ECONOMIC ANALYSIS

A. Project Costs

1. This chapter outlines the methodology and results of the economic analysis for the project, comprising (i) the construction of five urban roads, including traffic management system, in Ji'an; (ii) a public transport component, consisting of the implementation of a 6.9-kilometer (km) bus rapid transit (BRT) line and the development of a public transport hub; and (iii) a river rehabilitation and greenway component.

2. Financial costs were converted into economic costs and adjusted to the world price numeraire by (i) excluding taxes, price contingencies, and financial charges; (ii) using a 0.8 shadow price factor for low-skilled labor costs;[1] (iii) applying a standard conversion factor of 0.99;[2] and (iv) converting nominal costs to constant 2014 yuan. The road component also includes CNY135 million for utilities (water, sewer, drainage) that have been included in the economic evaluation. Land acquisition cost has been based on the opportunity cost derived from the discounted production value over 20 years.[3] The table below shows the cost estimates converted to economic costs of the overall project.

Table 1: Total Cost Estimate (Economic Costs)
(CNY million)

Item			Total
A.	**Base Cost**		
	1.	Civil works	
		a. Public transport	99.92
		b. River rehabilitation	30.23
		c. Urban roads	567.83
		d. Traffic management	1.61
	2.	Goods and equipment	151.42
	3.	Land acquisition and resettlement	336.17
	4.	Institutional strengthening and capacity building, consulting service on project supervision, capacity building programs	7.27
	5.	Survey, research, design and project management	105.55
		Subtotal (A)	**1,299.99**
B.	**Physical Contingencies**		**95.79**
Total Project Cost (A+B)			**1,395.78**

3. The operation and maintenance costs of the project components are also converted on the basis of the shadow cost factors mentioned above. Annual maintenance for the urban roads is estimated at CNY120,000 per km, increasing at 5% per annum in real terms. Major repairs are assumed every 10 years at five times the cost of regular (annual) maintenance, also increasing at 5% per annum in net real terms. Wages and staff welfare expenses are estimated to increase at 3% per annum in real terms. Other management fees are calculated on the basis of 20% of the annual operating and maintenance costs, excluding major repairs.

4. Operation and maintenance cost assumptions for the BRT system are presented in the Financial Analysis.[4] Annual maintenance and administration costs for the multimodal hub are

[1] Consistent with recent urban transport projects in the People's Republic of China, such as: ADB. 2012. *Report and Recommendation of the President to the Board of Directors: Proposed Loan to the People's Republic of China for the Jiangxi Fuzhou Urban Integrated Infrastructure Improvement Project*. Manila; and ADB. 2013. *Report and Recommendation of the President to the Board of Directors: Proposed Loan to the People's Republic of China for the Hubei-Yichang Sustainable Urban Transport Project*. Manila.

[2] Calculation based on published 2012 International Monetary Fund data and using methodology from ADB, Economics and Research Department (ERD) Technical Note No. 11: Shadow Exchange Rates for Project Economic Analysis, 2003.

[3] See Linked Document 14, Resettlement Plan.

[4] See Financial Analysis, accessible from the list of linked documents in Appendix 2.

estimated at CNY0.542 million in the first year, growing at 3% per annum in real terms, plus a periodic overhaul every 5 years of CNY3.971 million. For the Yudai River rehabilitation, annual maintenance is assumed to be 0.3% of project implementation costs per annum, increasing at 5% per annum in real terms; also assumed are six full-time staff employed at CNY18,000 per annum plus 14% welfare, increasing by 5% per annum in real terms.

5. Residuals were calculated assuming a 40-year life of each asset, taking into account the proportion of 10 yearly repair costs for which residuals could be generated.

B. Economic Benefits

6. The benefit streams of the transport components are expressed in 2014 prices and comprise travel time savings, vehicle operating cost (VOC) savings and road safety benefits. A travel-demand forecasting model was prepared to estimate demand for travel on the road and bus networks in Ji'an (see Demand Travel Forecast for a detailed description of the model and results[5]). The travel demand model provided forecasts of road-link volumes and ridership on all city bus lines for years 2020 and 2030. Demand in other years is based on interpolation of the forecasts. The economic benefits of the roads and BRT were derived from changes in vehicle-km traveled, and vehicle- and passenger-hours across the entire urban transport network.

7. The VOCs applied to calculate the relative transport cost savings of the project are presented in Table 2. The base VOC costs were derived from the Roads Economic Decision (RED) model[6] using published prices in the People's Republic of China in 2013 and adjusted to 2014. The VOCs with and without the project are calculated for each vehicle type using average speeds and volume–capacity ratios from the travel-demand forecasting model. The unit VOC values are expressed in constant economic costs, omitting tax and subsidies.

Table 2: Vehicle Operating Cost
(per vehicle-kilometer)

Vehicle Type	CNY
Car medium	1.04
Bus heavy	2.28
Truck medium	1.86
MC (33% medium car)	0.34

Source: Asian Development Bank estimates using Roads Economic Decision model (2014).

8. The economic analysis employed a weighted average economic value of time (VOT) of 60% of the hourly income per capita[7] as the shadow price VOT, escalated in line with projected growth in the real gross domestic product (GDP) per capita. The VOT for 2013 is based on a GDP per capita of CNY24,421 and 2,000 working hours per year, resulting in CNY12.21 per working hour. The weighted average for 2013 is therefore 60%[8] x CNY12.21 = CNY7.33 per passenger-hour.

9. The VOT has been adjusted over time to express the increasing relative value of time as the country develops. Real GDP per capita in Ji'an has grown by 15% per year on average from

[5] See Travel Demand Forecast, accessible from the list of linked documents in Appendix 2.
[6] World Bank 2004, Roads Decision Model, an Excel-model for economic evaluation of road investments options using the consumer surplus.
[7] Jiangxi Ji'an Statistics Bureau. 2012. *Jiangxi Ji'an Statistical Yearbook*. Jiangxi.
[8] Based on information obtained from the travel forecasting report, the assumption is that there are 80% non-work trips and 20% work-related trips. Assuming non-working time has half the value of work-related time, overall economic value of time is equivalent to 60% or work-related time. (i.e., 1.00 x 20% + 0.50 x 80% = 0.60). It is noted that this may be an under-estimate of the proportion of work-related trips and hence the economic analyses may be deemed to be conservative.

2008 to 2012. In the evaluation, the assumed growth in GDP per capita is 7% per year in 2014 and 2015, gradually decreasing to 3% per year in 2030 and onward.

10. The investment in traffic management systems is relatively low (CNY28 million in total, mainly equipment), but has a major additional impact on the travel time because it significantly increases the traffic flow (capacity) at junctions and the average traffic speed along major corridors. The time saving per junction is based on 30 seconds for a car in the peak hour. For off-peak traffic, 15 seconds are expected to be saved.

11. The savings on accident costs are based on the accident rate per million vehicle-km from the Ji'an Traffic Police from 2011 to 2013. According to the International Road Assessment Program (iRAP),[9] the value of a life saved is typically 60–80 times greater than current GDP per capita. Assuming a factor of 70 the cost of each fatality is about CNY1,900,000 with 4.2 serious injuries for each fatality. the cost of each such serious injury being valued at 25% of a fatality. These savings are applied to the reduction in traffic accidents expected to result from the improved intersection design and traffic management system.

12. The costs for utilities are assumed to be recovered over 20 years through charges. The potential cost saving in construction[10] is not accounted for.

13. Emission savings have been accounted for in the economic evaluation model as well, but result in insignificant (monetary) savings due to low values generally applied to emission reductions.

14. The benefits of the river rehabilitation component are based solely on the flood control benefits of the project. Benefits related to the park and greenway development are not counted because these benefits cannot be valued monetarily. The costs of landscaping are therefore excluded from the analysis. The Yudai River regularly floods, with flood damage cost (based on property damage and recovery works) estimated by the Ji'an Municipal Government at CNY4.03 million per annum, which formed the basis of the related benefit streams for flood control.

C. Results of the Economic Cost–Benefit Analysis

15. Table 3 presents the estimated overall economic internal rate of return (EIRR) for the project. EIRR estimates for the individual project components are listed in Table 4. The annual stream of costs and benefits are shown in Table 5.

Table 3: Economic Analysis Results

Item	Total project
Benefit–cost ratio of NPVs	1.53
EIRR (%)	16.4
NPV @ 12% (CNY million)	549.6

EIRR = economic internal rate of return, NPV = net present value.

Table 4: Economic Internal Rate of Return by Project Component (%)

Item	EIRR
Urban roads and TMS	14.9
BRT	24.4
Multimodal hub	25.0
River flood prevention	13.7

EIRR = economic internal rate of return, TMS = traffic management system, BRT = bus rapid transit.

[9] iRAP is a registered charity involved in the prevention of road crashes. iRAP has conducted research on the incidence and costs of crashes in countries around the world, including in the People's Republic of China.

[10] Once the roads are constructed it is likely to be more expensive to build the utilities.

Table 5: Summary of the Analysis of Costs and Benefits, Total Project

(CNY million)

Year	Total Costs (incl. O&M)	Time Savings Roads, TMS, BRT, MMH	VOC savings Roads and BRT	Road safety benefits	Flood savings	Total Benefits	Net Benefits
2015	**347.5**	0.0	0.0	0.0	0.0	**0.0**	-347.5
2016	**312.9**	0.0	0.0	0.0	0.0	**0.0**	-312.9
2017	**330.3**	9.7	9.0	1.5	0.0	**20.2**	-310.1
2018	**209.8**	19.7	19.5	2.7	2.3	**44.1**	-165.7
2019	**64.6**	49.7	56.8	6.4	3.5	**116.4**	51.8
2020	**18.0**	57.8	76.0	7.4	4.9	**146.2**	128.2
2021	**14.8**	65.9	90.6	8.0	5.1	**169.6**	154.8
2022	**16.2**	74.6	106.5	8.6	5.3	**195.1**	178.9
2023	**16.3**	84.1	123.7	9.3	5.5	**222.7**	206.4
2024	**17.0**	94.5	136.9	10.0	5.7	**247.1**	230.1
2025	**25.7**	105.7	162.7	10.7	6.0	**285.1**	259.4
2026	**25.2**	117.9	184.7	11.5	6.2	**320.2**	295.0
2027	**52.2**	130.9	208.4	12.3	6.5	**358.1**	306.0
2028	**20.6**	145.0	234.1	13.2	6.7	**399.0**	378.4
2029	**21.5**	160.1	261.8	14.2	7.0	**443.0**	421.5
2030	**26.5**	189.1	291.7	15.2	7.3	**503.2**	476.7
2031	**23.6**	201.0	307.8	15.7	7.5	**532.1**	508.4
2032	**25.8**	213.6	324.6	16.2	7.9	**562.3**	536.4
2033	**8.0**	226.9	342.0	16.8	8.2	**593.9**	585.9
2034	**27.1**	241.1	360.1	17.4	8.5	**627.1**	599.9
2035	**36.3**	256.1	378.9	18.0	8.8	**661.8**	625.5
2036	**40.3**	272.1	398.4	18.6	9.2	**698.2**	657.9
2037	**71.6**	289.0	418.6	19.2	9.6	**736.4**	664.7
2038	**32.6**	306.9	439.6	19.9	9.9	**776.3**	743.8
2039	**34.1**	326.0	461.4	20.5	10.3	**818.2**	784.1
2040	**-415.2**	346.2	484.0	21.2	10.7	**862.2**	1,277.3
						EIRR	**16.4%**
			Discount rate	12%		**NPV** (CNY million)	**549.6.4**

( ) = negative, BRT = bus rapid transit, EIRR = economic internal rate of return, MMH = Multi-Modal Hub NPV = net present value, TMS = traffic management system.
Source: Asian Development Bank.

D. Analysis of Least-Cost and Alternative Options

16. The scope and design of each project component was based on an analysis of the cost and capacity requirements needed to serve projected demand. For the urban road component, initial designs were prepared for larger roads (70 meters and 55 meters wide) rather than the road width actually adopted (55 meters and 40 meters). The travel-demand forecasts demonstrated that demand did not justify roads of 70 meters and 55 meters, and the designs were scaled back to improve economic viability. Likewise, the Yudai River rehabilitation and greenway component was reduced in scope during the feasibility study to reduce costs, while maintaining sufficient flood control capacity.

17. The BRT component was based on a careful assessment of three route options: (i) an east–west route between the existing railway station and the new development area, (ii) a route along Jizhou Road to the west of Jinggangshan Avenue, and (iii) the route through the central business district along Jinggangshan Avennue. Economic analysis was undertaken for each option and demonstrated that the economic return to the chosen alignment along Jinggangshan Avenue was much higher than to the other alternatives. Option 1 resulted in negative economic returns due to congestion on the main bridge in the city. Option 2 resulted in lower economic returns than the Asian Development Bank threshold rate of 12%, due to lack of demand. The selection of option 3 ensures that the most heavily traveled bus routes in the city benefit from the BRT infrastructure and can be implemented at low cost thanks to the 60-meter width of Jinggangshan Avenue, which requires no land acquisition or major changes to the alignment.

18. Three alternative designs for the improvement of the railway station square were prepared and considered by the municipal government. The government selected the least-cost option, which provides a substantial improvement in the service to passengers at a significantly reduced construction cost. The higher-cost options would have provided full separation of pedestrians from vehicle lanes through the construction of a pedestrian overpass. The overpass options would provide additional safety benefits, but were considered too costly by the municipal government.

E. Sensitivity and Risk Analysis

19. The sensitivity test results indicate that the project is highly likely to remain economically viable even with substantial cost overruns or benefit shortfalls. Even a combination of the three tests results in an EIRR above the threshold value of 12%. This is also true of all project components individually, except for the urban road and traffic management component under a combined cost overrun and benefit shortfall, and for the river flood prevention subcomponent, where both benefit and cost switching values are under 20%.

Table 6: Sensitivity Analysis

Item	Assumptions	Base EIRR	EIRR	NPV (CNY million)	Switching Value
Urban roads and TMS	Cost overrun of 20%	13.7%	12.1%	10.2	21%
	Value of time 20% lower	13.7%	13.1%	90.1	-51%
	VOC is 20% lower	13.7%	12.4%	37.0	-27%
	Combination of the above	13.7%	10.2%	-160.7	-
BRT	Cost overrun of 20%	24.4%	21.4%	325.3	139%
	Value of time 20% lower	24.4%	23.0%	325.6	-141%
	VOC is 20% lower	24.4%	22.5%	311.9	-112%
	Combination of the above	24.4%	18.3%	203.9	-
Multimodal hub	Cost overrun of 20%	25.0%	21.0%	19.3	96%
	Value of time 20% lower	25.0%	20.1%	14.4	-49%
	Combination of the above	25.0%	16.6%	9.3	-
River flood prevention	Cost overrun of 20%	13.7%	11.3%	-1.7	14%
	Benefits are 20% lower	13.7%	10.8%	-2.4	-12%
	Combination of the above	13.7%	8.8%	-7.9	-
Overall project	Cost overrun of 20%	17.5	15.5	451.6	66%
	Value of time 20% lower	17.5	16.6	520.6	(105%)
	VOC is 20% lower	17.5	16.2	464.0	(71%)
	Combination of the above	17.5	13.3	151.4	…

( ) = negative, EIRR = economic internal rate of return, NPV = net present value, TMS = traffic management system, VOC = vehicle operating cost.
Source: Asian Development Bank estimates.

F. Summary and Conclusion

20. The project will result in large positive net economic benefits with an EIRR of 16.4%. The urban road component, combined with the relatively small investment in traffic management systems (75% of the cost) has a satisfactory EIRR of 13.7%, while the EIRR for the BRT component (19% of the cost) is 24.4%.