] Urban and rural are classified by the location of the survey. If the location is a rural community, the sample in the community is defined as a rural resident. If the location is an urban community, the sample is defined as an urban resident.

[8] We estimate an expenditure function to predict health care expenditure for those who failed to report spending but were ill and went to a hospital. The dependent variable is expenditure in log form. Explanatory variables include age, gender, type of disease, severity of disease, provincial dummies, and year dummies. Such observations account for about 10% of total observations.

Table 1. **Summary Statistics for the Full Sample**

Variables	1991	1993	1997	2000	2004	2006	2009	2011
Having expenditure	0.074	0.041	0.050	0.052	0.125	0.120	0.130	0.148
Health expenditure (conditional, CNY)	743.6	775.1	876.5	924.4	925.9	780.1	1104.9	1166.0
Rural	0.696	0.717	0.684	0.697	0.665	0.667	0.666	0.600
0–9	0.104	0.124	0.087	0.053	0.036	0.037	0.035	0.041
10–19	0.195	0.189	0.186	0.189	0.126	0.098	0.083	0.078
20–29	0.194	0.167	0.168	0.151	0.094	0.080	0.086	0.081
30–39	0.168	0.169	0.159	0.173	0.160	0.156	0.140	0.128
40–49	0.132	0.147	0.167	0.174	0.199	0.200	0.202	0.206
50–59	0.098	0.093	0.106	0.123	0.189	0.209	0.209	0.207
60–69	0.070	0.074	0.080	0.084	0.113	0.125	0.140	0.157
70+	0.040	0.038	0.047	0.053	0.082	0.095	0.105	0.103
Male	0.493	0.498	0.502	0.505	0.487	0.484	0.488	0.475
Per capita income inflated (CNY, 1000)	3.622	4.079	4.996	6.304	8.253	9.756	13.751	16.326
Years of schooling	5.598	6.005	6.138	6.872	7.180	7.221	7.300	7.906
Insurance	0.280	0.229	0.236	0.206	0.269	0.489	0.906	0.951
Observations	12,393	12,048	12,390	12,956	10,511	10,154	10,407	13,412

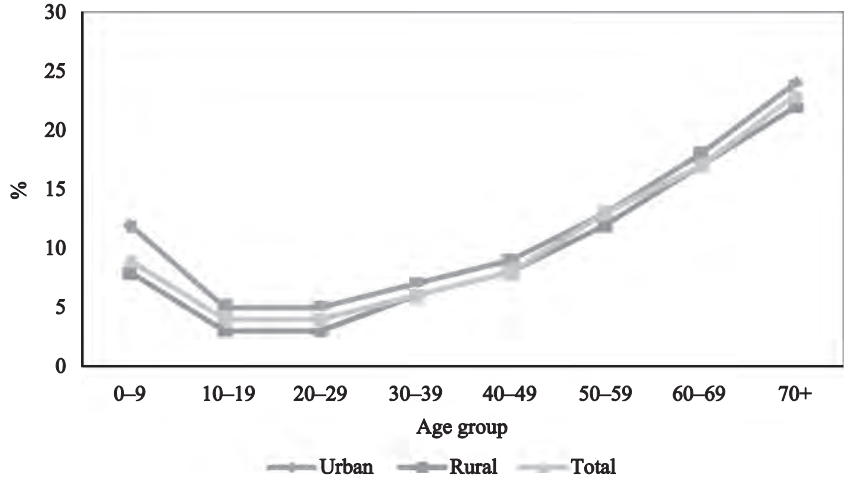
Source: Authors' computations.

B. Health Expenditure across Age Groups and Cohorts

We first present results from a cross-section analysis where we average the probability of expenditure and the level of health expenditure by age group. Health spending of those who were not ill during the past 4 weeks is counted as zero when averaging the expenditure for each age group. These profiles do not distinguish age, cohort, or period effects and therefore may introduce bias into health spending estimates over age groups. Figure 4 shows that the incidence of health spending during the 4 weeks is lowest in the 10–19 and 20–29 age groups. The incidence increases with age, reaching 23% in the group age 70 and over. Average health spending during the 4 weeks is lowest for the 10–19 age group (Figure 5a). The expected spending of those age 60 and over is 4.2 times as much as the rest, while for the elderly age 70 and over, it is 4.3 times as much. Incidence and level of health expenditure across age groups is similar for urban and rural residents (i.e., the older, the wider the gap), although spending of urban residents is significantly higher than that of rural residents.

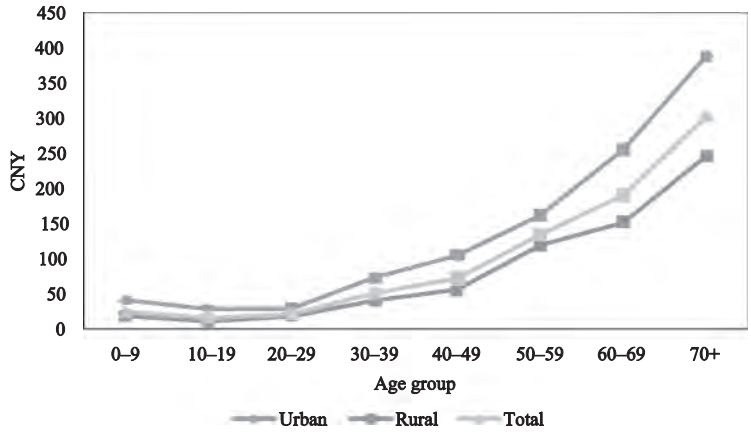
It is helpful to present health expenditure profiles for different cohorts. Cohorts vary in initial conditions—e.g., those who experienced war or famine or encountered various influences during the life cycle—which have a long-lasting impact on health (Ryder 1965). Cohorts here are divided by observation's birth year. The first cohort consists of people born after 1990, the second cohort comprises those with birth years from 1980 to 1989, the third cohort covers those with birth years from 1970 to 1979, etc. The eighth cohort covers people with birth years before

Figure 4. **Health Care Expenditure Incidence in 4 Weeks**
(1991–2011)



Source: Authors' calculations using data from the China and Health Nutrition Survey (CHNS).

Figure 5a. **Health Expenditure in 4 Weeks**
(1991–2011)

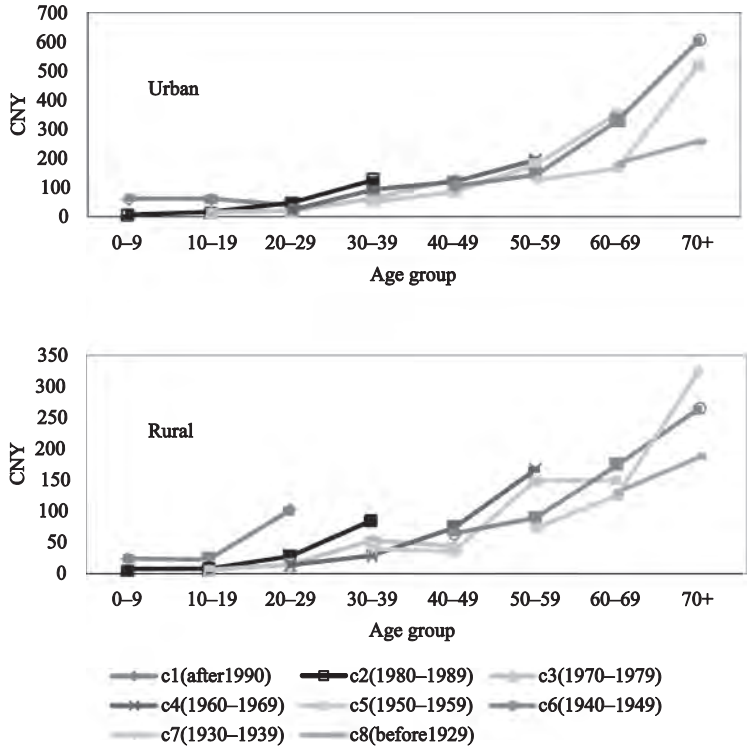


Note: Data are adjusted to 2011 CNY values.
Source: Authors' calculations using data from the China and Health Nutrition Survey (CHNS).

1930. Average health expenditures across age groups and cohorts are reported in Figure 5b. Results show that even in the same age group, cohorts with a later birth year tend to have greater health spending.

As there are fundamental changes in the health care system after 2003, we split the samples into two periods: 1991–2000 and 2004–2011. Each period contains information including the role of government, extension of health insurance coverage, improvement of health care technology, and level of income. All these

Figure 5b. **Health Expenditure by Cohort**
(1991–2011)



Note: Data are adjusted to 2011 CNY values.
Source: Authors' calculations using data from the China and Health Nutrition Survey (CHNS).

factors have some impact on health expenditure. As a result, spending increased significantly in the later period, especially the expenditures of the elderly (Figure 6a and 6b).

C. Gender and Health Expenditure

We present health expenditure profiles by gender in Figures 7a and 7b. In urban areas, it is shown that women spend a little more than men from age 20 to 69. Specifically, women age 30 to 39 spend on average 10.6% more on health care than men of the same age group. This is consistent with reports in the literature that women outspend men, especially during their prime childbearing years. In rural areas, men spend a little more than women in health care in most age groups. The special pattern is consistent with the observation that resource allocation within a household is male-biased in rural areas of the PRC. The significance of the difference will be tested in our regressions.

Figure 6a. **Health Expenditure by Period**
(urban residents, both sick and non-sick samples)

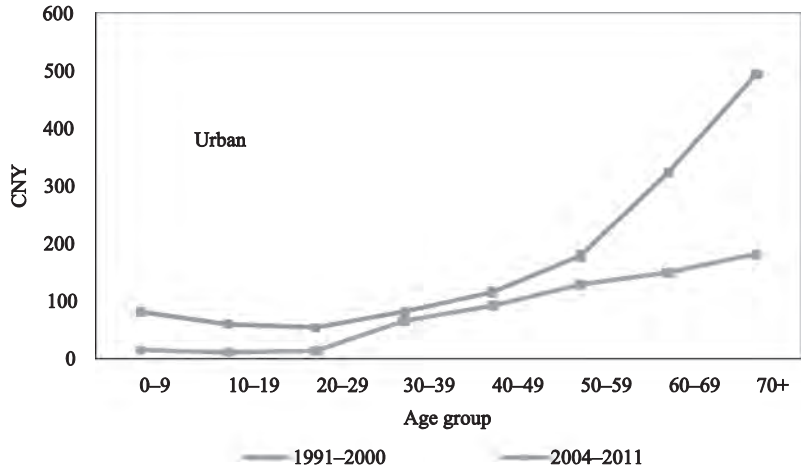
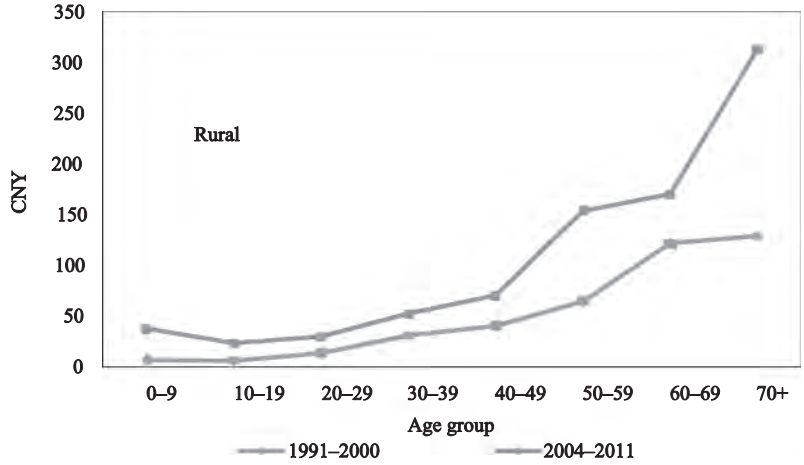


Figure 6b. **Health Expenditure by Period**
(rural residents, both sick and non-sick samples)



Source: Authors' calculations using data from the China and Health Nutrition Survey (CHNS).

D. Health Insurance and Health Expenditure

In our sample, the number covered by public health insurance programs has been increasing over time. Those programs include the BMI, the NCMS, the URBMI, and free medical care for government officials. In 1991, the coverage rate of the cooperative medical care system for rural samples was only 17%, but this rose to 95% in 2011. The coverage rate of health insurance for urban samples increased

Figure 7a. **Health Expenditure by Gender**
(urban residents, both sick and non-sick samples)

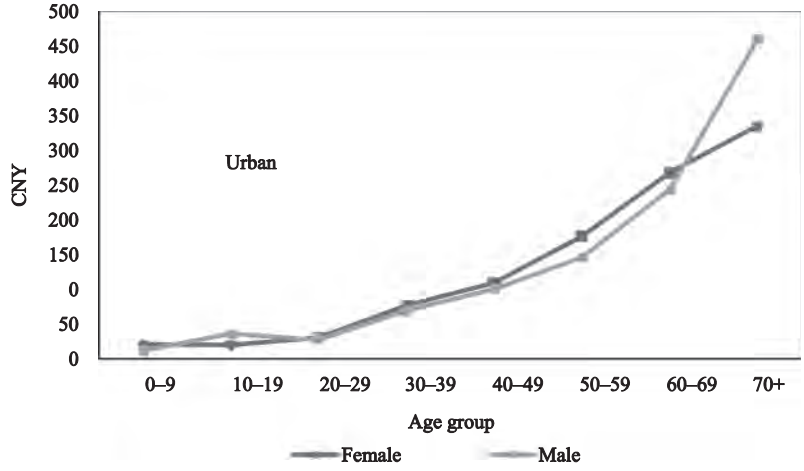
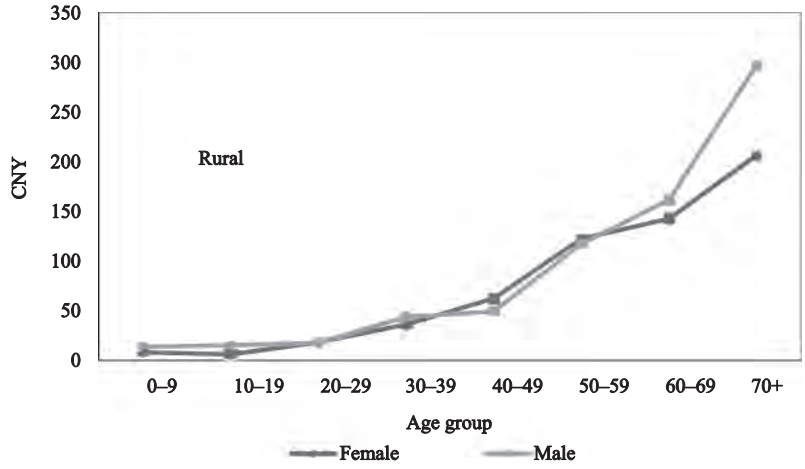


Figure 7b. **Health Expenditure by Gender**
(rural residents, both sick and non-sick samples)



Source: Authors' calculations using data from the China and Health Nutrition Survey (CHNS).

from 51% in 1991 to 85% in 2011. In the 2011 samples, 50% were covered by NCMS, 17% were covered by URBMI, 22% were covered by BMI, and 3% were still enjoying free medical care.

We compare the spending of those who have health insurance with those who do not have health insurance. Figures 8a and 8b show that, in both urban and rural areas, health insurance increases the expenditure in each age group.

Figure 8a. **Health Expenditure by Insurance Status**
(urban residents, 1991–2011, both sick and non-sick samples)

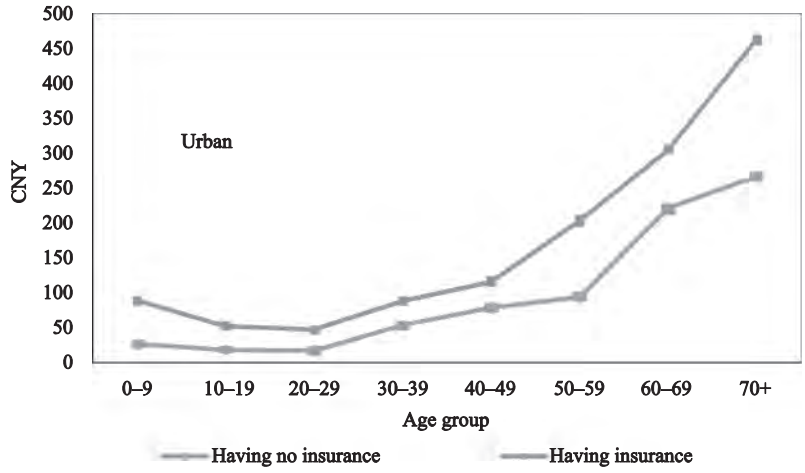
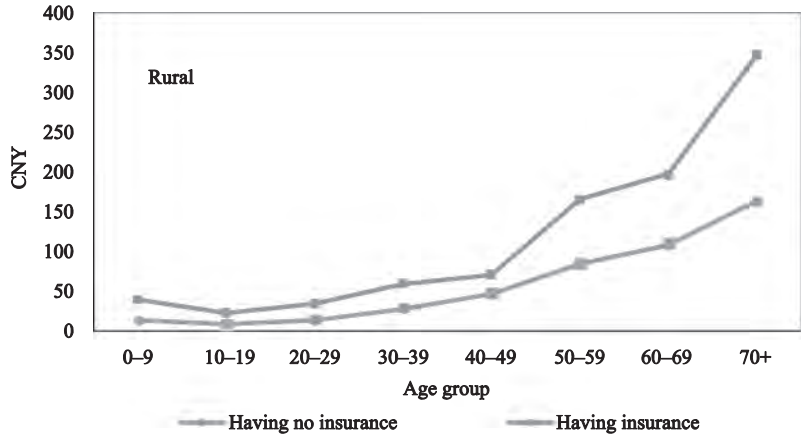


Figure 8b. **Health Expenditure by Insurance Status**
(rural residents, 1991–2011, both sick and non-sick samples)

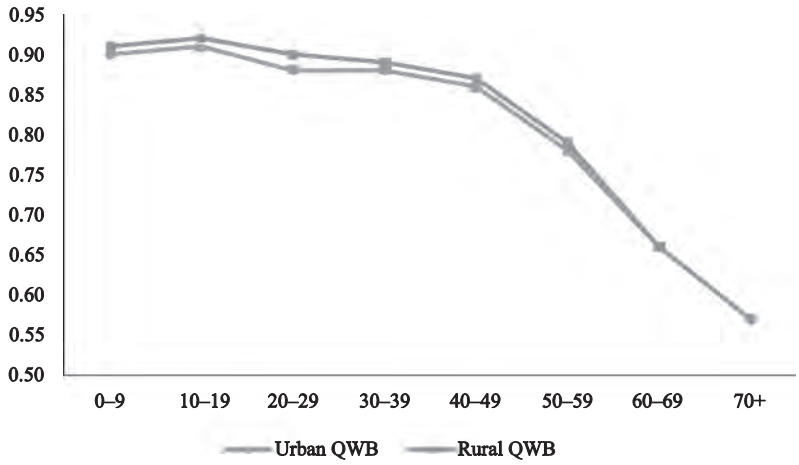


Source: Authors' calculations using data from the China and Health Nutrition Survey (CHNS).

E. Health Status across Age Groups

The survey provides comprehensive information for evaluating the health status of individuals. Self-reported health (SRH) refers to an individual's subjective evaluation of his or her own health. SRH is set according to the interviewee's reply to the question "How would you describe your health?" SRH is set to 1 when the answer is "very good" or "good," while it is 0 with an "ok" or "bad" reply. The

Figure 9a. **Quality of Well-being Scale**
(by rural and urban)



QWB = quality of well-being.
Source: Authors' calculations using data from the China and Health Nutrition Survey (CHNS).

quality of well-being scale (QWB) is also constructed to more objectively evaluate an individual's health. QWB is an index developed by Kaplan and Anderson (1988). It not only includes various objective indicators for one's health status, but subjective evaluation of one's own health as well. Related questions in the CHNS questionnaire are investigated. Based on those questions, we constructed QWB following the method in Zhao (2008).[9] QWB is between 0 and 1. Smaller QWB indicates worse health status.

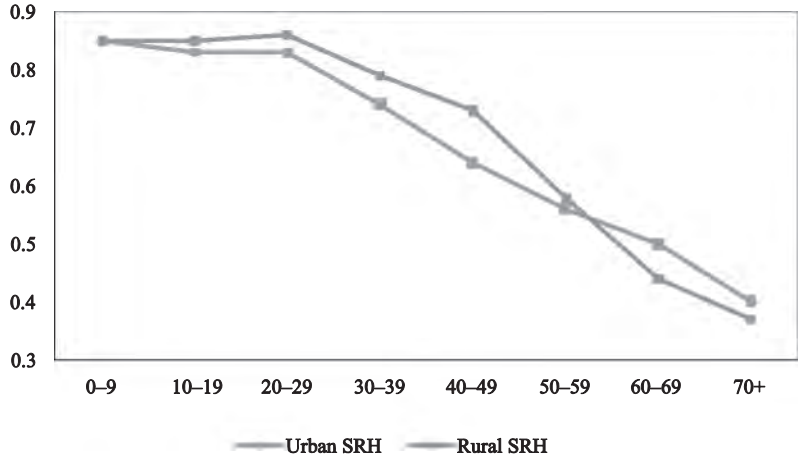
The sample is divided into two groups, those in urban and rural areas. Figures 9a and 9b present the average of SRH and QWB indicators for each age group, respectively. The figures show that in both rural and urban areas, health status deteriorates with age. QWB indicates that the health status of people age 60 and older in rural areas is worse than that of their counterparts in urban areas (Figure 9a).

V. Methodology

The relationship between age and health expenditure in summary statistics includes many forces other than the age structure of the population. To identify the age effects and test the differences of these effects between urban and rural areas, and

[9]QWB is constructed following three steps. First, daily activity is divided into three groups: mobility, physical activity, and social activity. Different illnesses and disabilities can then be catalogued into these three groups. Three sub-indexes can therefore be constructed, reflecting objective health status. Second, a subject index is constructed according to an individual's own description of his or her health status. Finally, preference weights are used to integrate all the four sub-indexes into one index.

Figure 9b. **Self-reported Health**
(by rural and urban)



SRH = self-reported health.
Source: Authors' calculations using data from the China and Health Nutrition Survey (CHNS).

across various periods, we simultaneously control for demographic characteristics, time effects, and county fixed effects.

The main problem of health spending data at the individual level is that there are a large number of zero-expenditure observations. Such may occur for two main reasons. First, the survey records health spending in the "last 4 weeks," and a large percent of individuals may not have made such expenditures during this period. Second, even though an individual may have been ill, he may not be able to afford health care. Neglecting these observations, the estimation will be biased. We therefore use a two-part model (2PM) proposed by Duan et al. (1983) to account for these zero-expenditure observations.[10] Two-part models have been widely used in modeling health care expenditure determination in recent studies (e.g., Madden 2008, Bjorner and Arnberg 2012).

In a two-part model, individual behavior is a two-stage process. First, individuals decide whether or not they wish to spend money on health care. Second, the amount of health expenditure is determined. The model regards these two decisions as independent processes and combines them to calculate the marginal effect of variables on health care spending.[11]

[10] Heckman's two-step procedure (1979) constructs the inverse Mills ratio to control for the unobserved selection factors. This correction for sample selection, however, is based on the assumption that the error term in the participating equation and the expenditure equation are subject to bivariate normal distribution. A large bias will be incurred if there is a departure from a bivariate normal distribution (Duncan 1983). Therefore, we use a two-part model to estimate medical spending, which relinquishes the strict assumption while controlling for selection.

[11] Although the two-part model assumes that the decision processes are independent, the estimation is still unbiased even if the process is a sample selection (Duan et al. 1983).

For the first part, we use a probit model to estimate, using the full sample, whether or not an individual has health expenditures. The equation is written as:

$$I_i = X_i\delta_1 + \varepsilon_i \quad \varepsilon_i \sim N(0, 1) \tag{1}$$

where X_i is a vector of explanatory variables for the ith individual (including age, gender, years of schooling, income, insurance status, year dummies, and county dummies), and ε_i is the error term. If $I \geq 0$, then health spending is larger than zero; otherwise, if $I < 0$, then spending is equal to zero.

The second part is a linear regression of the same vector of explanatory variables on health expenditure (y) using the subsample, with $y > 0$:

$$\log(y_i|I_i > 0) = X_i\delta_2 + u_i \quad u_i \sim [0, \sigma_u^2] \tag{2}$$

These two parts can be estimated separately. Expected health spending, which we are interested in, is the combination of these two parts. For the ith individual in the full sample, the expected health expenditure is:

$$E(y_i|X_i) = \Phi(X_i\delta_1) \times \phi \times \exp(X_i\delta_2) \tag{3}$$

where the transfer factor is $\phi = \exp(\sigma_u^2/2)$, $E(\cdot)$ denotes expected values, and Φ is the cumulative standardized normal distribution.

Furthermore, we can estimate the joint marginal effect of each variable on the probability and magnitude of spending. This is jointly determined by the two-part regression results.[12]

Adopting the two-part model, we first estimate the overall effect of age group and residence using observations from both urban and rural areas. We also estimate age effects of urban and rural residents separately. We then investigate the different age effects across periods.

VI. Estimation Results

Estimated coefficients from the first part of the two-part model are interpreted as the relative magnitude of the effects of explanatory variables on the probability of having positive health expenditure, while estimated coefficients from the second part are the marginal effects of these variables on log spending, for those who do have expenditures. It should be noted that the coefficients cannot tell the overall effect of a variable directly. The overall effect depends on the results of both parts

[12]We use the Stata command "tpm" to estimate coefficients and marginal effects of the two-part model.

jointly, which need further calculations. We will present the regression results and the estimation of overall marginal effects but will focus on the latter.

A. Age Effects in Urban and Rural Areas

The relationship between age and health expenditure in urban and rural areas is presented in Table 2. Columns 1 and 2 summarize the results based on the sample that includes both rural and urban observations. The coefficient of the rural dummy is significantly negative in both parts of the two-part model. In rural areas, the likelihood of spending is 8.22 percentage points lower than in urban areas, while the amount of spending is 44.6% lower among those who do spend.

We run regressions for urban and rural observations separately (Columns 3–4 and 5–6, respectively) to investigate whether urban and rural residents have different age–expenditure profiles. It is shown that after controlling for gender, years of schooling, per capita household income, health insurance, and county dummies, the direction of the coefficients of the age group dummies in rural and urban areas turns out to be similar. However, there are some differences in the size of the coefficients. In the first part of the two-part model, the likelihood of spending generally increases with age, but the size of the increase appears smaller in urban areas than in rural areas. In the second part, health spending similarly increases with age but at a higher rate in urban areas. Year dummies are all significant in the first part and there is a turning point in 2004. The likelihood of incurring expenditure is negative in 2004 compared to 1991 but gradually becomes positive afterwards. Year dummy coefficients are all positive in the second part.

Overall effects are calculated and listed in Table 3. On average, the 4-week expenditure of rural residents is CNY59 or significantly lower by 33% than that of urban residents during 1991–2011. In urban areas, spending is significant higher after age 30 compared to age 0–10. In rural areas, the increase in expenditure occurs beginning age 20.

The most important finding is the much steeper age–expenditure profile in urban areas compared to rural areas even after controlling for time effects and other personal characteristics (Figure 10). However, there is no evidence of better health status among rural residents. Figures 9a and 9b show that health–age profiles are very similar in urban and rural areas. In terms of self-reported health, the rural elderly are worse off than the urban elderly, and health status decreases with age at a more rapid rate. The findings imply that the health spending of the rural elderly may increase more during the process of rural–urban integration.

Although the effect of rising income and expanding health-insurance coverage has been controlled, year dummies capture the net effects of many drivers of health expenditure, such as technology progress and the comprehensive institutional impacts we described in Section II. Table 3 shows that the overall effects of the

Table 2. **Results of the Two-part Model in Urban and Rural Areas**

	(1)	(2)	(3)	(4)	(5)	(6)
	Total		Urban		Rural	
Variables	1st-part probit	2nd-part regress log	1st-part probit	2nd-part regress log	1st-part probit	2nd-part regress log
Rural	−0.0822***	−0.446***				
	(0.0135)	(0.0401)				
10–19	−0.133***	0.106	−0.223***	0.193	−0.0881*	0.0551
	(0.0377)	(0.127)	(0.0647)	(0.196)	(0.0470)	(0.165)
20–29	−0.0986**	0.556***	−0.216***	0.575***	−0.0436	0.529***
	(0.0396)	(0.132)	(0.0674)	(0.204)	(0.0496)	(0.173)
30–39	0.0680*	0.718***	−0.121*	0.824***	0.161***	0.632***
	(0.0363)	(0.118)	(0.0627)	(0.186)	(0.0450)	(0.153)
40–49	0.182***	0.860***	0.00718	1.013***	0.266***	0.766***
	(0.0347)	(0.112)	(0.0601)	(0.177)	(0.0430)	(0.145)
50–59	0.375***	1.166***	0.193***	1.241***	0.463***	1.114***
	(0.0338)	(0.108)	(0.0584)	(0.169)	(0.0418)	(0.140)
60–69	0.559***	1.320***	0.389***	1.397***	0.638***	1.254***
	(0.0340)	(0.108)	(0.0586)	(0.168)	(0.0423)	(0.139)
70+	0.729***	1.547***	0.594***	1.664***	0.788***	1.442***
	(0.0350)	(0.108)	(0.0594)	(0.167)	(0.0439)	(0.141)
1993	−0.295***	0.204**	−0.294***	−0.00167	−0.295***	0.335***
	(0.0285)	(0.0959)	(0.0490)	(0.154)	(0.0351)	(0.122)
1997	−0.237***	0.176*	−0.145***	0.201	−0.286***	0.194
	(0.0278)	(0.0917)	(0.0462)	(0.141)	(0.0352)	(0.121)
2000	−0.192***	0.222**	−0.138***	0.319**	−0.219***	0.202*
	(0.0277)	(0.0900)	(0.0469)	(0.142)	(0.0346)	(0.116)
2004	0.240***	0.177**	0.214***	0.282**	0.262***	0.112
	(0.0248)	(0.0752)	(0.0423)	(0.121)	(0.0308)	(0.0961)
2006	0.157***	0.0665	0.105**	0.324***	0.200***	−0.0899
	(0.0253)	(0.0764)	(0.0433)	(0.124)	(0.0318)	(0.0989)
2009	0.128***	0.460***	0.0709*	0.655***	0.193***	0.305***
	(0.0265)	(0.0787)	(0.0431)	(0.122)	(0.0351)	(0.107)
2011	0.0564**	0.452***	0.0580	0.561***	0.0878**	0.323***
	(0.0275)	(0.0818)	(0.0441)	(0.125)	(0.0364)	(0.112)
Male	−0.0729***	0.0966**	−0.103***	0.119**	−0.0504***	0.0803
	(0.0128)	(0.0386)	(0.0210)	(0.0590)	(0.0163)	(0.0508)
ln(income per capita)	−0.00528	0.0270	−0.0107	0.0186	−0.00521	0.0251
	(0.00570)	(0.0174)	(0.00939)	(0.0273)	(0.00723)	(0.0227)
Years of schooling	−0.0152***	0.0167***	−0.00809***	0.0136*	−0.0207***	0.0201***
	(0.00185)	(0.00532)	(0.00286)	(0.00771)	(0.00247)	(0.00747)
Having insurance	0.143***	0.0402	0.181***	0.0506	0.0955***	0.100
	(0.0165)	(0.0495)	(0.0257)	(0.0730)	(0.0229)	(0.0705)
Observations	89,235	8322	28,924	3,187	60,311	5,135

*** = p < 0.01, ** = p < 0.05, * = p < 0.1.

Note: County dummies are included in regressions as controls. Reference age group is 0–9 years, while reference year is 1991. Standard errors in parentheses.

Source: Authors' computations.

Table 3. **Overall Effects in Urban and Rural Areas**

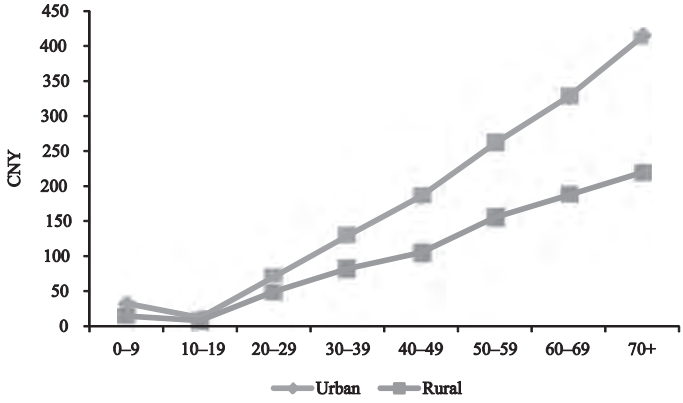
	Total dy/dx	Urban dy/dx	Rural dy/dx
Rural	−58.811***	–	–
10–19	−10.156	−20.490	−6.509
20–29	41.556***	37.928	34.875**
30–39	84.434***	96.516***	67.607***
40–49	117.035***	153.119***	90.521***
50–59	178.937***	228.547***	140.762***
60–69	223.778***	295.333***	172.610***
70+	273.880***	380.852***	205.139***
1993	−25.593**	−65.607	−10.384
1997	−19.307*	−2.171	−19.921*
2000	−7.474	17.046	−11.276
2004	56.092***	89.697***	40.285***
2006	31.665***	71.811***	17.504**
2009	67.380***	113.715***	46.543***
2011	55.272***	96.866***	35.213***
Male	−1.569	−5.147	−0.011
ln(income per capita)	1.940	0.413	1.271
Years of schooling	−0.672	0.244	−0.981
Having insurance	26.748***	47.762***	19.227***

*** = p < 0.01, ** = p < 0.05, * = p < 0.1.

Note: Overall marginal effects are calculated from the estimates in Table 2. For dummy variables, dy/dx is the change in health expenditure when there is a discrete change from the base level. For continuous variables, dy/dx is the change in health expenditure when x increases by 1 unit.

Source: Authors' computations.

Figure 10. **Estimated Age Profile of Health Expenditure in Urban and Rural Areas**



Source: Authors' computations (data obtained from the overall effects in Table 3).

year dummies for 1993, 1997, and 2000 are negative, and some of them are not significant. However, year dummies are significantly positive since year 2004. The results are largely driven by the rising government involvement in the health care sector, which increased the accessibility of health care.

Health insurance is very significant both in urban and rural areas, though the effect is larger in urban areas. The finding is consistent with the higher reimbursement ratio of BMI compared to that of NCMS.

The effect of gender is not significant but is negative. The expenditure of males is lower than that of females, a common finding in the literature (e.g., Strauss et al. 1993). The magnitude of this gender effect is smaller in rural areas, consistent with the observation that household resource allocation is male-biased in rural areas. Household per capita income and years of schooling have no significant overall effect on health spending. The more highly educated are less likely to incur expenditures because of better health but spend more if needed, so that the combined overall effect is not significant.

B. Age Effects across Different Periods

We further investigate whether age effects change across time. As explained in Section II, there have been some fundamental changes in health care reform after 2003. We also observe from the results in Tables 2 and 3 that the direction of year effects changes since 2004. Hence, we divide the samples into two periods: 1991–2000 and 2004–2011.

Table 4 presents the results of the two-part model for the two periods, for both urban and rural residents, where we focus on age effects. Based on the results, we then obtain the overall effects of the different age groups in Table 5. The results indicate that in urban areas, health expenditure is increasing with age after age 40 in both periods. The effects are larger during 2004–2011 for ages 50 and older.

It is worth noting that in rural areas, the marginal effect of the age group 70 and over is smaller than the age group 60–69 during 1991–2000. There is similar evidence in the literature that the rural elderly spend less than the primary-age household members (e.g., Yan and Chen 2010). The age–expenditure profile in rural areas changed to a more typical pattern during 2004–2011, where expenditure tends to increase with age in adulthood. The magnitude of age effects is also much bigger during the period 2004–2011 than during 1991–2000.

The estimated age–expenditure profile becomes steeper over time in both urban and rural areas (Figure 11). Other factors being equal, comparing age–expenditure profiles in the two periods may reveal a cohort effect that is mixed with age effects. The cohort effect captures a number of influences, including the various impacts across age groups of a changing health care system, economic

Table 4. **Results of the Two-part Model in Different Periods**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Urban 1991–2000		Urban 2004–2011		Rural 1991–2000		Rural 2004–2011	
Variables	1st part probit	2nd part regress log	1st part probit	2nd part regress log	1st part probit	2nd part regress log	1st part probit	2nd part regress log
10–19	−0.321***	0.385	−0.162*	0.00786	−0.173***	0.352	−0.00303	−0.157
	(0.0972)	(0.350)	(0.0892)	(0.237)	(0.0661)	(0.251)	(0.0676)	(0.221)
20–29	−0.300***	0.882**	−0.176*	0.278	−0.128*	0.743***	0.0422	0.382
	(0.0999)	(0.356)	(0.0938)	(0.251)	(0.0692)	(0.262)	(0.0720)	(0.233)
30–39	−0.0513	1.205***	−0.206**	0.517**	0.205***	0.750***	0.130**	0.517**
	(0.0921)	(0.319)	(0.0875)	(0.231)	(0.0638)	(0.236)	(0.0642)	(0.204)
40–49	0.139	1.321***	−0.0859	0.720***	0.254***	0.938***	0.292***	0.642***
	(0.0890)	(0.307)	(0.0836)	(0.218)	(0.0609)	(0.224)	(0.0614)	(0.194)
50–59	0.340***	1.598***	0.113	0.945***	0.442***	1.264***	0.490***	0.992***
	(0.0892)	(0.302)	(0.0802)	(0.205)	(0.0609)	(0.222)	(0.0590)	(0.185)
60–69	0.455***	1.769***	0.348***	1.090***	0.616***	1.413***	0.666***	1.119***
	(0.0892)	(0.301)	(0.0804)	(0.204)	(0.0622)	(0.221)	(0.0593)	(0.184)
70+	0.673***	1.841***	0.532***	1.424***	0.614***	1.328***	0.870***	1.371***
	(0.0939)	(0.310)	(0.0801)	(0.201)	(0.0691)	(0.241)	(0.0602)	(0.184)
1993	−0.312***	0.128			−0.297***	0.350***		
	(0.0496)	(0.170)			(0.0353)	(0.125)		
1997	−0.174***	0.250			−0.283***	0.244*		
	(0.0482)	(0.160)			(0.0361)	(0.127)		
2000	−0.187***	0.447***			−0.214***	0.261**		
	(0.0496)	(0.166)			(0.0358)	(0.124)		
2006			−0.103***	0.0188			−0.0512*	−0.144*
			(0.0398)	(0.105)			(0.0300)	(0.0872)
2009			−0.121***	0.392***			−0.0434	0.309***
			(0.0420)	(0.109)			(0.0355)	(0.101)
2011			−0.133***	0.300***			−0.149***	0.331***
			(0.0431)	(0.111)			(0.0370)	(0.106)

Continued.

Table 4. *Continued.*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Urban 1991–2000		Urban 2004–2011		Rural 1991–2000		Rural 2004–2011	
Variables	**1st part probit**	**2nd part regress log**	**1st part probit**	**2nd part regress log**	**1st part probit**	**2nd part regress log**	**1st part probit**	**2nd part regress log**
Male	−0.0593*	0.181	−0.131***	0.0724	−0.0233	0.0132	−0.0697***	0.102*
	(0.0351)	(0.115)	(0.0264)	(0.0683)	(0.0267)	(0.0949)	(0.0207)	(0.0602)
ln(income per capita)	−0.000752	−0.0846	−0.00669	0.0380	−0.00317	−0.0587	−0.00606	0.0391
	(0.0226)	(0.0767)	(0.0105)	(0.0289)	(0.0164)	(0.0611)	(0.00811)	(0.0244)
Years of schooling	0.00447	0.00155	−0.0146***	0.0232***	−0.0166***	0.0104	−0.0228***	0.0234***
	(0.00485)	(0.0151)	(0.00360)	(0.00899)	(0.00431)	(0.0150)	(0.00307)	(0.00871)
Having insurance	0.207***	0.102	0.135***	0.000760	0.138***	0.474***	0.0598**	−0.0841
	(0.0395)	(0.129)	(0.0351)	(0.0912)	(0.0364)	(0.127)	(0.0297)	(0.0860)
Observations	13,202	951	15,722	2,236	31,609	1,513	28,702	3,622

*** = p < 0.01, ** = p < 0.05, ∗ = p < 0.1.

Note: County dummies are included in regressions as controls. Reference age group is 0–9 years. Reference year in period 1991–2000 is 1991. Reference year in period 2004–2011 is 2004. Standard errors in parentheses.

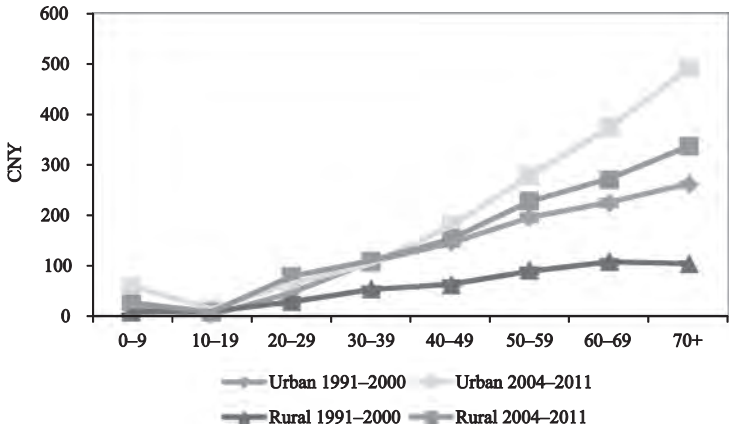
Source: Authors' computations.

Table 5. **Overall Age Effects in Different Periods**

Age group	Urban 1991–2000 dy/dx	Urban 2004–2011 dy/dx	Rural 1991–2000 dy/dx	Rural 2004–2011 dy/dx
10–19	−13.830	−44.130	0.860	−18.796
20–29	29.946	5.356	19.128	51.696
30–39	91.615	44.451	43.599***	82.645***
40–49	128.138***	118.706**	54.321***	125.224***
50–59	179.280***	219.151***	80.538***	200.303***
60–69	209.595***	314.352***	98.886***	245.691***
70+	246.440***	432.767***	95.500***	310.306***

*** = p < 0.01, ** = p < 0.05, * = p < 0.1.
Note: Overall marginal effects of age are calculated from the estimates in Table 4. For each age group, dy/dx is the change in expenditure compared with the reference group (0–9 years) when the group dummy changes from 0 to 1.
Source: Authors' computations.

Figure 11. **Estimated Age Profile of Health Expenditure across Periods**



Source: Authors' computations (data obtained from the overall effects in Table 5).

development, initial conditions of people born in different times, etc. The steeper profiles imply that the cohort effect is in the same direction as age effects in adulthood, which leads older groups to have greater increases in health spending than younger groups under the same circumstances.

VII. Population Aging and Growth of Aggregate Health Spending

The aggregate national health expenditure of the PRC has been growing as a share of GDP and in terms of per capita level. The figures were 4% and CNY65,

respectively, in 1990, and 4.6% and CNY362 in 2000, increasing to 5% and CNY1,400 in 2010. During 1990–2010, the real annual growth rate of health spending (including government spending, health insurance, and household expenditure) of the PRC was 13.3%. The growth rate is much higher than in OECD countries, where it stood around 5%. The higher growth rate of health spending in the PRC is related to a series of factors, including lower initial levels, rising per capita income, rising government spending, more comprehensive public health insurance programs, and rapid population aging. The difference implies that spending growth in the PRC during urbanization is a welcome development, as people receive much-needed health care.

We estimate the contribution of population aging and urbanization to the growth of spending in the PRC during this period based on the results of Section VI. We employ demographic data of the PRC from *World Population Prospects* of the United Nations.[13] We predict per capita health expenditure for each age group. Using per capita spending multiplied by the population of the age group, we sum the expenditures for each age group and obtain the total health expenditure for each year. Comparing the predicted health expenditure of a year with the amount spent in year 2010, we obtain the ratio from which we may calculate the annual growth rate of health expenditure. The growth rate we are estimating is purely due to the change of demographic structure and urbanization, and not due to other factors.

During 1990–2010, urbanization increased from about 26% to 45%. According to the estimation, annual growth of health expenditure caused by population aging during urbanization in this period was about 2.8%, accounting for about a fifth of the total 13.3% real annual growth.

Rapid population aging and urbanization will likely continue in the PRC. Using the method of estimation as in the previous paragraph (employing demographic projections by the United Nations shown in Table 6 and assuming an urbanization rate of 70% in 2030), we compute the annual growth in health expenditure caused by population aging during urbanization to be about 2.2%. However, we are cautious with such a projection, as there are many uncertainties in the future. As we have shown, the age–expenditure profile may change over time. This could be because different cohorts have different age profiles of health expenditure, or because people of different ages respond to the changing health care system differently. Insurance, for example, has exerted a significant influence on health care. However, the expansion of health insurance coverage will someday end, which will have different effects on people of various ages.

[13]United Nations, Department of Economic and Social Affairs. World Population Prospects: The 2012 Revision. Available online: http://esa.un.org/unpd/wpp/index.htm.

Table 6. **Demographic Change of the People's Republic of China**

	1990	1995	2000	2005	2010	2015	2020	2025	2030
Population (millions)									
0–9	245	245	192	162	164	177	176	160	146
10–19	219	204	242	244	191	161	163	176	175
20–29	232	245	216	201	239	241	189	159	161
30–39	172	190	228	241	212	198	237	239	188
40–49	111	148	168	186	223	237	209	196	234
50–59	86	90	105	141	161	179	216	230	203
60–69	59	68	75	80	95	127	145	163	198
70+	42	47	54	64	74	82	97	126	148
Total	1,165	1,238	1,280	1,318	1,360	1,402	1,433	1,449	1,453
Structure (%)									
0–9	20.98	21.06	16.51	13.86	14.06	15.15	15.11	13.76	12.52
10–19	18.78	17.49	20.79	20.90	16.41	13.79	13.98	15.08	15.05
20–29	19.88	21.06	18.56	17.24	20.51	20.68	16.25	13.65	13.85
30–39	14.78	16.30	19.56	20.71	18.23	17.01	20.31	20.50	16.11
40–49	9.54	12.67	14.41	15.93	19.16	20.36	17.97	16.79	20.09
50–59	7.39	7.73	9.03	12.11	13.82	15.34	18.52	19.72	17.44
60–69	5.07	5.84	6.40	6.82	8.12	10.93	12.47	13.98	16.97
70+	3.57	4.03	4.61	5.53	6.37	7.01	8.33	10.84	12.68

Note: We use the results of medium variant.
Source: United Nations, Department of Economic and Social Affairs. *World Population Prospects: The 2012 Revision*. Available online: http://esa.un.org/unpd/wpp/index.htm.

VIII. Conclusions

Estimating health expenditure over the life cycle is primary work needed to understand the influence of population aging on the growth of health spending in the PRC. We use eight waves of CHNS data during 1991–2011 to investigate the age–expenditure relationship for rural and urban residents in different periods. The estimations show that health care reform and urbanization increase the demand for health care generally, but expenditure by the elderly increases more than other age groups.

Specifically, while health care spending of rural residents is lower than that of urban residents in all age groups, the age–expenditure profile is much steeper in urban areas than in rural areas. Therefore, health expenditure of the elderly increases more during the process of rural–urban integration. There is also a significant difference in age–expenditure profiles across time in both urban and rural areas, with steeper profiles verified in the later period. The result suggests that there is a cohort effect mixed with age effects, which is in the same direction as age effects in adulthood. The cohort effect causes the elderly to increase health expenditure by more than the younger group even if they experience common social or economic changes.

Population aging during urbanization has contributed to the growth of aggregate health expenditure in the PRC by about 2.8%, accounting for about a fifth of total annual growth between 1990 and 2010. In the future, population aging and urbanization will continue to drive health spending.

Nevertheless, the growth of health expenditure has a different meaning for the PRC than for OECD countries. Our results suggest that there is an unmet health care demand among rural residents, particularly among the elderly. It has been reported by the National Health Services Survey that a non-negligible proportion of rural people refuse outpatient services and inpatient care when sick, even when they are referred to hospitals, as they cannot afford the services. Owing to the current low ratio of health care spending to GDP, the PRC has the potential to greatly improve health insurance and increase government investment in health care.

It is important to mention that our estimation of age–expenditure profiles is based on health spending from the demand side, without considering government spending directly. Referring to the findings of Shen and Lee (2014), who find a similar age profile of per capita public health care spending as in our estimations, the results we obtained can also apply to the scenario where government spending is included.

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Education Inequality between Rural and Urban Areas of the People's Republic of China, Migrants' Children Education, and Some Implications

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Education inequality between the rural and urban areas of the People's Republic of China (PRC)—a potential bottleneck for human capital accumulation—has long been of interest to researchers and policymakers. This paper uses data from the China Family Panel Survey (CFPS) and the Rural–Urban Migration in China (RUMiC) survey to compare the education performance of rural children, children of rural-to-urban migrants, and urban children over the period 2009–2010. Results show that education performance of rural children and migrants' children is significantly lower than that of their urban counterparts even after accounting for differences in personal attributes such as nutrition and parenting style. This provides useful insights for policymaking to reduce rural–urban education inequality and assist human capital accumulation in the PRC.

Keywords: education inequality, rural-to-urban migration, human capital accumulation
JEL codes: I24, O18, P36

I. Introduction

Over the past 3 decades, the People's Republic of China (PRC) has experienced dramatic economic growth. Between 1978 and 2013, gross domestic product (GDP) grew by more than 10% a year on average in the country, which is about three times the growth of Organisation for Economic Co-operation and Development (OECD) countries. As a consequence, the PRC has become the second largest economy in the world since 2011, second only to the United States. However, the period of "miraculous" economic growth appears to be nearing its end. Since 2011, the annual GDP growth rate has declined from 12.0% to 7.7% in the PRC, and the

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declining trend seems to be continuing over time. This has aroused concern that the country would fall into the "middle-income trap."

For decades, the PRC's economic growth has been criticized for its reliance on raising input usage with relatively low productivity improvement (Wu, Ma, and Guo 2014). Substantial rural-to-urban migration provides a large amount of unskilled labor and a relatively high rate of return (because of relatively low wages), encouraging public and private investment. When there is strong demand from the international market, labor-intensive manufacturing production can be easily duplicated, which in turn drives economic growth. However, this kind of growth is not sustainable from an economic perspective. As the population dividend diminishes and environmental concerns and international competition intensify, increasing input usage through low wages and rising investment can no longer fuel economic growth in the PRC as they did in the 1980s and 1990s.

In neoclassical economic growth theory, long-term development relies on productivity improvements driven primarily by human capital accumulation. This implies that, to maintain rapid growth and escape the so-called "middle-income" trap, the PRC needs to increase production efficiency and upgrade industries in order to make them high-valued, service-based, and innovation-based. However, recent statistics show that total factor productivity (TFP) in the PRC's industrial sector has been extremely low, while manufacturing production has been dominated by labor-intensive production techniques (Wu, Ma, and Guo 2014). A shortage of skilled labor supply serves as a major bottleneck for productivity improvement and economic transformation in the country.

Compared to other developing countries, human capital accumulation cannot meet the requirements of economic development in the PRC. Based on the 2005 1% Population Sampling Survey (conducted by National Bureau of Statistics, NBS for short), the number of years of schooling of the country's labor force was 8.6 years on average, while only 25% of the labor force (aged between 15 and 65) had an education level of junior high school or above. This implies that there is a large gap in human capital endowment between the PRC and Asian countries that have escaped the middle-income trap such as Japan and the Republic of Korea (Rozelle 2013). Among others, significant disparities in education between rural and urban areas could be an important factor in the PRC, affecting human capital accumulation at the national level. However, little is known about how education inequality between rural and urban areas has changed over time and only a few studies have been carried out to examine the education of migrants' children.

This paper uses data from the 2010 China Family Panel Survey (CFPS) and the 2009 Rural–Urban Migration in China (RUMiC) survey to compare education performance of rural children and urban children between 2009 and 2010. In the analysis, we distinguish rural-to-urban migrants' children from those of rural non-migrants and urban residents. The results show that education performance of rural children (including those of rural non-migrants and rural-to-urban migrants) is

significantly lower than their urban counterparts. Although attributes of different groups such as nutrition, parenting style, and education quality have played important roles in explaining inequality between rural and urban children, the remaining unexplained education disparity is still substantial.

Compared to previous research, this paper is the first to consider migrants' children separately when analyzing education inequality between rural and urban areas of the PRC. To reduce measurement errors associated with self-assessment, we use test scores in a unique dataset, namely CFPS, to measure education performance of children of different groups. In addition, the analysis to some extent also accounts for personal attributes and their effects in identifying education inequality across groups. The findings obtained from this study not only provide useful insights on potential education reforms in the PRC but also help to inform other developing countries with similar experiences.

II. Education Inequality in Rural and Urban Areas of the People's Republic of China

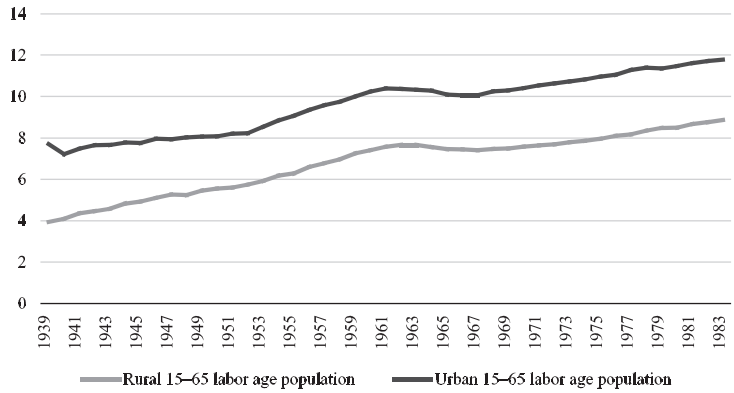
Since 1978, the PRC has exerted great effort to improve education level of the labor force in both rural and urban areas by increasing public investment in education. However, like most other developing countries experiencing economic transition, education inequality is still widely observed between rural and urban areas. Income disparity, various institutional barriers, and different parenting styles, among others, are regarded as potential causes of education inequality. With the increased migration of rural labor into cities in recent years, education inequality between rural and urban areas of the PRC has started to negatively affect human capital accumulation in the urban labor market. This section briefly summarizes education inequality between rural and urban areas in the country and the education performance of rural-to-urban migrants' children.

A. Education Disparity between Rural and Urban Areas

Although the 9-year compulsory education policy was implemented simultaneously throughout the whole country in 1985, the effect of this policy on education attainment in rural and urban areas of the PRC significantly differed. Between 1985 and 2005, average education levels of rural and urban populations both increased, but the latter grew more quickly than the former. As a consequence, the gap in education levels of the labor force in rural and urban areas of the country widened over the period.

There is a substantial gap in the average number of years of schooling between the rural and urban labor force, and this has not diminished over time. Figure 1 compares the average years of schooling of various birth cohorts of the rural and

Figure 1. **Average Years of Schooling for Each Birth Year of the Rural and Urban Labor Force in 2005**



Source: Authors' calculations based on the 2005 1% Population Sampling Survey of the PRC (from the National Bureau of Statistics).

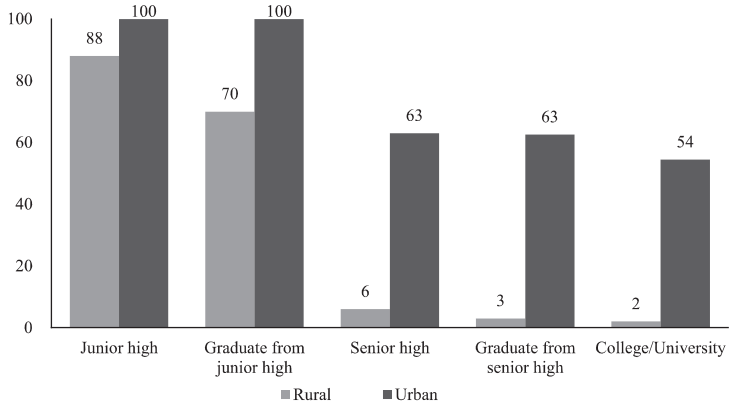
urban labor force using the 2005 1% Population Sampling Survey data. For those aged 15–65 years old, the average years of schooling increased from 4 to nearly 8 for the rural labor force and from 7 to 12 for the urban labor force. However, the gap in the average years of schooling between the rural and urban labor force does not decrease as cohort age declines. This implies that the urban labor force has more years of schooling than the rural labor force in the PRC, and that the gap has not narrowed over time.

There is also a significant gap in the average enrollment and graduation rates[1] of children (of school age) between the rural and urban population of the PRC, which implies that the educational disparity between rural and urban areas of the country has widened, especially in recent years, after the implementation of the compulsory education policy. Figure 2 compares the average enrollment and graduation rates of three grades (junior high, senior high, and college/university) of students living in rural and urban areas who enrolled in 2010 and graduated in 2012 based on statistics taken from the *China Education Statistical Yearbook* (2010–2013). Compared to Figure 1, Figure 2 provides more information on the effects of the 9-year compulsory education policy on school attendance of the rural population in the PRC, as it includes the birth cohorts after 1983.

As shown in Figure 2, among 100 rural children, 88% completed primary education and entered junior high schools, while the rest (12%) dropped out from primary schools. Moreover, only 70% of those who entered junior high schools completed their study. This means that around 38% of rural children were not able to fulfill the 9-year compulsory education. The finding is consistent with some

[1]Graduation rate is defined as the number of graduated students divided by the number of enrolled students.

Figure 2. **Average Enrollment and Graduation Rates of Junior High, Senior High, and College/University Students in 2010–2012, Rural and Urban**



Note: See Table A1.1 of Appendix 1 for detailed data on the generation of dropout rates for junior and senior high school students.
Source: Ministry of Education. 2009–2013. *China Education Statistical Yearbook*. Department of Development and Planning, Ministry of Education, PRC. Beijing: People's Education Press.

calculations using survey data, which show a high proportion of dropouts from primary and junior high schools (40%–50%). Finally, only 6 of 100 rural children can enter senior high schools, among whom 3 can finally graduate from senior high schools. Around 1–2 rural children had a chance to obtain tertiary education.

In contrast, almost all urban children finished junior high school education, of whom 63% entered senior high schools. Among the urban children who graduated from junior high schools, more than half (54%) entered college for tertiary education. Of those not enrolled in senior high schools, a majority were able to study in vocational or technical schools.

Of course, one should note that the above analysis of education inequality between rural and urban populations of the PRC is subject to two limitations. First, formal education levels do not necessarily link to education performance of rural and urban children. Second, the data used to estimate the enrollment ratio of rural children is likely to suffer from a selection problem.[2] It is therefore necessary to carry

[2] Since the data collected from the *China Educational Statistical Yearbook* (Ministry of Education 2009–2013) are compiled using school location rather than *hukou* registration place of students, there may be miscalculations regarding the enrollment of rural children. For example, rural children may have been given the chance to enter urban schools, in turn increasing enrollment in urban schools while reducing enrollment in rural schools. To reduce this bias, we add the increase in urban enrollment compared to the first grade to rural statistics. However, we still cannot adjust the bias for first grade enrollment rate because of the absence of *hukou* information for admitted students at each school level. As a result, the statistics illustrated in Figure 2 may to some extent exaggerate the rural and urban education disparity in terms of enrollment and graduation rates. However, given the substantial difference in the statistics, such measurement bias is unlikely to change the fact that education attainment has not been equally achieved in rural and urban areas of the PRC.

out more thorough comparisons before a strong conclusion on education inequality between rural and urban areas in the PRC can be reached.

B. Rural-to-Urban Migration and Education of Migrants' Children

Rural-to-urban migration is a feature specific to the PRC's economic transformation, one that has played an important role in shaping the structure of rural and urban labor markets in the country over the past 2 decades. Between 1990 and 2010, there had been 164 million workers moving from rural to urban areas, accounting for a third of total urban unskilled labor supply. As more and more rural migrants move into cities, their children's education and the implications for education inequality between rural and urban populations become important issues.

Due to restricted institutional arrangements and discrimination by urban residents, rural-to-urban migrants generally fail to gain access to the urban social welfare system in the PRC (Meng and Zhang 2013). As a consequence, migrants' children are unable to obtain the same opportunities as their urban counterparts in entering the formal education system. The children of migrants mostly receive their education through rural schools, urban informal education institutions, or a mixture of the two. The hybrid education experience, plus an unstable life, reduces the education performance of migrants' children. As rural migrants' children account for a large proportion of rural children, this exacerbates the education inequality between rural and urban populations of the country.

Migrants' children usually have two choices (get left behind or migrate with their parents), and education opportunities faced by various groups of children generally differ. When rural migrants work in urban areas, they can choose to leave their children in their rural hometowns or bring their children into the city for education. In the former case, migrants' parents play a role as the guardian of the children, while in the latter case, migrants have to pay an additional sponsorship fee to send their children to local schools (where most of these schools are for migrants' children). It should be noted that since migrants often need to work for long hours, they cannot spend much time on their children even if they live together.

Compared with children of non-migrants in rural areas, children of migrants seem to have better opportunities to attend schools in urban areas. For example, many migrants' children may have spent a period of time for education in cities, especially at a young age. Given the difference in the quality of education institutions in rural and urban areas, this would be a benefit. However, due to unfair treatment faced by migrants in urban areas and economic concerns, most migrants' children also spend a significant amount of time in rural areas for their education.

As an example, the RUMiC survey shows that economic and discrimination concerns are the two most important reasons why migrants leave their children

in their hometowns. Roughly 36% of the migrants make the choice to leave their children at home because of economic concerns, while 26.5% make the choice because they have no time to take care of their children in urban areas. This may lead to the inconsistent education outcomes of migrants' children in rural and urban areas. In addition, since migrants face a lot of pressures when working in cities, their children (including both those left behind and those migrating) are usually unable to get adequate parental care.

There is no serious empirical evidence regarding the education performance of migrants' children. However, there are those who believe that the performance of migrants' children is likely inferior to their rural/urban counterparts. A primary reason is that mixing rural and urban education leads to inconsistency. Meanwhile, lack of care from parents also makes it hard for migrants' children (especially the left-behind rural children) to obtain good education outcomes. In extreme cases, migrants' children may be prone to commit crimes due to lack of discipline received from their parents (Cameron, Meng, and Zhang 2014).

C. Education Inequality, Rural-to-Urban Migration, and Related Literature

There have been many studies carried out in recent years that explore education inequality between rural and urban areas of the PRC and education performance of migrants' children. A common feature of these studies is the analysis of why education levels of rural and urban residents differ. Two interesting arguments are summarized below.

First, unlike successful neighbors in Asia, the PRC's central government has traditionally spent less on education, particularly of rural residents. For example, Heckman and Li (2003) show that the PRC spent about 2.5% of GDP on education in the 2000s, which was much lower than the amount spent by other developing countries in Asia (about 4%–5%) and the world average (5.2%). Most of the spending had been used to support compulsory education of urban residents.

Second, the relatively low private and social rates of return associated with rural education usually discourage private investment. Rates of return to education in the rural areas of the PRC have on average been perceived to be no more than 5% in the late 1980s and 1990s (Meng 1996, Zhao 1999). This differs from the average for other Asian countries and the world (10%). Given the relatively low return to education, it is not surprising to see rural residents drop from high schools. As an example, well over 90% of students in large cities of the PRC attend senior high school, in contrast to only half of all junior high graduates in poor rural areas (Loyalka et al. 2014, Shi et al. 2014).

As for attempts to examine the education level of migrants' children, most studies have focused on cross-country migration. Edwards and Ureta (2003), Hanson

and Woodruff (2003), and Mansuri (2006) find that international migration can impose positive effects on the performance of migrants' children in education. However, Long (1975), Pribesh and Downey (1999), and de Brauw and Giles (2006) find that international migration generates negative effects on family life and in terms of the continuity of education of migrants' children.

Although significant progress has been made in related data collection, only a few studies have been carried out to examine rural-to-urban migration and its effects on the performance of migrants' children in education in the PRC. These include Ye, Murray, and Yihuan (2005); Han (2003); Liang and Chen (2005); Feng and Chen (2012); and Meng and Yamauchi (2013). These studies generally find an association between the lack of parental care and the mental pressure and the sense of insecurity felt by left-behind children. They also find a lower enrollment rate for children migrating to the cities compared to their urban counterparts as well as to non-migrant children in the migrant-sending communities. In addition, education outcomes of migrant children in cities seem to be significantly worse than those of their local counterparts.

In sum, previous literature provides useful information on education inequality between rural and urban areas in the PRC, and the migration behavior and its effects on education performance of migrants' children. However, few attempts have been made to combine these two issues. This leaves room for this paper to re-examine the effects of education inequality in the country from a migration perspective.

III. Data Sources

The data used in this study comes from two surveys: 2009 RUMiC and 2010 CFPS. Both datasets have their advantages and shortcomings and serve different purposes in our analysis.

The RUMiC survey started to collect information from households in 2008, and 2 years of data have been made available to the public. About 18,000 households were surveyed each year, with the sample split into three groups representing rural residents (8,000 households), rural-to-urban migrants (5,000 households), and urban residents (5,000 households). The sampled households in 2009 were traced from 2008 whenever possible. The random sampling technique and the sample rotation technique were used to fill the gap and to ensure representativeness of the population across regions and over time.

The survey was carried out in both rural and urban areas. In rural areas, nine provinces/municipal cities were selected, including Henan, Jiangsu, Sichuan, Hubei, Anhui, Zhejiang, Guangdong, Hebei, and Chongqing. These provinces/municipal cities accounted for around 47% of emigrants from rural areas in 2000 according to the China Population Census for that year. In urban areas, 15 large and medium-sized cities were selected, namely Shanghai, Hangzhou, Ningbo, Nanjing, Wuxi,

Guangzhou, Shenzhen, Dongguan, Zhengzhou, Luoyang, Hefei, Bengbu, Wuhan, Chongqing, and Chengdu. These cities accounted for around 66% of immigrants into the urban areas in 2000 according to the national census.

The main advantage of RUMiC is that the data collected from the survey provide a good representation of migrants, as they simultaneously provide samples among the three population groups (rural residents, rural-to-urban migrants, and urban residents).[3] Therefore, one can easily distinguish between migrating and left-behind children. Moreover, the survey also provides detailed and consistent information on social and economic behavior of rural residents, rural-to-urban migrants, and urban residents at the individual, household, and regional levels.[4] The information enables us to compare education performance, expenditure, and school choices of migrants' children (including both left-behind children and migrating children) and their rural and urban counterparts.

However, the RUMiC survey has two shortcomings. First, it measures education performance of migrants' children using their math and word test scores in the latest final exam. The measurement could be biased since it involves subjective assessments of performance and differences in test questions. Second, the survey does not provide information on children's mental health, which can affect their education performance. To overcome these two problems, we also use CFPS data.

The CFPS is a nationwide, biannual, and longitudinal survey of communities, families, and individuals launched in 2010. The survey was conducted by the Institute of Social Science Survey (ISSS) of Peking University and covered 25 provinces (except Xinjiang; Xizang; Qinghai; Inner Mongolia; Ningxia; Hainan; Hong Kong, China; Macau, China; and Taipei,China), representing 95% of the total population. In 2010, the baseline survey successfully interviewed 14,789 families, covering 33,600 adults and 8,990 children. The second wave in 2012 surveyed 13,319 families or about 36,062 adults and 8,627 children.[5]

Compared to other surveys on the Chinese family, the CFPS provides much more basic information on each family member as well as various indicators measuring children's education performance and psychological well-being. In particular, unified math, word, and psychological tests were carried out for children aged 10 to 15. The scores obtained from the tests were used to construct a measure of children's education performance and psychological well-being. Specifically, each child participating in the survey needed to answer 24 arithmetic questions in sequence, arranged from easy to hard. The number of correctly answered questions was treated as the child's math test score. The word test scores were obtained in a similar way with

[3]For detailed sampling strategy of the migrant samples, please refer to the following survey website: http://rse.anu.edu.au/research-projects/rural-urban-migration-in-china-and-indonesia/.

[4]The survey collects a large amount of information on migrants (including their hometown, destination, occupation and skills, working experience, and income) and information on their children (under school age), including education level, school choice, and education performance.

[5]The differences between the 2 years mainly come from the combination and split of communities and families as well as the birth and death of individuals.

34 different characters. Psychological well-being status is measured by depression level with six selected psychological questions.

Similar to the RUMiC survey, the CFPS allows for a comparison of children coming from different groups. Using information on individuals' working history in both rural and urban areas, we distinguished the sample into migrants' children (including left-behind and migrating children) and rural/urban residents' children as in the RUMiC data. Specifically, a left-behind child is defined as one living in the rural area with an agriculture *hukou* and at least one parent going out for work, while a rural non-migrant child is defined as one with an agriculture *hukou* but with both parents staying at home. Using this definition may cause bias, however. If the surveyed child lives with a single mother or single father, for instance, he or she will be wrongly categorized as a left-behind child. In this sense, the revealed proportion of left-behind children is likely to be lower than the real proportion.

Due to data constraints, the definitions for migrating children and urban residents' children when using CFPS data are complex and require multifaceted criteria. We define migrating children as those residing in urban areas and born in rural areas with an agriculture *hukou*. Accordingly, urban residents' children are defined as those residing in urban areas and born in urban areas with non-agriculture *hukou*. These definitions, though useful, may cause concern, as they exclude two types of children residing in urban areas. One type comprises those born in urban areas but with agriculture *hukou*, while the other type comprises those born in rural areas but with non-agriculture *hukou*.[6]

Finally, the RUMiC survey and the CFPS each has its own advantages and disadvantages. RUMiC data define rural and urban children in an explicit way and thus provide more reliable information for cross-group comparison. CFPS data meanwhile provide an objective measure of the education performance of children. In this paper, we will use both datasets to examine education inequality between rural and urban populations in the country.

IV. Education Inequality between Rural and Urban Areas of the People's Republic of China: Comparison Analysis

By comparing two measures of education performance (i.e., self-reported and test scores) across sample groups from different datasets, we examined education inequality between rural and urban areas of the PRC. Moreover, left-behind and migrating children are split from rural and urban residents' children, respectively, and their education performances are separately examined. The discussion on the

[6]These children are apparently hard to categorize. An urban-born child with an agriculture *hukou* could be an urban local child or a migrants' child born secretly (without birth certification). A rural-born child with a non-agriculture *hukou* could be a migrating child with *hukou* alteration or an urban child born in a rural area.

Table 1. **Children's School Performance**
(2009 RUMiC)

	Rural Household Survey			Urban Migrant Survey		Urban Household Survey
	Rural	Left-behind	Migrated	Left-behind	Migrated	Urban
Self-reported school performance (%)						
Very good/Above average	41.87	38.72	65.00			60.97
Average	54.68	57.43	30.00			36.82
Below average	3.44	3.85	5.00			2.21
Observations	1,655	1,144	80			994
Self-reported score in Chinese exam during the last semester	82.10	82.49	85.40	84.23	84.93	87.63
(full score = 100)	(11.39)	(10.86)	(12.46)	(10.89)	(11.03)	(10.68)
Observations	1,453	1,025	70	404	517	906
Self-reported score in math exam during the last semester	83.54	83.49	87.01	84.67	85.48	89.36
(full score = 100)	(12.01)	(11.83)	(13.32)	(12.68)	(12.21)	(10.35)
Observations	1,450	1,024	70	399	515	908
Average study time outside school (hours per week)	8.68	7.98	11.32	7.63	7.41	12.48
	(6.90)	(6.56)	(7.23)	(8.40)	(6.22)	(7.62)
Observations	1,247	722	56	423	652	887

Note: Standard deviations are in parentheses.
Source: 2009 Rural–Urban Migration in China Survey.

attributes of different sample groups, such as personal characteristics, individual living and social environments, and institutional arrangements, provides some potential explanation on education inequality.

A. Comparing Education Performance of Children in Rural and Urban Areas

Using data obtained from 2009 RUMiC survey, we construct measures of education performance based on self-reported school performance and test scores and compare these measures for rural and urban children (Table 1).

Education performance of urban children generally exceeds that of rural children. For example, 61% of urban residents believe their children have obtained good or very good school performance (in terms of scores), while 37% believe their children have obtained common school performance. In contrast, only around 40% of rural residents believe their children have obtained good or very good school performance, while about 55% believe their children have obtained common school performance. We find similar results for self-reported scores in individual subjects

Table 2. **Scores on Word and Math Tests of Rural and Urban Children** (2010 CFPS)

	Rural	Urban	Group difference with t-test results
Word test score (full score = 10)	6.144	6.895	−0.751***
	(2.166)	(1.930)	
Primary school	5.417	6.125	−0.708***
	(2.115)	(1.946)	
Junior high school	7.526	7.910	−0.384***
	(1.479)	(1.354)	
Math test score (full score = 10)	4.489	5.025	−0.536***
	(1.886)	(1.790)	
Primary school	3.535	3.891	−0.356***
	(1.495)	(1.405)	
Junior high school	6.298	6.518	−0.219***
	(1.030)	(0.948)	
Observations	1,719	848	

*** = significant at 1%, ** = significant at 5%, * = significant at 10% level.
Note: Standard deviations are in parentheses.
Source: 2010 China Family Panel Survey.

(i.e., in word and math). The average self-reported scores of urban children are 87.6 and 89.4, respectively for word and math (total score is 100), which are higher than those of rural children. This implies that there are significant differences in education performance of children in rural and urban areas of the country, whether it is measured using self-reported school performance or exam scores.

Since self-reported school performance and scores are likely to be affected by subjective judgment and differences in test quality, the comparison analysis using these measures could be biased. To overcome this problem, we also use the objective (word and math) test scores obtained from 2010 CFPS to construct a measure of education performance. Since the two objective tests are only carried out for students from 10 to 15 years of age, inferences from this exercise can only be made for children falling into specific age groups. In addition, to capture the change in education performance over time, we split the sample into two groups: primary school and junior high school.

As shown in Table 2, urban children, on average, perform better in objective test scores than rural children. The gaps in objective test scores between the two groups of children are a standard deviation (SD) of 0.75 for word tests and 0.54 SD for math tests, with both gaps being statistically significant. The finding is consistent with that previously obtained using self-reported school performance and scores, suggesting there is indeed education inequality between rural and urban areas in the country. In addition, the gap in objective test scores between rural and urban children does not change significantly for those enrolled in primary and junior high schools. This implies that education inequality between rural and

Table 3. **Summary Statistics for Rural and Urban Children**
(2010 CFPS)

	Rural	Urban	Group difference with t-test results
Observations	1,719	848	—
%	66.965	33.035	—
Gender			
% Male	49.971	51.297	−0.013
	(0.500)	(0.500)	
Age			
average	12.554	12.456	0.097
	(1.724)	(1.732)	
Health			
Weight(kg)	36.709	40.870	−4.161***
	(10.342)	(11.875)	
Height(cm)	144.156	150.708	−6.552***
	(17.101)	(14.967)	
Degree of depression	1.275	1.143	0.132*
	(1.659)	(1.510)	
Family characteristics			
Mother's years of schooling	4.599	8.579	−3.980***
	(3.870)	(4.444)	
Father's years of schooling	6.365	9.533	−3.168***
	(3.706)	(3.903)	
Annual education expense(Yuan)	844.188	2232.514	−1,388.326***
	(1,283.733)	(3,619.970)	
School attendance			
% Junior high school	34.497	43.160	−8.664***
	(0.475)	(0.496)	
School type			
% Key School	2.618	8.962	−6.344***
	(0.160)	(0.286)	
Class type			
% Key class in a school	6.399	12.618	−6.219***
	(0.245)	(0.332)	

*** = significant at 1%, ** = significant at 5%, * = significant at 10% level.
Note: Standard deviations are in parentheses. Migrating children are included in the urban sample as they were sampled in the cities.
Source: 2010 China Family Panel Survey.

urban areas may not diminish as these children grow older and obtain more formal education.

Previous literature has cited plenty of possible factors based on developed countries' experience to explain education inequality between rural and urban populations in the PRC. These include differences in nutrition, parenting style, genetics, and living environments (Edwards and Ureta 2003; Meng and Yamauchi 2013; Feng and Chen 2012). Although it is hard for us to establish a causal relationship between differences in personal attributes and education inequality because of identification problems, it is still worth reporting the differences in these attributes (Table 3).

As shown in Table 3, weight and height of rural children are generally lower than those of their urban counterparts. On average, rural kids were 4.2 kilograms lighter and 6.5 centimeters shorter than their urban counterparts. As there are no significant differences in sex–age distributions of rural and urban children, substantial differences in weight and height may imply poor nutrition of rural children, which may lead to even worse education outcomes. In addition, there exist significant differences between rural and urban children in terms of their parents' education level. Mothers of rural children spent 4.6 years on average in school, nearly 4 years less than the time spent by mothers of urban children. Similarly, the average number of years of schooling of fathers of rural children was 6.4 years (i.e., primary school), which is 3.2 years less than the average of their urban counterparts (9.5 years of schooling). The extremely low education outcomes of parents of rural children may negatively affect the education performance of rural children. Finally, there exists a significant gap in education investment at the household level between rural and urban populations. On average, the family of rural children spend just CNY844 a year on schooling, or CNY1,388 less than their urban counterparts (up to CNY2,233). In sum, all these differences highlight the education disparity between rural and urban areas in the PRC.

B. Comparing Education Performance of Migrants' Children with Rural and Urban Counterparts

What is the level of education performance of migrating children and how does the migration behavior affect education inequality between rural and urban areas of the PRC? To answer these questions, we compare the education performance of migrating children (measured using self-reported and objective test scores) with that of rural and urban children.

Education performance of migrating children is generally lower than that of urban residents' children but higher than that of rural non-migrants' children. The average objective scores of migrating children for word and math tests are 6.3 and 4.6, respectively, which are higher than the scores of rural non-migrants' children (6.1 and 4.5) but lower than those of urban residents' children (7.2 and 5.2) (Table 4). This is consistent with the findings obtained from subjective assessments of school performance. Moreover, when we split migrants' children into the left-behind group and the migrating group, we find that: (i) there is no strong evidence to show that migrating children's education performance is better than the performance of left-behind children, and (ii) education performance of migrating children is significantly weaker than that of urban residents' children.

The findings above generate important insights on the potential effects of rural-to-urban migration on education inequality between rural and urban areas of the PRC. On one hand, there is no strong evidence to show that migrants' children will be better off if they migrate with their parents to cities and enter

Table 4. **Scores in Word and Math Tests by Children Category**
(2010 CFPS)

	Rural			Urban		
	Left-behind	**Rural non-migrants**	**Group difference with t-test results**	**Migrating**	**Urban local**	**Group difference with t-test results**
Word test score (full score = 10)	6.229	6.105	0.124	6.302	7.213	−0.911***
	(2.044)	(2.220)		(2.114)	(1.744)	
Primary school	5.546	5.355	0.192	5.550	6.455	−0.905***
	(1.975)	(2.178)		(2.137)	(1.748)	
Junior high school	7.572	7.505	0.067	7.404	8.156	−0.752***
	(1.420)	(1.506)		(1.516)	(1.196)	
Math test score (full score = 10)	4.463	4.500	−0.037	4.619	5.242	−0.624***
	(1.840)	(1.908)		(1.882)	(1.701)	
Primary school	3.563	3.522	0.041	3.478	4.129	−0.651***
	(1.459)	(1.513)		(1.428)	(1.337)	
Junior high school	6.234	6.328	−0.093	6.292	6.628	−0.336**
	(1.064)	(1.015)		(1.015)	(0.895)	
Observations	549	1,170		296	552	

*** = significant at 1%, ** = significant at 5%, * = significant at 10% level.
Note: Standard deviations are in parentheses.
Source: 2010 China Family Panel Survey.

urban schools. On the other hand, the significant gap in education performance of migrating children and urban residents' children suggests that education inequality exists between the two groups, working specifically against migrating children in urban areas. Both findings suggest that rural-to-urban migration cannot help mitigate education inequality between rural and urban populations in the country under the current institutional environment.

V. Education Inequality between Rural and Urban Areas of the People's Republic of China: Regression Analysis

Although the descriptive analysis is informative, it does not provide solid evidence on education inequality between rural and urban populations of the PRC or between migrants' and non-migrants' children. In practice, education performance of children is not only affected by the training that they receive from schools but on many other factors such as children's health status, parents' income and education levels, parenting styles, and school characteristics. If these factors are not taken into account, one could overestimate education inequality between rural and urban children and between migrants' and non-migrants' children. To bolster the findings in the comparison analysis, we use the regression analysis that controls for individual attributes to test education inequality between children of different groups.[7]

Three regression scenarios are employed to analyze the objective test scores. In the first scenario, both rural and urban samples are used to examine if there is a gap between the education performance of rural and urban children (with urban children as the base group). In the second scenario, the urban sample is used to examine if there is a gap between the education performance of migrating children and urban residents' children (urban residents' children as the base group). In the third scenario, the migrating children sample is compared with the rural sample to examine whether there is a gap between the education performance of migrating children and rural children (rural children as the base group). The corresponding results for word and math test scores are reported in Tables 5 and 6, respectively. The major findings are summarized below.

First, even after accounting for various personal attributes, family characteristics, and school quality, there are still significant differences in word test scores between rural and urban children. The coefficient of the rural children dummy (from first scenario regressions, column 1 of Table 5) is –0.242 and significant at the 5% level, which suggests that when other conditions are the same, rural children's word test score is 0.242 SD less than that of urban counterparts. Compared with the raw test score gap shown in Table 2, 32% of the raw test score gap between rural and urban children ($6.144–6.895 = -0.751$) can be explained by the difference in

[7] See Appendix 2 for a detailed discussion of the model specification.

Table 5. **Regression Analysis of Word Test Scores of Chinese Children**

Dependent Variable: (standardized word test score)	**(1)** **Rural vs. Urban Children**	**(2)** **Between Urban: Migrating vs. Urban Local Children**	**(3)** **Migrating vs. Rural Children**	**(4)** **Rural vs. Urban Children**	**(5)** **Between Urban: Migrating vs. Urban Local Children**	**(6)** **Migrating vs. Rural Children**
Group dummy (rural = 1, urban = 0)	−0.242**	—	—	−0.450***	—	—
	(0.100)	—	—	(0.149)	—	—
Group dummy (migrating = 1, urban local = 0)	—	−0.392***	—	—	−0.623**	—
	—	(0.151)	—	—	(0.254)	—
Group dummy (migrating = 1, rural = 0)	—	—	0.086	—	—	0.099
	—	—	(0.110)	—	—	(0.221)
Child's age	0.275***	0.311***	0.307***	0.205***	0.280***	0.308***
	(0.039)	(0.067)	(0.040)	(0.051)	(0.071)	(0.041)
Interaction between child age and the group dummy	—	—	—	0.088**	0.087	−0.005
	—	—	—	(0.044)	(0.072)	(0.065)
Dummy for male	−0.386***	−0.266**	−0.341***	−0.388***	−0.268**	−0.341***
	(0.071)	(0.107)	(0.078)	(0.070)	(0.107)	(0.078)
Weight	−0.001	0.004	0.006	−0.000	0.004	0.006
	(0.005)	(0.007)	(0.006)	(0.005)	(0.007)	(0.006)
Height	0.023***	0.024***	0.019***	0.022***	0.023***	0.019***
	(0.004)	(0.007)	(0.004)	(0.004)	(0.007)	(0.004)
Degree of depression	−0.026	−0.019	−0.033	−0.024	−0.017	−0.032
	(0.022)	(0.035)	(0.024)	(0.022)	(0.034)	(0.025)
Mother's years of schooling	0.039***	0.053***	0.052***	0.039***	0.052***	0.052***
	(0.011)	(0.019)	(0.012)	(0.011)	(0.019)	(0.012)
Father's years of schooling	0.051***	0.014	0.048***	0.049***	0.015	0.048***
	(0.012)	(0.020)	(0.012)	(0.012)	(0.020)	(0.012)
Dummy for school level (junior high = 1)	0.680***	0.244	0.609***	0.701***	0.257	0.610***
	(0.119)	(0.205)	(0.123)	(0.119)	(0.205)	(0.123)
Annual education expense	0.030***	0.030***	0.047	0.029**	0.030***	0.047
	(0.011)	(0.011)	(0.030)	(0.011)	(0.012)	(0.030)
Dummy for being in a key school	0.243*	0.265	0.183	0.249**	0.267	0.184
	(0.125)	(0.177)	(0.189)	(0.126)	(0.178)	(0.188)
Dummy for being in a key class of a school	0.278**	0.305**	0.436***	0.292***	0.317**	0.436***
	(0.111)	(0.141)	(0.148)	(0.110)	(0.139)	(0.148)
Constant term	1.929***	1.922**	1.979***	2.206***	2.101**	1.971***
	(0.700)	(0.957)	(0.500)	(0.695)	(0.960)	(0.516)
Control for province	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	2,271	848	2,015	2,271	848	2,015
R-squared	0.406	0.407	0.383	0.407	0.408	0.383

*** = significant at 1%, ** = significant at 5%, * = significant at 10% level.
Note: Robust standard errors are in parentheses.
Source: 2010 China Family Panel Survey.

Table 6. **Regression Analysis of Math Test Scores of Chinese Children**

Dependent Variable: (standardized math test score)	**(1)** **Rural vs. Urban Children**	**(2)** **Between Urban: Migrating vs. Urban Local Children**	**(3)** **Migrating vs. Rural Children**	**(4)** **Rural vs. Urban Children**	**(5)** **Between Urban: Migrating vs. Urban Local Children**	**(6)** **Migrating vs. Rural Children**
Group dummy (rural = 1, urban = 0)	−0.196***	—	—	−0.178	—	—
	(0.073)	—	—	(0.109)	—	—
Group dummy (migrating = 1, urban local = 0)	—	−0.443***	—	—	−0.432**	—
	—	(0.105)	—	—	(0.174)	—
Group dummy (migrating = 1, rural = 0)	—	—	−0.069	—	—	−0.081
	—	—	(0.077)	—	—	(0.144)
Child's age	0.317***	0.387***	0.292***	0.323***	0.388***	0.291***
	(0.030)	(0.047)	(0.031)	(0.037)	(0.049)	(0.031)
Interaction between child age and the group dummy	—	—	—	−0.008	−0.004	0.004
	—	—	—	(0.030)	(0.049)	(0.044)
Dummy for male	0.002	0.025	−0.012	0.002	0.025	−0.012
	(0.052)	(0.080)	(0.057)	(0.052)	(0.080)	(0.057)
Weight	0.005	0.003	0.007*	0.005	0.003	0.007*
	(0.004)	(0.005)	(0.004)	(0.004)	(0.005)	(0.004)
Height	0.009***	0.014***	0.007**	0.009***	0.014***	0.007**
	(0.003)	(0.004)	(0.003)	(0.003)	(0.004)	(0.003)
Degree of depression	−0.046***	−0.026	−0.046***	−0.046***	−0.026	−0.046***
	(0.016)	(0.026)	(0.017)	(0.016)	(0.026)	(0.017)
Mother's years of schooling	0.033***	0.004	0.039***	0.033***	0.004	0.039***
	(0.008)	(0.014)	(0.008)	(0.008)	(0.014)	(0.008)
Father's years of schooling	0.017*	0.024*	0.011	0.017**	0.024*	0.011
	(0.009)	(0.014)	(0.009)	(0.009)	(0.014)	(0.009)
Dummy for school level (junior high = 1)	1.569***	1.206***	1.696***	1.567***	1.206***	1.695***
	(0.096)	(0.150)	(0.099)	(0.096)	(0.150)	(0.099)
Annual education expense	0.017	0.019*	0.032	0.017*	0.019*	0.032
	(0.010)	(0.011)	(0.021)	(0.010)	(0.011)	(0.021)
Dummy for being in a key school	0.106	0.100	0.098	0.106	0.100	0.098
	(0.098)	(0.124)	(0.123)	(0.098)	(0.124)	(0.123)
Dummy for being in a key class of a school	0.118	0.028	0.202*	0.117	0.028	0.202*
	(0.085)	(0.116)	(0.110)	(0.085)	(0.115)	(0.110)
Constant term	1.534***	0.841	1.092***	1.509***	0.832	1.099***
	(0.403)	(0.587)	(0.402)	(0.413)	(0.596)	(0.412)
Control for province	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	2,271	848	2,015	2,271	848	2,015
R-squared	0.589	0.641	0.574	0.589	0.641	0.574

*** = significant at 1%, ** = significant at 5%, * = significant at 10% level.
Note: Robust standard errors are in parentheses.
Source: 2010 China Family Panel Survey.

observed attributes included in the regressions. Meanwhile, for the math test score results, the rural–urban education gap is –0.196 with 1% level of significance. The controlled attributes can help explain 26% of the raw test score gap in math between rural and urban local children.

Second, when focusing on the urban sample, we find that urban residents' children have much better education performance than migrating children. The coefficient of the dummy for migrating children (from second scenario regressions, column 2 of Table 5) is –0.392 and significant at the 1% level. Given that the difference in the raw word test scores of the two groups of children is 0.912 (Table 4), the regression results show that 43% of the test score gap can be explained by the regression controls. For the math test regression in column 2 of Table 6, the coefficient of the dummy for migrating children (–0.443) is also negative and significant at the 1% level. Up to 71% of the raw math test score gap (–0.624) can be explained by the controlled characteristics.

Third, the difference in test scores between migrating children and rural residents' children (including both left-behind and rural non-migrants' children) is small and statistically insignificant and likely due to different personal attributes. This suggests that migrating with parents cannot really improve the education performance of migrants' children.

Fourth, the major contributors to the rural–urban education disparity include demographic features, physical health measures, parental education levels, and household education spending. Basically, a child's age positively affects the word test score, with girls often exhibiting better performance. Physical health can generate better education outcomes, while parental education positively correlates with test scores. Other attributes that impact on word and math test scores also include the depression level of the child, which has a strong negative effect on math test scores though little effect on word test scores, and being in a key school, which is positively associated with word test scores but with no significant effect on math test scores.

Fifth, to gauge how the education disparity changes over time, we include an interaction term of the child's age and the group dummy into the regressions. The coefficients of the interaction terms show that the group difference in test scores varies with the age of the children. The results are shown in the last three columns of Tables 5 and 6. As seen in column 4 of Table 5, the coefficient of the interaction term between the rural dummy and age is positive and significant at the 5% level. This suggests that, holding other things constant, the gap in word test scores between rural and urban children is wider for the younger age group. The other interactions are insignificant, which implies that those group differences in test scores would not change with a child's age.

The above findings suggest the following: (i) there exists a substantial disparity in education outcomes of rural and urban children even after controlling for many attributes, (ii) there is no significant difference in education outcomes between rural

children who stay in rural areas and those who migrate with parents and receive their education in urban areas, (iii) migrating children generally have significantly poorer education performance than their urban counterparts although they are educated in the same cities, and (iv) there is evidence to show that the education disparity between rural and urban children tends to be widened for younger age cohorts.

VI. Policy Implications

Improving education performance of children has long been regarded as one of the most important targets of national policy in the PRC because it affects human capital accumulation of the country. However, how to efficiently use limited public resources to achieve this target is still under question. In this analysis, we find that there is still significant inequality in the education performance of children between rural and urban areas of the PRC. In particular, rural-to-urban migration, which had been expected to play an active role in reducing education inequality, could not contribute much to narrow the gap. To date, there is still a significant difference in the education performance of migrating children and urban residents' children. This provides some useful insights for policymaking.

First, it is essential to reduce education inequality between rural and urban populations of the PRC in order to improve average education performance at the national level. Although there are many personal attributes that affect education performance, providing equal rights and access to quality schools is important to improve education inequality between rural and urban areas of the country.

Second, it is important to reduce institutional barriers and discriminative policies against migrating children in urban areas in order to improve their education performance. In our analysis, migrating children do not exhibit better performance in education than left-behind children and rural residents' children, and are unable to catch up with the performance of urban residents' children. In addition to non-education-related factors, such as parenting styles and family characteristics, existing institutional barriers and discriminative policies that restrict migrating children from accessing the urban education system may be a reason. From this perspective, reducing these restrictions may allow more migrating children to improve their education performance and thus contribute to reducing education inequality between rural and urban populations of the PRC.

Third, in addition to reforming the education system, public policies should pay more attention to factors such as family income, children's nutrition, parenting style, and mental health, as these factors can also affect migrant children's education performance. This paper has shown that personal attributes, such as mental health status, play an important role in explaining the difference in math test performance of rural and urban children. Although it is hard to quantify the real effects due to potential identification problems, improving the living conditions of rural

left-behind children and paying more attention to their living environment will definitely help to increase their education performance.

VII. Conclusion

This paper uses CFPS and RUMiC survey data to examine the differences in education performance of children between rural and urban areas of the PRC. In particular, we separately examine the education performance of migrants' children (including both left-behind and migrating children) and compare this to the education performance of their rural and urban counterparts. Results show that there exists a substantial disparity between rural and urban children, with rural-to-urban migration playing a weak role in terms of narrowing the gap. In particular, our analysis shows that education performance of migrating children is significantly worse than that of urban residents' children, which causes some concerns.

As urban birth rate declines and more rural migrants move into cities, rural children are becoming an important part of the urban labor supply. Improving education performance of migrants' children, especially those migrating into cities with their parents, is not only in the interest of migrants but also crucial for human capital accumulation and the long-term economic growth of the PRC. Since there is a large gap in education performance of children in rural and urban areas of the country, further reforms need to be implemented to address the problem.

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Appendix 1. Descriptive Statistics on RUMiC Survey and CFPS Data

This appendix provides descriptive statistics of our samples.

Table A1.1. **Calculating the Dropout Rate for Junior High and Senior High School Students by Rural and Urban Areas**

	Total Number of Students Admitted in 2009	1st Grade in 2009	2nd Grade in 2010	3rd Grade in 2011	Graduates in 2012	Overall Dropout Rate	Adjusted Dropout Rate	Dropout Rate, Grades 7–8	Dropout Rate, Grades 8–9	Dropout Rate, before Graduation
Junior high schools										
Total	17,863,912	17,902,174	17,570,301	16,912,985	16,607,751	7.03%	—	1.85%	3.74%	1.80%
Urban	11,553,227	11,576,311	11,590,357	12,962,891	12,968,178	−12.25%	0.00%	−0.12%	−11.84%	−0.04%
Rural	6,310,685	6,325,863	5,979,944	3,950,094	3,639,573	42.33%	20.00%	5.47%	33.94%	7.86%
Senior high schools										
Total	8,303,384	8,316,126	7,946,667	7,960,881	7,915,046	4.68%	—	4.44%	−0.18%	0.58%
Urban	7,708,066	7,720,353	7,415,284	7,631,187	7,651,157	0.74%	—	3.95%	−2.91%	−0.26%
Rural	595,318	595,773	531,383	329,694	263,889	55.67%	—	10.81%	37.96%	19.96%

Source: Author's calculations. Ministry of Education. 2009–2013. *China Education Statistical Yearbook*. Department of Development and Planning, Ministry of Education, PRC. Beijing: People's Education Press.

Table A1.2. **CFPS Summary Statistics—Education-related Features**

	Rural		Urban	
Total no. of observations	1,719		848	
%	66.965		33.035	
	Left-behind	**Rural non-migrants**	**Migrating**	**Urban**
No. of observations by groups	549	1170	296	552
%	31.937	68.063	34.906	65.094
Gender				
% Male	48.998	50.427	52.027	50.906
	(0.500)	(0.500)	(0.500)	(0.500)
Age				
Average years	12.607	12.529	12.689	12.332
	(1.721)	(1.725)	(1.685)	(1.745)
Health				
Weight (kg)	36.526	36.794	38.590	42.092
	(9.939)	(10.529)	(11.900)	(11.690)
Height (cm)	144.501	143.994	146.547	152.938
	(17.152)	(17.082)	(17.201)	(13.101)
Depression	1.392	1.220	1.150	1.140
	(1.721)	(1.626)	(1.419)	(1.558)
Family characteristics				
Mother's years of schooling	4.224	4.774	5.280	10.348
	(3.790)	(3.896)	(3.975)	(3.594)
Father's years of schooling	6.434	3.493	7.057	10.861
	(6.332)	(3.803)	(3.762)	(3.283)
Annual education expense (CNY)	773.244	877.477	1,098.980	2,840.351
	(1,183.061)	(1,327.525)	(1,674.712)	(4,193.070)
School attendance				
% Junior high school	33.698	34.872	40.541	44.565
	(0.473)	(0.477)	(0.492)	(0.497)
School type				
% Key School	2.550	2.650	2.360	12.500
	(0.158)	(0.161)	(0.152)	(0.331)
Class type				
% Key class in a school	6.560	6.320	8.450	14.860
	(0.248)	(0.244)	(0.279)	(0.356)

Note: Standard deviations are in parentheses.
Source: 2010 China Family Panel Survey.

CFPS Data

Table A1.2 shows the basic summary statistics for each child category that we have defined.

Similar to the RUMiC data, boys are more likely to number among the migrating children, while girls are more likely to be among the left-behind children. However, the finding that migrating children tend to be relatively younger than left-behind children no longer holds. This probably occurs because of a province-specific effect, as the RUMiC and the CFPS draw their samples from different regions. The

migration of children from different regions starts in different years, giving rise to differences in the distributions based on children's age when RUMiC and CFPS data are used. Meanwhile, Chinese families' preference for taking care of boys is the same for different regions.

Not surprisingly, children in urban areas are healthier than those in rural areas, as coarsely measured by height and weight. Furthermore, urban local children are healthier than migrating ones. There is a huge difference in the family environment of the different children in terms of education. Urban local children's parents have much greater education experiences than parents of migrating, left-behind, and rural children, and they spend much more resources on their children's education. Under different family backgrounds, parents of children from better environments tend to invest more heavily in education. This contributes to the education gap between groups, and aggravates the severity of the disparities in the next generation.

Finally, migrating, left-behind, and rural non-migrating children are all younger than urban local children on average, so they have larger proportions enrolled in primary school. Conditional on the age distribution of different children categories, school attendance results show that rural children are more likely to delay their enrollment into the school system. Apart from that, rural children face greater restrictions to entry to key schools and classes. The results are a reminder that immediate action should be taken to relieve the education disparity problem before it goes too far.

RUMiC Data

Table A1.3 presents descriptive statistics on school-aged children from the rural, migrant, and urban samples. In particular, the migrant sample is split into the migrating children group and the left-behind children group, and is compared to the rural and urban samples. Statistics compiled using the rural sample in 2009 suggests that around 43% of rural children's parents migrated to urban areas for work. Of the total for migrants' children, around 55% migrated with their parents, while around 45% were left behind (using the urban sample). Compared with the numbers in 2008, the proportion of left-behind children has been declining over time, while that of migrating children has been increasing. This suggests that there are increasingly more children of migrants moving into urban areas for education, hence migrating children have become an important phenomenon in the PRC. There are four characteristics of migrants' children summarized below.

First, boys are more likely to become migrating children, while girls are more likely to become left-behind children. Also, migrating children are relatively younger than left-behind children. In our sample, the male–female ratio of migrating children is significantly higher than that of school-aged migrants' children, which is already greater than 1. This suggests that boys are more likely to migrate with their parents. A possible explanation of this phenomenon is that there is gender selection among

Table A1.3. **RUMiC Summary Statistics—Education-related Features**

	Rural Household Survey			Urban Migrant Survey		Urban Household Survey
Total no. of observations		3,047		1,358		1,058
%		55.78		24.86		19.37
	Rural	**Left-behind**	**Migrated**	**Left-behind**	**Migrated**	**Urban**
No. of observations by groups	1,747	1,216	84	605	753	
%	57.33	39.91	2.76	44.55	55.45	
Gender						
% Male	54.87	55.23	57.83	55.87	56.31	52.89
% School attendance						
Primary school	64.11	64.56	66.67	64.63	65.21	69.85
Junior high school	35.43	34.95	32.14	35.04	34.26	29.96
Dropped out	0.46	0.49	1.19	0.33	0.53	0.19
% Living with						
Both parents	94.96	0	78.57	0	87.52	85.82
Single parents	0	30.02	21.43	28.93	7.17	6.52
Both parents absent	5.04	69.98	0	71.07	5.31	7.66
Total years educated in cities for migrant sample				3.99 (2.88)	4.75 (2.70)	
Observations				143	687	
% School type						
Rural School					9.29	
City Migrant School					27.59	
City Non-migrant School					60.03	
Other					3.1	
Public						92.58
Private						7.12
Other						0.3
% Education quality of schools						
Best in the city/county	3.44	3.23	16.67	3.17	1.48	11.98
Fairly good in the city/county	24.71	18.79	43.59	16.67	25.03	55.49
Average in the city/county	69.86	75.35	39.74	74.83	71.6	32.23
Worse in the city/county	1.99	2.62	0	5.33	1.88	0.3
Observations	1,659	1,144	78	600	743	993
Education expenditure (CNY)						
Total payment for all regular school fees in 2010	880.98 (1,548.08)	996.78 (1,634.91)	1354.07 (1,416.78)	1413.80 (2,048.11)	1778.82 (2,334.82)	1814.18 (3,012.39)
Tuition and other related fees	207.96 (711.24)	202.03 (593.26)	600.47 (1,085.73)	300.08 (580.31)	440.71 (940.99)	611.68 (1,716.46)
Food and accommodation	508.12 (981.47)	636.45 (1,167.65)	686.03 (1,078.92)	718.00 (1,404.12)	737.72 (1,230.19)	780.64 (1,625.41)
Remedial classes at school	69.86 (312.03)	46.00 (280.23)	47.91 (116.03)	92.74 (504.47)	157.47 (962.75)	131.09 (464.50)
Other fees (e.g., school uniform and books)	145.88 (267.13)	147.35 (307.96)	162.25 (263.76)	324.20 (723.98)	413.97 (939.07)	220.73 (645.88)
Supplementary classes outside school	68.68 (430.56)	35.15 (466.01)	153.09 (748.25)	56.52 (352.68)	263.72 (932.58)	1,385.81 (2,729.99)
Sponsorship fees/study fees/school selection fees	53.54 (555.30)	33.56 (391.53)	150.70 (520.13)	68.72 (507.80)	732.90 (3,068.47)	588.00 (3,174.74)

Note: Standard deviations are in parentheses.
Source: 2009 Rural–Urban Migration in China Survey.

migrants' migration decision, with an apparent preference for boys. In addition, the ratio between the number of migrating children and that of left-behind children is lower in middle schools than in primary schools. This implies that migrating parents are more likely to take their younger children with them, leaving their older children in their hometowns. Economic concerns about the education costs of migrating children are an important reason for explaining this phenomenon.

Second, left-behind children have an increasingly lower likelihood of living with one or both of their parents over time relative to migrating children. In 2008, the proportion of left-behind children not living with both of their parents was 56%. However, this proportion increased to 70% in 2010. The proportion of left-behind children living with only one of their parents (usually the mother) has also been declining over time. Grandparents often substitute for the role of parents of left-behind children. In contrast, 88% of migrating children lived with both their parents in 2008, while 7% lived with one of their parents. This pattern did not change much in 2009.

Third, most migrants' children (including both migrating children and left-behind children) experienced going to urban schools, though these episodes were usually short-lived and different from those of their urban counterparts. In our sample, around one-fourth of left-behind children even attended the urban schools, where the average length of experience had been 4 years. For migrating children, the average length of experience in urban schools was 4.75 years, with most staying in urban schools for 3–7 years. Although migrants' children went to urban schools, these urban schools are usually different from those that urban residents' children attend. In our statistics, only 60% of migrating children were able to access public urban schools (which are of relatively lower quality), while the rest (40%) had to attend schools for migrants' children or rural schools. In contrast, around 93% of urban residents' children had access to public urban schools, while the rest (7%) went to high-level private schools.

Fourth, family spending on education was significantly higher for migrants' children than for rural residents' children, though the money was mostly used to cover additional living costs rather than improve education quality. In 2009, the average spending on migrating children's education by their families was nearly CNY1,800 per capita annually, or around 80% more than the average spending for rural residents' children (less than CNY1,000 per capita a year). However, of the total expenditure, about CNY740 was used for food and accommodation; there were still additional costs related to school sponsorships and bench fees.

In contrast, urban residents' children spent about CNY1,814 on education, of which CNY1,400 had been used for additional training courses. This is about 40 times greater than that spent on migrants' children for the same spending categories. On the rural side, spending on the education of left-behind children was higher than that on children of non-migrant families, with the additional money spent on food and accommodations, as left-behind children were more likely to go

to choice boarding schools with extra charge. And the spending on other categories for left-behind children was generally less than rural non-migrants' children. The difference in family education expenditure among groups may suggest that (i) migrating children are vulnerable when educated in cities, as they are generally from low-income families and have to pay an extra fee to access urban schools, reducing resources for their education development; and (ii) left-behind children not only lack parental care but also receive limited spending on their education, which can worsen their education performance. Significant differences in characteristics between migrants' children and rural and urban residents' children may therefore lead to inequality in education.

Appendix 2. Model Specification for Regression Analysis

Regression analysis can be used to quantify the impact of rural-to-urban migration on education performance of migrants' children in a more accurate way than comparison analysis. This is because regressions can net out the effects of migration by controlling for a large number of non-migration factors. The basic regression function in our analysis is specified as

$$Y_i = \beta_0 + \beta_1 D_i + \beta_2 X_i + \beta_3 Z_i + \beta_4 S_i + \varepsilon_i, \quad (1)$$

where Y_i denotes performance in education or the mental health of child i. We consider three different outcome variables in separate models, including word test scores, math test scores, and depression level scores.

The variable D_i is the group dummy that indicates the group used for comparison—for example, D_i equals 1 if child i is migrating and 0 if he or she is a rural child (or urban local child). X_i denotes a set of children's personal characteristics such as age, gender, physical health status (measured by weight and height), mental health (measured by depression level), and current school level (primary school or junior high school). Z_i represents information on children's families, including the education levels of parents, and annual earnings and expenses in children's education. S_i denotes the characteristics of the school child i attends—for instance, whether or not the child was admitted to a key school or a key class, which may capture the differences in education quality due to school choice. The province fixed effect is also included to capture other unobservable regional disparities that may generate group differences. All three groups of variables (X_i, Z_i, and S_i) are used to control for non-migration factors. Finally, ε_{it} is the residual. The estimate of β_1, which is the main interest of this analysis, captures the impact of rural–urban migration on education outcomes and mental health status of rural children controlling for all other group differences in personal, family, and school characteristics.

Based on Equation (1), we design three regression scenarios for each outcome variable to examine the impact of rural–urban migration on human capital

accumulation of rural children. In the first scenario, we use the rural sample to analyze the difference between the education performance and mental health of left-behind children and rural non-migrants' children (the base group). In the second scenario, we use the urban sample to analyze the difference between the education performance of migrating children and urban local children (the base group). In the third scenario, we combine both rural and urban samples to analyze the gap among migrating children, rural non-migrants' children, urban residents' children, and left-behind children (the base group).

It would also be interesting to see how differences across children's groups vary over time. One way to conduct dynamic analysis using cross-section data is to examine if the age effect on test scores or depression levels significantly differs across various groups. Therefore, we also incorporate an interaction term between the child's age and the group dummy in the equation—i.e., (age–10) multiplied by D_i. The coefficient of the interaction term captures the difference in the age effect between the two groups of children. The group dummy D_i then captures the group difference between left-behind children (or migrating children) and rural local children (or urban local children) at age 10. For example, if the interaction term is positive and significant for the test score regressions, we can claim that the left-behind (or migrating children) are getting better in their test scores relative to their counterparts as their age increases.

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