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PROJECT PERFORMANCE ASSESSMENT REPORT



CHINA

ShiZheng Railway Project

Report No. 129933

NOVEMBER 28, 2018

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Report No.: 129933

PROJECT PERFORMANCE ASSESSMENT REPORT

PEOPLE'S REPUBLIC OF CHINA

SHIZHENG RAILWAY PROJECT (IBRD-75570)

November 28, 2018

Currency Equivalents (annual averages)

Currency Unit = Renminbi (RMB)

| | | |
|------|--------|----------|
| 2008 | \$1.00 | RMB 6.95 |
| 2009 | \$1.00 | RMB 6.83 |
| 2010 | \$1.00 | RMB 6.77 |
| 2011 | \$1.00 | RMB 6.46 |
| 2012 | \$1.00 | RMB 6.31 |
| 2013 | \$1.00 | RMB 6.20 |
| 2014 | \$1.00 | RMB 6.14 |
| 2015 | \$1.00 | RMB 6.23 |
| 2016 | \$1.00 | RMB 6.64 |

Abbreviations

| | |
|-------|---|
| CMV | catenary maintenance vehicles |
| CPS | Country Partnership Strategy |
| CRC | China Railway Corporation |
| ERR | economic rate of return |
| FCTIC | Foreign Capital and Technical Import Center (of the Ministry of Railways) |
| HSR | high-speed railway |
| ICR | Implementation Completion and Results Report |
| ISR | Implementation Status and Results Report |
| IEG | Independent Evaluation Group |
| M&E | monitoring and evaluation |
| NPV | net present value |
| PAD | project appraisal document |
| PDO | project development objective |
| PMO | project management office |
| PPAR | Project Performance Assessment Report |

All dollar amounts are U.S. dollars unless otherwise indicated.

Fiscal Year

Government: January 1—December 31

| | |
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This report was prepared by Kavita Mathur and Houqi Hong, who assessed the project in China in March 2018. The report was peer reviewed by Atul Agarwal and panel reviewed by Jack W. van Holst Pellekaan. The team would like to thank Elisabeth Goller for her comments. Richard Kraus provided administrative support.

Principal Ratings

| Indicator | ICR | ICR Review | PPAR |
|-----------------------------|--------------|--------------|--------------|
| Outcome | Satisfactory | Satisfactory | Satisfactory |
| Risk to development outcome | Negligible | Modest | Negligible |
| Bank performance | Satisfactory | Satisfactory | Satisfactory |
| Borrower performance | Satisfactory | Satisfactory | Satisfactory |

Note: The Implementation Completion and Results (ICR) report is a self-evaluation by the responsible Global Practice. The ICR Review is an intermediate Independent Evaluation Group product that seeks to independently validate the findings of the ICR. PPAR = Project Performance Assessment Report.

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IEG Mission: Improving World Bank Group development results through excellence in independent evaluation.

About This Report

The Independent Evaluation Group (IEG) assesses the programs and activities of the World Bank for two purposes: first, to ensure the integrity of the World Bank's self-evaluation process and to verify that the World Bank's work is producing the expected results, and second, to help develop improved directions, policies, and procedures through the dissemination of lessons drawn from experience. As part of this work, IEG annually assesses 20–25 percent of the World Bank's lending operations through fieldwork. In selecting operations for assessment, preference is given to those that are innovative, large, or complex; those that are relevant to upcoming studies or country evaluations; those for which Executive Directors or World Bank management have requested assessments; and those that are likely to generate important lessons.

To prepare a Project Performance Assessment Report (PPAR), IEG staff examine project files and other documents, visit the borrowing country to discuss the operation with the government, and other in-country stakeholders, interview World Bank staff and other donor agency staff both at headquarters and in local offices as appropriate, and apply other evaluative methods as needed.

Each PPAR is subject to technical peer review, internal IEG panel review, and management approval. Once cleared internally, the PPAR is commented on by the responsible World Bank country management unit. The PPAR is also sent to the borrower for review. IEG incorporates both World Bank and borrower comments as appropriate, and the borrowers' comments are attached to the document that is sent to the World Bank's Board of Executive Directors. After an assessment report has been sent to the Board, it is disclosed to the public.

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IEG's use of multiple evaluation methods offers both rigor and a necessary level of flexibility to adapt to lending instrument, project design, or sectoral approach. IEG evaluators all apply the same basic method to arrive at their project ratings. Following is the definition and rating scale used for each evaluation criterion (additional information is available on the IEG website: <http://ieg.worldbankgroup.org>).

Outcome: The extent to which the operation's major relevant objectives were achieved, or are expected to be achieved, efficiently. The rating has three dimensions: relevance, efficacy, and efficiency. *Relevance* includes relevance of objectives and relevance of design. Relevance of objectives is the extent to which the project's objectives are consistent with the country's current development priorities and with current World Bank country and sectoral assistance strategies and corporate goals (expressed in Poverty Reduction Strategy Papers, Country Assistance Strategies, sector strategy papers, and operational policies). Relevance of design is the extent to which the project's design is consistent with the stated objectives. *Efficacy* is the extent to which the project's objectives were achieved, or are expected to be achieved, taking into account their relative importance. *Efficiency* is the extent to which the project achieved, or is expected to achieve, a return higher than the opportunity cost of capital and benefits at least cost compared with alternatives. The efficiency dimension is not applied to development policy operations, which provide general budget support. *Possible ratings for outcome:* highly satisfactory, satisfactory, moderately satisfactory, moderately unsatisfactory, unsatisfactory, highly unsatisfactory.

Risk to Development Outcome: The risk, at the time of evaluation, that development outcomes (or expected outcomes) will not be maintained (or realized). *Possible ratings for risk to development outcome:* high, significant, moderate, negligible to low, and not evaluable.

Bank Performance: The extent to which services provided by the World Bank ensured quality at entry of the operation and supported effective implementation through appropriate supervision (including ensuring adequate transition arrangements for regular operation of supported activities after loan or credit closing, toward the achievement of development outcomes). The rating has two dimensions: quality at entry and quality of supervision. *Possible ratings for Bank performance:* highly satisfactory, satisfactory, moderately satisfactory, moderately unsatisfactory, unsatisfactory, and highly unsatisfactory.

Borrower Performance: The extent to which the borrower (including the government and implementing agency or agencies) ensured quality of preparation and implementation, and complied with covenants and agreements, toward the achievement of development outcomes. The rating has two dimensions: government performance and implementing agency(ies) performance. *Possible Ratings for borrower performance:* highly satisfactory, satisfactory, moderately satisfactory, moderately unsatisfactory, unsatisfactory, and highly unsatisfactory.

Preface

The purpose of this Project Performance Assessment Report (PPAR) for the World Bank's ShiZheng Railway Project in China is to provide closer and deeper insights on the project's outcome based on updated evidence, including an assessment of the project's contribution to railway sector reform and institutional improvement in China. The ShiZheng Railway Project was the first of the six projects in a programmatic engagement initiated by the World Bank in 2008 to support the construction of priority high-speed railway lines and provide a platform for continuing the policy dialogue between the World Bank and the government on China's railway sector reform.

The PPAR is the second of three PPARs, each for a World Bank-financed large railway investment project in China that was completed during the past five years. (The other two PPARs are for the NanGuang Railway Project and the Third National Railway Project.) Although the World Bank's financing ranged from \$200 million to \$300 million, and it accounted for a small percentage of the total cost of each project (from about 5 percent to 12 percent), all three projects were a platform for railway sector policy engagements between the World Bank and the government.

The goal of the ShiZheng Railway Project was to enhance transport capacity and services in a major, busy corridor connecting central and north China, with the aim of meeting growing market demand for improved transport in the corridor.

This assessment was based on the World Bank's Independent Evaluation Group (IEG) mission to China in March 2018. The assessment used a mixed-methods approach that included field visits, interviews with stakeholders (such as government officials, implementing agency staff, experts from research institutes and universities, the World Bank operations team, and other knowledgeable persons), and desk research, including a review of project documents, research papers, and other materials.

IEG is grateful to the government of China, the China Railway Corporation, the World Bank operations team, and other stakeholders for their strong support to the mission during its visit to China.

Following standard IEG procedures, a copy of the draft PPAR was sent to the relevant government officials and agencies for their review and feedback and no comments were received.

Summary

Context

Railways are vital to China's social and economic development. As a large economy with a vast geographical area and a huge population, China has massive volumes of passenger and freight traffic moving over medium to long distances. Because of the high demand for rail services, railways are one of the most economic and effective means of transport for the medium- to long-distance transport market in China. They are also more energy-efficient and environment-friendly than other transport modes on a comparable capacity basis.

Since as early as the mid-1990s, China's railways had been pursuing capacity expansion and reform to meet a dramatically increasing demand for railway transport services. However, the expansion had not kept pace with the increased demand. Consequently, the government developed an ambitious plan to invest more in railways, especially through the State Council's approval of China's 11th Five-Year Plan (2006–10).

The World Bank initiated a programmatic engagement with China's railways in 2008 through a program of six projects to support construction of priority high-speed railway (HSR) lines by financing a small percentage (about 2 percent to 5 percent) of the total cost (see appendix B for details). The program was also intended to be a platform for the World Bank to continue its policy dialogue with the government on railway sector reform. The ShiZheng Railway Project was the first of the six projects.

This is a Project Performance Assessment Report (PPAR) for the ShiZheng Railway Project. The project supported the construction of a 355-kilometer dedicated passenger HSR line between Shijiazhuang and Zhengzhou, two large inland cities along the Beijing to Guangzhou high-speed rail corridor. It also financed the procurement of advanced catenary maintenance vehicles (CMVs) for high-speed rail lines in China. The World Bank Group's Board of Executive Directors approved the project in May 2008. The project was restructured in 2012 and completed in November 2015.

Project Objectives, Relevance and Design

The project's original objectives were to meet the growing freight and passenger market demand in the railway corridor section between Shijiazhuang and Zhengzhou while substantially improving the level of service offered to customers. After the restructuring in 2012, a new objective was added ("to improve the maintenance of the catenary system on high-speed rail lines"), but the original objectives were unchanged.

The relevance of the project objectives is rated **high**. The objectives were closely aligned with China's 11th Five-Year Plan for 2006–10 and China's 12th Five-Year Plan for 2011–

15, which placed a high priority on developing a network of dedicated high-speed passenger railways to support regional development, including the development of inland provinces, and using advanced technology to enhance effectiveness and safety of high-speed rail lines. The objectives were also highly consistent with the World Bank's country partnership strategies for China for 2006–10 and 2013–16. Both emphasized upgrading railroads linking inland provinces to more dynamic economic centers, fostering greener growth through developing low-carbon transport such as HSRs, and developing and maintaining sustainable and safe transport systems. HSRs are an energy-efficient and environment-friendly means of transport given the high demand for rail transport in China. The high-speed rail infrastructure is costly, and therefore selection should be based on all cost-benefit dimensions.

The relevance of design is rated **substantial**. The specific project activities were causally linked with the achievement of project development objectives. The construction of the new dedicated passenger HSR line was key to achieving increased transport capacity and improved quality of services on the ShiZheng railway corridor, and to alleviating the capacity constraint on the existing conventional line, thus improving its level of service. The use of the advanced CMVs would contribute to faster response to catenary system incidents and to timely maintenance of the system on China's high-speed rail lines. However, the project should have included measures at the design stage to ensure that concrete plans are in place for timely, sound integration of the high-speed train with other transport modes, especially at smaller, intermediate stations.

Project Results

The achievement of the first objective of meeting growing transport demand in the ShiZheng railway corridor is rated **substantial**. The new high-speed passenger railway between Shijiazhuang and Zhengzhou (the project line, or ShiZheng line) was constructed as planned, meeting key international standards and permitting a train speed of up to 350 kilometers per hour. The average number of passenger train pairs per day in the railway corridor (including the project line and the existing conventional line) increased from 76 in the appraisal year 2008 to 125 in 2015 and to 114 at the PPAR mission in March 2018, meeting the project end target of 114 pairs (outbound and return trips). The high-speed trains on the project line increased from zero to 60 pairs during 2008–15 and reached 74 pairs in March 2018. According to the PPAR mission's calculations, this train supply in the corridor caters to approximately 90.2 million passenger-kilometers/route-kilometers. Regarding demand in the corridor, the PPAR mission estimated the 2018 passenger density because no updated figures were available, calculating an overall 2018 passenger density of 92 million passenger-kilometers/route-kilometers using the growth rates from the Implementation Completion and Results Report. The current train supply essentially meets this increasing passenger volume.

The average number of freight trains on the conventional line was unchanged at 55 pairs from 2005 to 2016, which was 82 percent of the project target of 67 pairs, reflecting a network-wide freight traffic contraction during 2015 and 2016. The PPAR mission was unable to obtain updated data on freight train numbers and demand in the project corridor from China Railway Corporation (CRC). However, the Independent Evaluation Group (IEG) used published train timetables that show that a significant reduction in the number of conventional passenger trains had occurred on the line since 2016. This would have released capacity for increases in freight trains if needed. Therefore, the objective of meeting the growing freight demand, if any, would be achieved.

The achievement of the second objective of improving services to customers is rated **substantial**. According to the published train timetable, the nonstop travel time of trains on the project line is 81 minutes—less than half of that on the existing conventional line, which is 197 minutes to 261 minutes. The high-speed trains travel at about 300 kilometers per hour. Passengers and experts that the IEG PPAR mission interviewed agreed strongly that the high-speed trains were punctual, safe, comfortable, and affordable for the middle class. Both the high-speed trains and the stations along the ShiZheng line have accessible designs. The trains have the necessary amenities, and large stations are accessible to all passengers with good intermodal transport connections. A moderate shortcoming in small-station cities along the project line is that the integration of the high-speed train with other transport modes has not yet been completed. No data were available on how the level of service had improved on the existing conventional line. However, the project included only interventions related to the high-speed line, and this project did not address the service level of the conventional line. However, the high-speed trains reduced congestion for both passenger and freight trains on this line. Therefore, by significantly reducing the number of conventional passenger trains, improved service was substantially achieved on the conventional line. According to the CRC, this led to passenger benefits such as fewer delays in train movements.

The achievement of the third objective of improving the maintenance of the catenary system on high-speed rail lines is rated **substantial**. The project financed the procurement of 28 advanced CMVs that were distributed to the maintenance units in 10 regional railway administration bureaus across China. The CMVs had performed satisfactorily and met all operational requirements by project closure. The IEG PPAR mission was unable to obtain updated information on the CMVs' performance and their impact on maintenance of the catenary system on China's HSRs. However, the catenary system power failure rate decreased rapidly with the introduction of the CMVs and thus might be attributable to these vehicles. Interviews with the CRC during the PPAR mission confirmed that CMVs have been operating effectively since they started services.

Regarding policy impact and impact on local economic development, the World Bank engaged with the government on core railway system reform issues—such as separation of policy and regulatory functions from commercial management, railway price regulation, and railway investment mobilization—using this project and the other five HSR projects as a platform. China’s railway sector achieved significant progress in these reform areas during the project’s implementation, especially the landmark separation of the commercial management of railway services from the railway regulatory function and establishment of corporations for railway services delivery. IEG interviews with authorities and other stakeholders showed that the World Bank’s policy dialogue contributed significantly to this achievement. The project also generated a substantial impact on economic development along the ShiZheng high-speed rail line. IEG observations during a field visit for this PPAR and the PPAR mission’s interviews with Chinese railway and policy experts both confirmed this impact on economic development.

The efficiency of project implementation is rated **high**. The project’s investment cost per kilometer was comparable to the lowest in the world. The ShiZheng line also achieved a traffic density level and a reduction of travel time necessary for the line to be economically viable. Its economic rate of return (ERR) was estimated at 15 percent at completion—higher than the social discount rate of 12 percent and excellent for railways by international standards. Its estimated net present value was RMB 21 billion at 2015 prices (\$3.4 billion). The ERR and net present value would be much higher if the project’s agglomeration benefits were taken into account. The Project Appraisal Document, the Implementation Completion and Results Report, and this PPAR made no attempt to assess these benefits. The CMVs component achieved an estimated ERR of 30 percent at project closure.

The overall outcome of this project is rated **satisfactory**, based on the high relevance of the project development objectives, the substantial relevance of the project design, the substantial efficacy in achieving the project development objectives “to meet the growing freight and passenger market demand in the railway corridor section between Shijiazhuang and Zhengzhou, while substantially improving the level of service offered to customers, and to improve the maintenance of the catenary system on high-speed rail lines,” and the project’s contribution to sector reforms and institutional development; and the project’s high efficiency.

Bank performance is rated **satisfactory**. The project design was based on comprehensive technical, economic, social, and financial analyses and was satisfactory. The World Bank project team worked closely and proactively with the Ministry of Railways, the CRC, and the implementing agencies on the project implementation and restructuring, providing guidance and support to ensure that the project’s preparation and implementation met high standards. The team also conducted several studies to identify

project benefits and impacts. The World Bank's policy engagements with the government were satisfactory and contributed significantly to China's railway sector reforms.

Borrower performance is rated **satisfactory**. The Ministry of Railways and CRC were strongly committed to the project, prepared it based on sound preliminary design and planning, and implemented it in strict compliance with technical standards and specifications and in compliance with the World Bank's fiduciary and social safeguards policies. The ministry and CRC coordinated effectively with local governments on land acquisition and provided timely counterpart financing. The Ministry of Railways collaborated with the World Bank on policy analysis of railway sector reforms and considered the World Bank's recommendations during its reform process.

Lessons from the Project Experience

The following lessons are drawn from the project experience:

- **Sound technical design, project preparation, and implementation management, combined with assured financial resources and effective interinstitutional collaboration, are a recipe for success for a complex HSR project.** Like the NanGuang Railway Project, the ShiZheng Railway Project was completed on time with high quality and at a relatively low cost. This success was attributable mainly to sound preliminary design, meticulous planning, and strict control over compliance with standards and specifications, for which the CRC and the Ministry of Railways deserve major credit. The project's success was also attributable to the smooth coordination between the Ministry of Railways and the CRC with local governments on land acquisition and timely provision of counterpart financing. The World Bank contributed to the project's success through its guidance and support to ensure that the project's preparation and implementation met high standards, especially on social and environmental matters, even though its financing accounted for only about 5 percent of the total project cost.
- **Effective HSR systems require certain preconditions.** This and the other HSR projects in China showed that for a HSR system to be effective, a high and concentrated travel demand in an already congested corridor and customers with sufficient purchasing power are essential. This finding is confirmed by analytical work carried out under the parallel policy dialogue with the Chinese authorities. This work shows that the main prerequisites or success factors for embarking on a high-speed rail project are: (a) an already congested trunk rail corridor (or if there is no rail link, a congested transport corridor) operating in markets with strong underlying growth; (b) a corridor of exceptionally high and concentrated travel demand; (c) even if there is demand, passengers need to

have the purchasing power because HSR fares are expensive compared to the conventional rail; and (d) high interconnectivity to other modes.

- **Successful reforms in large and complex infrastructure sectors such as railways involve sustained policy changes supported through long-term policy dialogue and engagements.** When the ShiZheng Project was approved, China had already pursued many significant policy reforms in the railway sector for about 10 to 15 years while collaborating with the World Bank on capacity building and institutional development in multiple dimensions across the system. The government had also developed a framework for further reforms in the railway sector, was committed to these reforms, and asked the World Bank to provide advice on relevant international experience. The World Bank continued its policy engagements with the government on a parallel but separate path from the implementation of this and other investment projects. The World Bank's policy advice was important in informing the reforms in China's railway sector, especially the 2013 landmark reform that separated the commercial management of railway services from the railway regulatory function and established corporations for railway services delivery.
- **Agglomeration effects are an important benefit of high-speed rail development and could be incorporated in the cost-benefit analysis of such projects.** In addition to traditional benefits, such as user time savings, operating cost savings for traffic diverted from the conventional lines, and reductions in environmental externalities, experiences of this and other projects in China and elsewhere have shown that a high-speed rail project also has significant agglomeration benefits. The magnitude of agglomeration benefits depends on local circumstances, such as industry structure, local conditions, and governance. The project appraisal did not assess the project's agglomeration benefits because the methodology for assessing agglomeration effects for HSR projects was still relatively new. The project completion report also did not assess agglomeration benefits to maintain comparability with the appraisal report. However, the IEG field mission observed signs of remarkable economic development in station cities along the ShiZheng HSR line that were more significant than those observed along the NanGuang Railway line were. If the agglomeration benefits were taken into account in the economic analysis, as in the NanGuang Railway Project, the ERR of the ShiZheng Project would be much higher.
- **Good connections of HSR lines with other transport modes and between the rail stations and urban centers are critical to achieving the full benefits of high-speed trains.** Like the NanGuang Railway Project, the experience of the ShiZheng Project once again shows that an HSR line involves a major investment and requires high traffic density to be economically viable. Integration of the railways with other transport modes is important to achieving high traffic density throughout the system and high-quality services to customers. Therefore,

it is important to take measures at the design stage to ensure that rail station cities have detailed plans for a timely buildup of complementary infrastructure and the provision of services necessary for good local transport connections to the railway stations—for example, reliable and safe public transport and taxi services.

José Carbajo Martínez
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1. Background and Context¹

Country Background

1.1 Railways are vital to China's social and economic development. As a large economy with a vast geographical area and a huge population, China has massive volumes of passenger and freight traffic moving over medium and long distances. Given the high demand for rail transport, railways are one of the most economic and effective means of transport for the medium- to long-distance transport market in China. They are also more energy efficient and environment-friendly than other transport modes on a comparable capacity basis, and they use less land space than highways of comparable capacity. Railways are also crucial to China's ability to extend the benefits of economic development widely within the society and to people living in the more remote western and central parts of China.

1.2 Traffic on China's railways grew very rapidly between 1997 and 2007. Passenger traffic (measured in passenger-kilometers, a unit of measurement used to measure traffic volume representing the transport of one passenger traveling one kilometer) increased by 100 percent (about 7 percent per year), and freight (in ton-kilometers) increased by 80 percent (about 6 percent per year). Despite the expansion of the network during those 10 years, China's railways could not keep pace with the increased demand. As a result, much of the network was operating at or near full capacity. Some traffic was diverted to other transport modes that had higher economic and social costs. The network's infrastructure utilization in traffic units per kilometers was about three times that of the United States and more than nine times as high as in the European Union system. Hence, the need for investment in capacity expansion was strong (World Bank 2008).

1.3 Since as early as the mid-1990s, China had pursued enhancing the capacity and service quality of a railway network that was already the busiest in the world, along with reforming the industry to be more responsive to the market economy and to ensure the efficient use of resources. The 2004 Mid- and Long-Term Railway Development Plan, approved by the State Council, set an annual investment target of about \$12–15 billion through 2020. With the State Council's approval of China's 11th Five-Year Plan (2006–10), the Ministry of Railways planned to increase the annual investment in railways dramatically.

1.4 The Ministry of Railways explored ways to mobilize external funds to meet the target, including private sector funds. In 2007, the total investment in the railway sector reached about \$23 billion. In addition to the vast amount of investment, the Ministry of Railways had introduced many reforms, including separating noncore functions (such as construction, manufacturing, hospitals, and railway law enforcement) from the railway system; granting concessions to branch lines; establishing regulations allowing foreign investment; and various improvements to management practice and approach.

1.5 The World Bank had supported the Chinese government through financing and technical advice to implement its railways investment agenda since the 1980s through a total of 17 projects, policy advice and numerous advisory services. During the period 1984–2007, the World Bank supported the development of Chinese conventional rail services. In 2008, the World Bank got involved in financing high speed rail.

1.6 The ShiZheng Railway Project was the first of the World Bank’s broad program consisting of six railway projects that involved construction of 2,660 kilometers of high-speed railway (HSR) lines. This programmatic engagement aimed to support construction of priority railways through provision of financing for a small percentage (about 2 percent to 5 percent) of total cost (see appendix B for details). At the same time, it aimed to provide a platform for the World Bank to continue its policy dialogue with the government on China’s railway sector reform for improved railway sector management and railway development policy.

1.7 The government was committed to continued policy reform in the railway sector and had asked for the World Bank’s advice on relevant international experiences with reforms in areas such as separating administrative functions from enterprise management, introducing competition, and strengthening industry regulations. Recognizing that political imperatives independent of the capital investment program would largely drive progress on reforms, the World Bank, the Ministry of Railways, and the National Development and Reform Committee (the ministry in charge of China’s development planning) agreed that the World Bank would provide the advice on a parallel but separate path from the implementation of individual investments, including this project. Under this advisory support program, which started in the early 2000—more than a dozen Advisory Services & Analytics (ASA) were carried out (see para 4.40 for details).

Project Context

1.8 The project consisted of the construction of 355 kilometers of a new double-track electrified HSR ShiZheng line exclusively for passenger services connecting the provincial capitals of Hebei (Shijiazhuang) and Henan (Zhengzhou), and reserving the existing lines for movement of freight and slow passenger trains. This was a section of the planned 2,100 kilometers high-speed passenger line connecting Beijing and Guangzhou within the corridor of the existing conventional rail line. The Beijing to Guangzhou line was one of the national “four vertical and four horizontal” HSRs planned in the 2004 Mid- and Long-Term Railway Development Plan, comprising the busiest HSR lines in China and forming the backbone of China’s HSR network. The ShiZheng line was planned for completion by 2012, the same year in which the Beijing to Guangzhou high-speed line was expected to be completed (World Bank 2008).

The World Bank Group’s Board of Executive Directors approved the ShiZheng Railway Project in May 2008. The total project cost was estimated at \$6.11 billion or RMB 43.86 billion at appraisal (World Bank 2008). The actual cost, including the appraisal estimate of rolling

stock cost for comparison (planned for purchase at appraisal, but was leased instead), was \$6.06 billion at project closure, about 0.8 percent less than the appraisal estimate of the project cost in U.S. dollars. In local currency, the actual cost at closure—including the appraisal estimate of the rolling stock cost—was RMB 40.85 billion, about 7 percent less than the appraisal estimate of the project cost (World Bank 2016a, annex 1). The World Bank provided an International Bank for Reconstruction and Development loan of \$300 million, which accounted for a small percentage (about 5 percent) of the total project cost estimated at appraisal. The World Bank loan financed the international procurement of electrification, communications, and signaling equipment; maintenance vehicles; and concrete bridge beams that were essential for the quality of the rail line to be constructed under the project and its safe and effective operations. The project was restructured when 65 percent of the loan was disbursed, and the balance was disbursed after restructuring.

2. Objectives, Design, and their Relevance

Objectives

2.1 The original project development objectives (PDOs), as stated in the project’s loan agreement, were “to meet growing freight and passenger market demand in the railway corridor section between Shijiazhuang and Zhengzhou while substantially improving the level of service offered to customers” through construction of a new high-speed passenger railway along the corridor.

2.2 Through a project restructuring on August 21, 2012, the PDO was expanded to include a new subobjective of strengthening the maintenance of the catenary system across China’s high-speed rail network, which by then had become the largest high-speed rail network in the world with a strong demand for strengthened maintenance to ensure high service quality, safety, and reliability. The revised PDOs were “to meet growing freight and passenger market demand in the railway corridor between Shijiazhuang and Zhengzhou while substantially improving the level of service offered to customers and to improve the maintenance of the catenary system on high-speed rail lines” (World Bank 2012). This change in the PDO required the Independent Evaluation Group (IEG) to use split rating methodology for the evaluation of the outcomes.

Relevance of Objectives

2.3 **Relevance of original objectives.** At appraisal, the existing double track electrified railway lines in the project corridor were very congested, fully utilized, and unable to meet all current and future demands (World Bank 2008). The PDOs of meeting “growing freight and passenger market demand in the railway corridor section” while “substantially improving the level of services” were highly aligned with China’s 11th Five-Year Plan for 2006–10. The plan placed a high priority on developing a network of dedicated high-speed passenger railways to promote development of the passenger transport service industry and to bolster regional development, including the development of China’s inland area. The

project was an important part of a planned high-speed passenger railway connecting the two large inland cities of Shijiazhuang in Hebei Province and Zhengzhou in Henan Province with the relatively more developed Beijing area. Both Zhengzhou and Shijiazhuang had a population of about 10 million at the end of 2016, according to the Henan Statistical Yearbook 2017 and Shijiazhuang municipal government data, respectively.

2.4 The PDOs were also highly consistent with the World Bank’s Country Partnership Strategy (CPS) for 2006–10. The CPS’ pillar on “expanding economic opportunities for the rural poor” focused on upgrading railroads linking inland provinces to more dynamic economic centers so that the economic benefits from improved transport, such as increased employment opportunities, could accrue to the poor. The PDO was also very consistent with the CPS’ pillar on managing resource scarcity and environmental challenges. Railways are more environmentally friendly and resource efficient than other transport modes on a comparable capacity basis.²

2.5 **Relevance of revised objectives.** The additional objective of strengthening the maintenance of the catenary system across China’s high-speed rail network was consistent with the country strategy on use of advanced and appropriate technology in HSR networks to enhance system effectiveness and safety, as stated in China’s 12th Five-Year Plan (2011–15). It was also substantially relevant to the World Bank CPS for FY2013–16, which underscored the need for support for developing and maintaining sustainable and safe transport systems. Moreover, the additional objective that aimed to improve the catenary system’s level of maintenance further was substantially relevant to the long-term sustainability of the original PDO.

2.6 At project completion, the revised PDO remained highly consistent with China’s national development strategy. China’s 12th Five-Year Plan (2011–15) emphasized accelerating the construction of a high-speed passenger railway network, developing economic corridors along trunk transport lines (including the Beijing to Guangzhou Railway line, a section of which is the project line), and achieving economies of agglomeration. The Five-Year Plan also assigned a high priority to development of a society that is both resource efficient and environmentally friendly.³ The PDO continued to be closely aligned with the World Bank’s CPS for China for the 2013-16 period. The CPS focused strongly on fostering greener growth through support for developing a low-carbon transport system, and on improving transport connectivity to urban centers—particularly in western and central provinces—to promote balanced and sustained regional economic development such as through HSRs.

2.7 The relevance of both the original and revised objectives is rated **high**.

Design

Components

2.8 The project components at appraisal included the following, as summarized from the Project Appraisal Document (PAD) and other project documentation⁴:

- Construction of a new 355-kilometer high-speed, dedicated passenger railway line with a maximum speed of 350 kilometers per hour connecting Shijiazhuang in Hebei Province and Zhengzhou in Henan Province (the project line or ShiZheng line), including construction of bridges, culverts, subgrades, and buildings; acquisition and installation of communications, signaling, electrification, and maintenance equipment and concrete bridge beams; and provision of technical assistance, with scope to be identified during implementation.
- Construction of six new railway stations in Anyang, Gaoyi, Handan, Hebi, Xingtai, and Xinxiang cities along the rail line.
- Resettlement and rehabilitation of displaced persons in connection with carrying out of component (a) and component (b).

2.9 The World Bank loan was to finance procurement of equipment and goods, and \$1 million was set for technical assistance. All other activities, such as civil works and resettlement, were expected to be financed in full by counterpart financing. The World Bank's social and environmental safeguards policies would apply to the whole project.

2.10 A new component was added during the project restructuring on August 21, 2012 to support the purchase of the catenary maintenance vehicles (CMVs) with \$115 million World Bank loan savings achieved because of international tendering, a drop in the prices of raw materials, and the use of domestic funds for the procurement of signaling equipment (World Bank 2016a). These vehicles would be able to travel at a maximum speed of 160 kilometers per hour to respond rapidly to any incident or system failure on the HSR network and undertake timely inspection and necessary maintenance. In addition, they were equipped with twin working platforms and an extending arm and were able to work on the adjacent line (World Bank 2012).

2.11 At appraisal, domestic counterpart financing was estimated at \$5.92 billion. The counterpart financing was expected to come from equity investment by the project company partners, loans from domestic commercial banks, and bonds issued in China. The counterpart financing would fund mainly civil works, for which China's railways had developed strong capacity.

Arrangements for Implementation

2.12 As with the previous World Bank-financed railway projects in China, the Foreign Capital and Technical Import Center (FCTIC) of the Ministry of Railways was responsible

for the financial management of the World Bank loan and for management of World Bank–financed procurement, including provision of implementation progress reports semiannually.

2.13 The ShiZheng line passed through Hebei and Henan Provinces, the territories of the Beijing Railway Administrations and Zhengzhou Railway Administration, respectively. A project management office (PMO) was established in each of the two railway administrations to initially manage contracts financed wholly by the Ministry of Railways, including civil work contracts and contracts for installation of equipment, including equipment procured using the World Bank loan. The PMOs would “use competitive bidding to procure independent contractors to carry out the civil works and to install all equipment, including that financed by the World Bank. The regional PMOs would also be responsible for supervising the construction and installation” (World Bank 2008, annex 6).

2.14 At appraisal, it was anticipated that two project companies would be established to own and manage the implementation and operation of the project line and that the Ministry of Railways would transfer the assets created by the project to the two companies. The Hebei part of the project was expected to be eventually owned by the Dedicated Passenger Railway Company Limited and the Henan part by the JingGuang Dedicated Passenger Railway Henan Company Limited. The Beijing and Zhengzhou Railway Administrations, respectively, would hold controlling shares of the two companies through an investment arm. The second largest shareholders were expected to be the two respective provinces, also holding their shares through an investment arm. Other minor shareholders were expected to be state-owned enterprises.

2.15 During implementation, the two companies monitored resettlement and payment of compensation to project-affected persons, coordinated with local governments on improving connectivity between the new stations and urban areas, and provided data on project results and outcomes (World Bank 2016a, para. 72).

Relevance of Design

2.16 The original project design—clear and realistic objectives supported by causally linked project activities—was logical. The construction of the new dedicated passenger HSR line would significantly increase the passenger transport capacity in the railway corridor and the quality of the railway services, such as reduced travel time and improved punctuality. Alleviating the passenger transport pressure on the existing congested corridor would lessen the capacity constraint on freight transport. Overall, this would contribute to meeting the increasing market demand for freight and passenger transport in the rail corridor while improving the service quality.

2.17 The project activities could be expected to contribute to the achievement of the higher-level objectives of managing resource scarcity and environmental challenges because, as mentioned previously in this Project Performance Assessment Report (PPAR),

railway transport is relatively more environmentally friendly than other comparable transport modes.

2.18 The design, however, should have included measures to ensure that concrete plans are in place for timely, sound integration of the high-speed line with other transport modes, especially in smaller, intermediate stations.

2.19 The relevance of the original design is rated **substantial**.

2.20 The introduction of the CMVs in 2012 represented an innovation in China because the existing maintenance equipment for the catenary system was outdated (World Bank 2012). The CMVs would contribute fast response to catenary system incidence or failure because of their advanced features, such as travel speed and the ability to work on adjacent lines. This would significantly improve the system's reliability by improving the maintenance of the catenary system on China's HSR lines.

2.21 The relevance of the revised design is rated **substantial**.

3. Implementation

3.1 The project implementation process was smooth, in line with expectations, and completed on time and below cost. According to this project's Implementation Completion and Results Report (ICR), the quality of work was good, and the project took appropriate measures to ensure compliance with environmental, social, safety, and specified quality standards (World Bank 2016a). The World Bank's Implementation Status and Results Reports (ISRs), issued from 2013 to 2015, consistently rated the project's overall implementation progress as satisfactory based on information available in the World Bank's project portal.⁵

Safeguards Compliance

3.2 **Social safeguards.** The project triggered OP/BP 4.12 on involuntary resettlement. It prepared and disclosed a resettlement action plan in accordance with OP/BP 4.12, based on public consultations with affected villages and households on the selection of project alignment and location of railway stations, and on relocation arrangements, compensation rates, and livelihood restoration measures. According to the project documentation, 4,752 households were relocated, of which 3,195 were in Hebei and 1,557 in Henan. The project complied with the World Bank's social safeguard policy during appraisal and implementation (World Bank 2016a).

3.3 The PPAR mission interviewed the resettlement specialist for the project and found that the project's purchase of the right of way for the project line affected farmers to a varying extent. The overall impact in a typical village was small, allowing affected households to be relocated within their villages with compensation. For those affected,

compensation was a combination of cash payments and the reallocation of land among farmers in a village. Each affected household signed a formal agreement with the local government for its relocation. The FCTIC, the project implementing agency, recruited an external team from a list of candidates the World Bank recommended to monitor the implementation of the resettlement program. The World Bank conducted a supervision mission once or twice a year. The government showed strong implementation capacity.

3.4 **Environmental safeguards.** The project was classified as category A and triggered the World Bank's OP/BP 4.01 on environmental assessment. The project complied with the World Bank's environmental safeguard policy during appraisal and implementation (World Bank 2016a). The project's environmental management plan, which was prepared based on public consultations, included specific actions to address the environmental impact issues identified in the environmental impact assessment. The potential environmental impacts identified at appraisal included soil erosion, negative impact on water conservation and ecology caused by civil works, dust, noise, and social disturbance during construction.

3.5 The environmental management plan was implemented satisfactorily, according to project documentation (World Bank 2015a), and the ICR notes project compliance with the environmental safeguards. Adequate noise barriers were installed along the project line. Passages over and under the tracks were provided according to standards and based on additional demand from local residents. Construction and campsites were restored through replanting grass and trees and farmland reclamation, and returned to local governments or local communities as agreed. Slope protection and greening works were conducted properly. Necessary environmental facilities, such as wastewater and sanitation facilities, were installed in accordance with the project design. The IEG PPAR mission traveled along the project line and interviewed the project's environmental specialist. The PPAR mission's site observations and interviews confirmed that sound environmental mitigation measures were implemented along the project line.

Financial Management and Procurement

3.6 **Financial management.** The project appraisal conducted a financial management assessment and concluded that the FCTIC in the Ministry of Railways had the required ability to manage the project's financial management, and the overall financial management risk was rated as **modest**. According to the ICR, the project's financial management complied with World Bank policies during implementation, though with several minor delays (World Bank 2016a). The information the project's financial management system provided was accurate and timely and showed with reasonable assurance that the World Bank loan was used for its intended purposes. Counterpart funding was provided as planned. The audits were unqualified and identified minor issues, including a delay in providing interim financial reports.

3.7 **Procurement management.** The project appraisal team concluded that FCTIC had the required ability to manage the World Bank-financed procurement under the project.

The actual procurement process went well, and there were no procurement issues or delays during implementation, despite the project's very large size (World Bank 2016a, para. 31). However, some procurement and contract management issues were found in activities financed entirely by counterpart funds, and FCTIC and the project companies addressed these quickly at the World Bank's request (World Bank 2016a, para. 32).

3.8 The procurement process for World Bank–financed goods and services complied with World Bank guidelines, according to project documentation and confirmed during the IEG PPAR mission's interview with China Railway Corporation (CRC). IEG found that all six of the World Bank's ISRs, issued between 2013 and 2015, rated the project's performance on procurement as satisfactory.

4. Achievement of the Objectives

4.1 The original project objectives included two elements: "meet growing freight and passenger market demand in the railway corridor section between Shijiazhuang and Zhengzhou," and "substantially improving the level of service offered to customers." After the restructuring in 2012, an additional objective was added, "to improve the maintenance of the catenary system on high-speed rail lines," but the original objectives remained unchanged.

4.2 The railway corridor between Shijiazhuang and Zhengzhou includes the newly built high-speed passenger line and the conventional passenger and freight railway line. The construction of the new dedicated passenger high-speed line significantly expanded the passenger transport capacity in the corridor and reduced congestion on passenger and freight transport on the existing line, thus meeting the growing freight and passenger market demand in the rail corridor.

Objective 1

4.3 Objective 1 was to meet growing freight and passenger market demand in the railway corridor section between Shijiazhuang and Zhengzhou.

4.4 The project's outputs and outcomes show this first objective was substantially achieved.

Outputs

4.5 The project delivered its outputs as planned. A new, double-track electrified high-speed dedicated passenger railway line of about 355 kilometers (including six stations) was constructed, running broadly in parallel with the existing railway line and connecting Shijiazhuang in Hebei Province and Zhengzhou in Henan Province (World Bank 2016a, annex 2). The new railway line was opened to traffic fully in December 2012, a year ahead of the original loan closing date of December 31, 2013. The HSR is suitable for lightweight

electric multiple units. The trains are equipped with a maximum speed of 350 kilometers per hour and initially operated at this speed. However, the actual operational speed was reduced to a maximum speed of 310 kilometers per hour, mainly to lower energy consumption. About 84 percent of the ShiZheng line (298.7 kilometers of the 355 kilometers) was laid on viaducts to reduce land use by the rail tracks and improve access of people and animals below the tracks.

4.6 The ShiZheng line met international standards in many key technical respects, such as track, power supply, electric system, communications and signaling systems, train control and dispatching, and energy conservation. Comprehensive safety systems such as automatic train protection systems, radio communications on the train, and monitoring of fire and hazardous weather conditions, among others, were installed.

Outcomes

4.7 **Passenger traffic, supply side.** IEG found that the average number of pairs of passenger trains in the corridor between Shijiazhuang and Zhengzhou, including both the express trains on the new HSR and the conventional trains, had increased from 76 pairs in the appraisal year 2008 (conventional trains only) to 125 pairs in 2015 and 114 pairs at the time of IEG’s field mission for this PPAR in March 2018 (table 4.1). This met the project end forecast of 114 pairs in the PAD (World Bank 2016a, para. 41). As expected at appraisal, the increase was due mainly to the traffic growth on the HSR line constructed under the project. The average number of pairs of high-speed passenger trains on the new line increased from zero in 2008 to 60 pairs in 2015 (the third full year of operation) and to 74 pairs at the time of the PPAR mission in March 2018. By comparison, the number of conventional passenger trains on the existing line decreased gradually from 76 pairs in 2008 to 65 pairs in 2015 and 2016, and then to 40 pairs when IEG conducted the PPAR mission.

Table 4.1. Average Daily Pairs of Trains in the ShiZheng Rail Corridor

| Type of Train | 2008 | 2015 | 2018 |
|-------------------------------|-----------------|------|------|
| High-speed trains | 0 | 60 | 74 |
| Conventional passenger trains | 76 | 65 | 40 |
| Total passenger trains | 76 | 125 | 114 |
| Freight trains | 55 ^a | 55 | 55 |
| Total | 131 | 180 | 169 |

Source: World Bank 2016a and IEG Calculation based on data from CRC website
a. This is a 2005 figure.

4.8 During the IEG mission, the average number of pairs of high-speed passenger trains on the ShiZheng line was 74 percent of the project end target of 100 pairs. The gap can be explained by the government’s decision to have more conventional trains operating on the existing line for meeting basic social needs than were expected at appraisal, and by the resulting number of passengers – which was less than expected – diverting from the conventional line to the high-speed trains (World Bank 2016a). This policy was intended to

ensure that the market demand for the basic, conventional train services was met, and the principle of the policy was still in effect at the time of the PPAR mission, based on interviews with knowledgeable experts.

4.9 Overall, the supply in the corridor as a whole increased significantly compared with the baseline year 2008 and met the project target.

4.10 **Passenger traffic, demand side.** The PPAR mission was unable to obtain new data on whether the demand in the corridor has been growing or has been adequately met. However, the mission traveled on the project line in late March 2018 and observed very high occupancy. Although this was not a busy travel season, IEG found that the passenger car the mission took was fully occupied throughout the entire trip from Zhengzhou to Shijiazhuang. Using the railway timetable on the CRC's ticket booking website, the mission checked the availability of tickets of all classes at three other times and consistently found that tickets were available only for standing passengers for many trains and a few tickets for other trains in all classes about five hours before the train departure time.

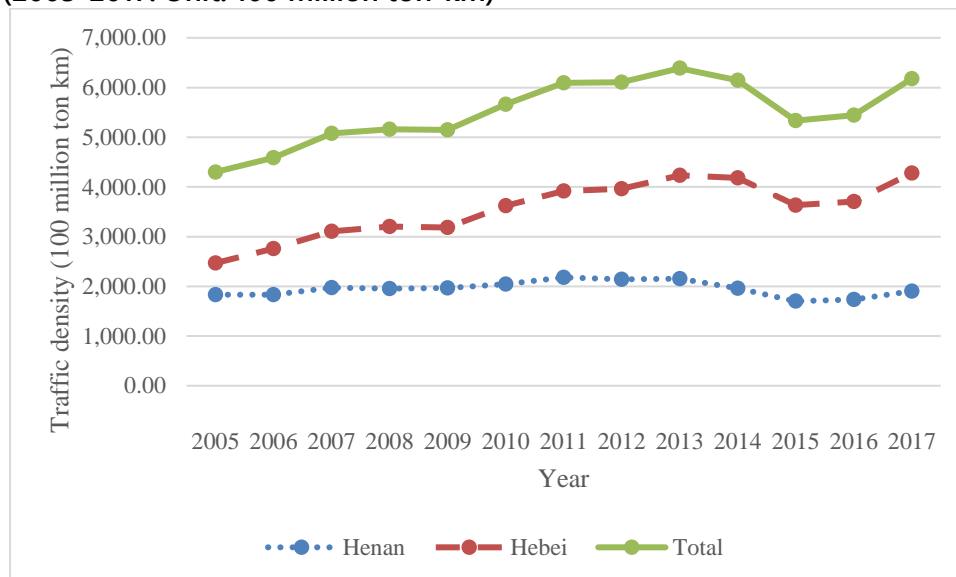
4.11 The CRC confirmed to the PPAR mission that passenger volumes on the ShiZheng line have grown rapidly since the line opened to traffic at the end of 2012, but no data were provided. Therefore, considering that the 74 high-speed train pairs seem to run at nearly full capacity, the PPAR mission calculated the current passenger volumes for this line. The mission assumed an average of an average of 12 cars per train and 80 passengers per car by taking into account the shares of different classes of seats.⁶ This led to an estimate of about 50.4 million annual passengers, excluding passengers traveling part of the line's full length, and would represent a 90 percent increase in the 2015 traffic density of 26.5 million passengers reported in the ICR (annex 3), or about 24 percent increase per year during 2015-18.

4.12 The latest passenger density figure available for the ShiZheng corridor, including both the high-speed and the existing conventional lines, was 75 million passenger-kilometers/route-kilometers in 2014.⁷ Without current information on passenger growth, the PPAR mission used the estimated passenger growth rates from the ICR (page 28) to derive the passenger density in 2018, which would be 92 million passenger-kilometers/route-kilometers.

4.13 **Currently available capacity on the corridor.** IEG estimates the 2018 available capacity in the corridor as a whole at about 90.2 million passenger-kilometers/route-kilometers. IEG calculated this figure using the high-speed train numbers and capacity assumptions stated previously and assuming an average of 100 passengers per car and 14 cars per conventional train for the 40 conventional train pairs. This capacity is 98 percent of the PPAR mission passenger volume forecast for 2018 of 92 million passenger-kilometers/route-kilometers, and hence the capacity essentially met the increasing passenger demand.

4.14 **Freight traffic.** The average number of pairs of freight trains remained the same at 55 pairs in 2005 and in 2015 and 2016, or 82 percent of the project target of 67 pairs, reflecting a network wide freight traffic contraction around 2015 and 2016 (Figure 4.1) caused by an economic adjustment policy to address overcapacity, especially in the coal and steel industries. The PPAR mission was unable to obtain updated data on freight train numbers and traffic in the project corridor. However, it is reasonable to assume that the significantly decreased number of conventional passenger trains since 2016 would have released capacity for increases in freight trains on the existing line if needed. Therefore, the objective of meeting the growing freight demand, if any, would be achieved. From 2016 to March 2018, the daily passenger trains on the existing line decreased by 25 pairs (from 65 pairs to 40 pairs). Because the operation of two passenger trains requires about the same rail capacity as the operation of one freight train on the existing line (World Bank 2008, 47), the reduced passenger traffic 12 additional freight trains to operate on the corridor.

Figure 4.1. Volume of Freight Rail Traffic in the Two Project Provinces, (2005-2017. Unit: 100 million ton-km)



Source: China Data Online, All China Marketing Research⁸

4.15 Overall, the efficacy of the project in contributing to the achievement of this objective of meeting growing freight and passenger market demand is rated **substantial**.

Objective 2

4.16 Objective 2, as set in the project loan agreement, was to substantially improve the level of service offered to customers through the construction of the new ShiZheng high-speed passenger railway. This objective was unchanged during the project's implementation period.

4.17 The outputs for the second objective are the same as for Objective 1.

Outcomes

4.18 **Reduced travel time, safety, and comfort.** The project resulted in substantial improvements in passenger services through provision of quality high-speed rail transportation. People interviewed by the IEG PPAR mission uniformly acknowledged that the express trains were fast, punctual, safe, and comfortable. Some experts mentioned safety as one of the key competitive edges of the high-speed trains over long-distance buses, and cited punctuality as one of the key competitive edges over air travel.

4.19 The IEG PPAR mission traveled the project line and observed and experienced the same improvements. During that trip, for example, the train's speed was between 300 and 309 kilometers per hour most of the time, except when it was near Shijiazhuang (a station located close to an urban center). Additionally, the train was on schedule, and the carriages were smooth, safe, clean, and spacious.

4.20 Data from the CRC ticket-booking website show that it takes 81 minutes to travel nonstop on the high-speed line from Shijiazhuang to Zhengzhou. By contrast, it takes 197 minutes to 261 minutes to travel the same route nonstop on the conventional line. In the past, a bus trip between the two cities took more than 300 minutes (5 hours). After the introduction of the ShiZheng high-speed rail, bus services along the corridor have been reduced sharply (World Bank 2016b). Additionally, the World Bank project team conducted an onboard survey of passengers in August and September of 2015 and found that 58 percent of passengers said they took the high-speed train because of the short travel time.

4.21 **Affordability.** The fares of the high-speed trains are relatively inexpensive and affordable for the local middle class. For example, the ticket for a one-way, second-class seat on the high-speed train from Shijiazhuang to Zhengzhou (412 kilometers, including the 355 kilometers of the project rail line) with travel time ranging from 1 hour and 21 minutes to 2 hours and 10 minutes costs RMB 189.50 (\$29).⁹ This is 0.67 percent of the 2016 per capita annual disposable income of RMB 28,168 (\$4,056) for urban households in Anyang,¹⁰ a medium-sized station city on the project line.

4.22 Comparing the fare to an Amtrak train ticket from Washington, DC to New York City, the price is \$152 for a value seat (the lowest class seat) on a 7:00 a.m. departure train traveling 3 hours and 30 minutes for about 362 kilometers (priced on the Amtrak website, accessed on May 15, 2018). The Amtrak ticket price is about 0.64 percent of the 2016 per capita income of \$23,696 in Philadelphia, Pennsylvania, which is a station city midway between Washington, DC and New York City,¹¹ but the train is much slower, and the distance is shorter than the Shijiazhuang to Zhengzhou HSR line.¹²

4.23 Similarly, the World Bank project team conducted an onboard survey in 2015. It found that 27 percent of passengers traveling on trains on the project line had a monthly income of RMB 2,800 (\$424) or less, and 53 percent had a monthly income of RMB 5,000 (\$758) or less.^{13, 14} IEG calculated that only 11 percent of passengers had more than RMB 10,000 (\$1,515) in income per month.

4.24 A caveat is that many people still cannot afford the high-speed trains. Based on an onboard survey of passengers on the conventional trains along the ShiZheng corridor conducted in 2015, when asked about reasons for not taking the high-speed trains instead, 42 percent of the passengers stated that the main reason they did not take the high-speed trains is the high price of a ticket (World Bank 2016a). The conventional trains were carrying 70 percent of all rail passenger traffic in the ShiZheng corridor at the project closure. Without the ShiZheng project, however, the quality of services on the conventional line would most likely have deteriorated, as discussed in this PPAR's section on the achievement of the second objective.

4.25 **Inclusiveness.** The high-speed trains on the project line have accessible design, and IEG observed that male and female passengers were generally equal in number. The PPAR mission observed, for example, that a restroom specially designed for people with disabilities is located in the middle of the train and is shown on a display board installed in each train car. Other express trains on the project line should have the same or similar design feature because they are in the same model series manufactured by the same joint venture company.

4.26 An internet search showed that the intermediate stations on the project line (all located in medium-size cities) typically have accessible elevators, and some even have escalators and other accessible facilities, though there was a customer complaint online that the two elevators in one station were not operating on one occasion. The large Zhengzhou and Shijiazhuang stations have even better accessible facilities.

4.27 **Integration with other transport modes and with city development.** All eight high-speed rail stations on the project line except for the Shijiazhuang station are located at least several kilometers away from existing city centers, and for some, integration with other transport modes has not yet been achieved fully, as reflected by the lack of well-developed public transportation and taxi services. Partly because of the related inconvenience, the share of passengers using public transport to access the HSR stations was significantly smaller than the share of passengers using it to access conventional railway stations (World Bank 2016b).

4.28 The IEG PPAR mission observed in the field and learned from interviews with local knowledgeable experts that access to HSR stations using public transportation in large cities was much better than in smaller cities. For example, using some complementary internet searching, the IEG PPAR mission found that the Shijiazhuang HSR station is integrated with the city's metro system and a conventional railway station, and it was planned to connect the station with an urban rail transit system to be constructed soon. The Zhengzhou HSR station is integrated with the city's metro system and urban rail transit system, through which it is convenient to arrange transport from the HSR station to the airport and the conventional railway station. In addition, a large long-distance bus station was constructed near the Zhengzhou HSR station recently.

4.29 The mission also learned through interviewing Chinese railway policy and management experts that intermodal integration at stations in smaller cities is catching up to the larger cities because of investments by local governments or the private sector. The IEG mission learned that the governments of cities across China that are connected to an HSR with a station along the ShiZheng project line attach great importance to leveraging access to an HSR line to boost local economic development. Many either have completed a development plan (often called an HSR Economy Development Plan) or are in the process of preparing one. This plan usually includes integrating HSR with other transport modes, investment in local transport infrastructure to improve connections with HSRs, development of integrated logistics centers, and development of priority industries in the station areas. Several experts who are familiar with CRC operations mentioned that CRC reviews local development plans and consults with local development planning officials when selecting the route and station sites for a proposed HSR line to ensure connection with local economic development centers.

4.30 In conclusion, the PPAR mission's passenger surveys and field observations confirm the improved speed, punctuality, safety, and comfort provided by the HSR. The PPAR mission's assessment of the affordability, inclusiveness, and improved intermodal connections at stations reinforced the conclusion that the HSR has led to improved services for passengers. IEG could not obtain data on the level of service for passengers and freight on the existing conventional line. However, the project aimed only to contribute to the improvement of the service level through reducing congestion for both passenger and freight transport on the existing line, and the congestion reduction has been achieved.

4.31 The contribution of the second project objective to improve the level of service offered to customers is rated **substantial**.

Objective 3

4.32 The third project objective was to improve the maintenance of the catenary system on high-speed rail lines.

4.33 This third objective was added through a project restructuring on August 21, 2012. The modification expanded the original PDO to include a focus on strengthening the maintenance of the catenary system across China's high-speed rail network.

Outputs

4.34 The project procured and delivered 28 CMVs. According to the World Bank project team, 8 were imported and 20 were manufactured domestically based on local technology or imported components. These CMVs were the first of their kind in China, capable of providing very fast response to catenary system failures and working on the catenaries above two rail tracks simultaneously.

Outcomes

4.35 The 28 CMVs were distributed to the maintenance units in 10 regional railway administration bureaus across China between the end of 2014 and the end of 2015. The first CMV started operating in February 2015, and most other CMVs entered service in early 2016. By project closure, all 20 domestic CMVs and 5 of the 8 imported CMVs were operating after being tested (World Bank 2016a).

4.36 According to the ICR, all CMVs in service had performed satisfactorily and met all operational requirements by project closure. As a result, CRC planned to order many additional CMV units of the same type as part of a program to strengthen China's HSR network maintenance. Major domestic manufacturers were taking steps to localize the manufacturing of these CMVs through purchase of relevant technical expertise (World Bank 2015b).

4.37 The impact of CMV use on HSRs has been associated with a lower number of power failure incidents per billion passenger-kilometers (the power failure rate). Data reported in the ICR show that the power failure rate on the electrified high-speed rail lines decreased significantly from 0.775 in 2013 to 0.379 in 2014 and then to 0.116 in 2015. Because no CMVs were operating before 2015, the significant reduction in the power failure rate in 2014 shows that other factors had a role in the reduction. CMVs could have had a role in the reduction in 2015. An IEG analysis based on data reported in the ICR shows that the power failure rate achieved an accelerated decrease in 2015 compared with 2014: it decreased by 51 percent in 2014 and by 69 percent in 2015.

4.38 The IEG PPAR mission was unable to obtain detailed, updated information on the CMVs' performance and their impact on maintenance of the catenary system on China's HSRs. However, interviews with CRC during the mission confirmed that CMVs had been operating effectively since they started services.

4.39 Overall, the project's contribution to the third objective of improving the maintenance of the catenary system on high-speed rail lines is rated **substantial**.

Policy Impact

4.40 The World Bank used the railways investment projects — the ShiZheng Railway Project and the other five HSR projects as a platform to conduct policy dialogue with Chinese authorities in charge of railway sector reforms, and to provide support for institutional development. During project implementation, the World Bank produced 16 policy notes, briefs, and papers covering core reform areas such as separation of policy and regulatory functions from commercial management of service provision, railway price regulation, and railway investment mobilization, and these are included in this PPAR's bibliography. China's railway sector has achieved significant reform progress in these areas, and by railway sector experts in China told the IEG PPAR mission that the World Bank's policy studies and dialogue contributed to this achievement.

4.41 For example, a 2011 World Bank policy note introduced key elements of the experiences of eight countries in railway sector governance and institutional structure. These included having a Ministry of Transport overseeing the policy for all transport modes, separating commercial management of railway services from government regulatory functions, using company structures for service delivery, separating freight and passenger transport, and having multiple service providers (Amos and Bullock 2011). IEG's PPAR mission learned from multiple experts that this note, along with some other policy advice, had an important role in supporting the government of China's landmark reform of the railway sector in 2013.

4.42 The Ministry of Railways was split into the National Railway Administration and the China Railway Corporation as part of this major reform in 2013. Its government administrative functions were entrusted to the National Railway Administration under the newly formed Ministry of Transport, and provision of railway services was assigned to the new CRC. IEG also learned from interviews with knowledgeable experts and government agencies that the reform resulted in a stronger focus on commercial management of service delivery, cost, and revenues, and a commitment to continued market-oriented management reform. Other examples of relevant policy and institutional development work included railway price regulation, private capital mobilization, business and financial management, and intermodal logistics and system integration.

4.43 Overall, railway policy experts in research institutions and universities and government officials in charge of managing the World Bank's portfolio in China concurred strongly that the World Bank's policy dialogue was valuable and had an important role in informing the railway sector reform. Some experts specifically emphasized that the World Bank's policy support was a unique, valuable platform for collaborative and in-depth exchange of experiences on best practices with relevant experienced agencies in other countries.

5. Efficiency

5.1 **Economic analysis.** An economic analysis was conducted at both appraisal and completion for the Shijiazhuang to Zhengzhou HSR constructed under the project, based on a project life cycle of 30 years and a social discount rate of 12 percent. At appraisal, the project was expected to achieve an economic rate of return (ERR) of 20 percent and a net present value (NPV) of RMB 64 billion (\$10.4 billion) at 2015 prices. At completion, the ERR in the ICR was estimated at 15 percent with an NPV of RMB 21 billion (\$3.4 billion) at 2015 prices. The ERR and NPV at project completion were significantly lower than those at appraisal, primarily because of the major national slowdown in demand for freight transport by rail and CRC's changed operating strategy of having more conventional trains operating on the existing line than expected, resulting in slower growth of passenger traffic than expected on the new HSR line. However, the ShiZheng line is still a high-density HSR

line and has an excellent ex post ERR of 15 percent, even by international standards (World Bank 2016a, para. 44 and 48).

5.2 The economic analysis followed a set of standard assumptions on benefits for a transport project. These benefits were assumed to come from reduced travel time and distance savings for passengers diverted from the conventional line and from other transport modes; freeing up capacity in the existing line to handle projected freight traffic increases, which would travel by road without the project; and wider economic, social, and environmental benefits, such as reductions in road accidents and congestion, and reduced vehicle and greenhouse gas emissions.

5.3 If agglomeration effects are included in the overall economic analysis, the ERR and NPV would be much higher than the estimates in the ICR. The economic analysis at both appraisal and completion did not include the agglomeration benefits coming from more closely connected economic activities and markets, knowledge sharing, and greater productivity caused by increased competition. These benefits can be about half of all project benefits, based on the experience with the World Bank's NanGuang Railway Project and similar projects in the United Kingdom (World Bank 2018). In the field visit for this PPAR, IEG observed signs of fast economic development in station cities along the ShiZheng HSR line, reflected, for example, in the development of modern, well-maintained residential and commercial real estate properties. The development, especially in the station cities in Henan Province, was much more significant than that observed along the NanGuang Railway line.

5.4 The results of the economic analysis of the CMVs at project completion were the same as the results at the restructuring in 2012 because most of the CMVs were not deployed for operation until early 2016, and this project closed on November 30, 2015 (World Bank 2016a). It was estimated at restructuring that the CMV component had an ERR of 30 percent and a NPV of RMB 271 million, which were robust to a range of sensitivity tests based on various scenarios, such as a reduction in the number of conventional maintenance vehicles saved because of using CMVs and no reduction in accident costs. The economic analysis assumed that using CMVs would reduce routine inspection and maintenance costs and the costs to both the railway and passengers caused by otherwise slower response to incidents. The IEG PPAR mission found that the CMV component was implemented efficiently. Although the procurement of the CMVs experienced some delay, the accrual cost of the CMV component was 99 percent of the estimate at the project restructuring (World Bank 2016a, annex 1), and all CMVs in service met all operational requirements as expected by project closure, as discussed in the section on achievement of project objectives.

5.5 **Financial analysis.** The traffic volume on the ShiZheng high-speed line was not as large as projected at appraisal because the government decided to keep more trains that were conventional on the existing line. Related to the decision, the fares on the ShiZheng high-speed rail services were set higher than those suggested at appraisal. This assumed a comparatively smaller, more gradual increase in the fares and projected that an increase

would generate greater demand and lead to the transfer of almost all traffic on the conventional line to the high-speed line (World Bank 2016a, p 27). According to the appraisal, the project would achieve a financial rate of return of 13 percent.

5.6 Despite traffic volume that was lower than expected, a financial analysis in the ICR estimated that the revenues of the ShiZheng line would cover its operation and maintenance cost, with revenues typically more than twice the operation and maintenance cost.¹⁵ The revenues would also cover the annual interest payment (estimated to be about RMB 1.2 billion, or \$194 million) if the interest payment was made before payment of the maintenance cost. Even after paying interest, the ShiZheng line would still be able to pay most, if not all the maintenance cost as the traffic volumes continue to grow. The local CRC subsidiaries, as the major shareholders, would probably have to cover the rest of the maintenance cost from their other operations. However, the debt would need to be restructured until the mid-2020s or later to pay the principal because of a mismatch of the commercial loans' maturities and the life of the asset, and the need for the traffic volume to ramp up (World Bank 2016a, p 36). It is unlikely that CRC would not arrange for refinancing for the project line given its strong positive cash flows, strategic importance, and sound economic return.

5.7 **Administrative efficiency.** The project was implemented with high administrative efficiency. The actual project cost was 91 percent (in local currency) of the appraisal estimates and 97 percent in U.S. dollars, which is very satisfactory given the project's large size and high technical complexity. The project management cost was included in the "other" item in annex 1 of the ICR based on a clarification from the World Bank project team. This item is 3 percent of the project's actual total cost. Hence, the actual project management cost was no more than 3 percent of the project's total cost. The ShiZheng line was completed and opened to traffic in December 2012, one year ahead of the originally scheduled loan closing date of December 31, 2013. Although the project closing date was extended for two years, this extension was for completion of the new CMV component added during the restructuring in 2012. The project was completed with 99 percent of the World Bank loan disbursed. The project's unit cost is \$14.7 million per kilometer, comparable to the unit cost of \$14.5 million per kilometer for the NanGuang Railway Project, which was among the lowest in the world at the time of the NanGuang Project completion (World Bank 2015a, para. 42).

5.8 The efficiency of the project is rated **high**.

6. Ratings

Outcome

6.1 The PDOs—both original and revised—were highly relevant to China's development strategy and to the World Bank's country partnership strategy for China at

appraisal and remained relevant at project completion. The relevance of the project design was **substantial**. The efficacy of each of the three objectives was **substantial**, indicating that the efficacies of both the original PDO and the revised PDO were substantial. The project contributed to the World Bank's policy engagements with the government that led to significant progress on sector-level reforms and institutional development. The project was implemented with high efficiency with a unit cost among the lowest in the world and a high ex post ERR for the ShiZheng HSR line by international standards.

6.2 Together, the overall outcome of the project is rated **satisfactory** for both the original PDO and the revised PDO. Weighting the two outcome ratings for the original and revised PDOs by the shares of loan disbursements before and after the PDO change (which were 65 percent and 35 percent, respectively), the overall outcome is **satisfactory**.

Risk to Development Outcome

6.3 The ShiZheng high-speed rail line was built using mature technology and management. It is part of a national trunk high-speed rail network and has an important role in connecting central and north China. However, the project's development outcomes have some potential risks.

6.4 **Financial risk.** At project completion, the ShiZheng line was generating revenues that were typically more than twice its operation and maintenance cost. The ShiZheng line's cash flow should be even more positive now, given that the current traffic density is larger than the density estimated at completion. The ICR predicted that when repayment of principal began, the project would need to restructure its debt until the mid-2020s or later because of the difference in maturities between the commercial loans and the life of the asset, and the need for traffic to ramp up (World Bank 2016a, para. 36). However, it is highly unlikely that CRC will not arrange for the refinancing of such a strategically important line, which is economically viable, generates significant positive cash flows, and has great potential for further traffic growth. The economy faces some downside risks, but "China has the potential to sustain strong growth" in the medium term (IMF 2017). The project's financial risk is rated **modest**.

6.5 **Technical risk.** The project line is based on complex modern technology and management systems, but similar railway systems have been operating with high levels of reliability in China since 2007. Such systems have also been "in operation in Japan, Germany, Italy, the United Kingdom, and France for many years" (World Bank 2016a, para. 61). According to project documentation, CRC introduced effective maintenance systems for China's intensively used high-speed rail systems. Therefore, the technical risk is rated as **negligible**.

6.6 **Social risk.** The ICR reports, "Public concerns over affordability led CRC to reconsider the reduction in conventional trains originally foreseen" (World Bank 2016a, para. 42), though a detailed survey in the PAD showed that the public was very willing to

pay a surcharge of 50 percent for HSR services compared with conventional rail services (World Bank 2008, para. 38).

6.7 However, the fare for the second-class seats of the high-speed trains on the ShiZheng line was very affordable, and the PPAR mission confirmed through interviews with knowledgeable experts that the government is highly committed to ensuring that the people's needs for conventional railway transport are met. The PPAR mission learned that the fare for China's conventional trains has not increased since 1995, and the fares for high-speed trains (though proposed by CRC based on costs that can float between upper and lower limits) are subject to government approval through the National Development and Reform Commission. Based on the information available on social risks, the social risk to this project's development outcome is assessed as **negligible**.

6.8 **The risk of reduced government commitment.** Railways are a large and strategically important sector in China with a fundamental role in China's social and economic development. The government is committed to providing support to the railway sector and CRC when such support becomes essential. Because of the project's strategic importance in China's railway network and the economic and social development of an important region, the government, through CRC, is also committed to providing essential support to this project when necessary. The risk of reduced government commitment to this project line is rated as **negligible**.

6.9 The overall risk to development outcome is rated **negligible**.

Bank Performance

6.10 This assessment considers both the World Bank's performance in ensuring quality at entry and the quality of the World Bank's supervision of project implementation as satisfactory. Overall, Bank performance is rated **satisfactory**.

Quality at Entry

6.11 The PDOs were clear, measurable, and highly relevant to the World Bank country partnership strategies for China and the country's national development and transport sector strategies. The project activities were targeted and very consistent with the objectives. The World Bank provided guidance and support to ensure that the feasibility studies, especially regarding technical and environmental specifications and poverty reduction considerations, were prepared with high quality and on a timely basis. For example, the World Bank's project preparation involved an effort to identify the poorest cities and the poverty reduction impact of the project line (World Bank 2016a, para. 65). The World Bank's assessment of the project's social and environmental impacts was sound, and effective mitigation plans were developed accordingly.

6.12 The selection of FCTIC in the Ministry of Railways as the World Bank's direct counterpart responsible for managing the World Bank loan, including financial and

procurement management, contributed to efficient and cost-effective implementation because FCTIC had strong, relevant experience. The project design envisioned the formation of two project companies in the two project provinces as the implementing agencies and the companies responsible for future operations. According to IEG's PPAR mission interviews with relevant railway experts, this arrangement proved helpful in strengthening the ownership of the project by relevant parties (especially local governments) for improved implementation and operations, particularly in land acquisition and resettlement that involved a lot of coordination with local governments.

6.13 The project design did not include a midterm review to assess the project's progress. However, all contracts for the project had been awarded by the midterm, and the core project team met the implementing agencies every six weeks rather than every six months because the core team was located in the country office. This enabled engagement that was much more frequent than usual on the project's progress and improved the resolution of issues during implementation (World Bank 2016a, para. 14). The results framework, however, had several shortcomings (discussed in the next section).

6.14 Based on this evidence, IEG rates the quality at entry for this project as **satisfactory**.

Quality of Supervision

6.15 The World Bank team worked closely with the Ministry of Railways, CRC, and the implementing agencies. The team conducted project implementation supervisions diligently and with the required expertise. It provided guidance and support to ensure that the project's preparation and implementation met high standards. The PPAR mission particularly learned from CRC that the World Bank's supervision on social and fiduciary safeguards compliance was very strict.

6.16 ISRs were prepared every six months, and the IEG PPAR considered them to be good quality. The ISR's ratings were candid and appropriate. Risk ratings and risk management status ratings were updated in all ISRs (World Bank 2016a, para. 67). The World Bank team also conducted studies to identify the project's benefits and impacts and drew lessons that could be used by this and other similar projects, as reflected in the production of research notes and papers in areas such as traffic analysis, environmental management, construction costs, and wider economic impact analysis.

6.17 The World Bank team, collaborating with the government, was proactive in restructuring the project in 2012 to allow procurement of the advanced CMVs using World Bank loan savings. This contributed substantially to improved maintenance of the catenary system on high-speed rail lines.

6.18 The results framework was not revised to reflect the government's decision to keep more slow trains on the conventional line, mainly because the government decided this very close to project completion, when such a revision would not have added any value.

6.19 Overall, the World Bank project team worked closely with the Ministry of Railways, CRC, and the implementing agencies to ensure that this complex project was completed on time, within budget, and to high-quality standards, even though the World Bank financed only 5 percent of the total project cost (World Bank 2016a, para. 67).

6.20 This report rates the quality of World Bank supervision as **satisfactory**.

Borrower Performance

6.21 This assessment rates government performance on the project as **highly satisfactory** and the implementing agency performance as **satisfactory**. Overall borrower performance is **satisfactory**.

Government Performance

6.22 Government performance is rated **highly satisfactory**. The Ministry of Railways and CRC were highly committed to the project and ensured that it was well prepared based on sound preliminary design and planning, and well implemented in strict compliance with technical standards and specifications and with the World Bank's fiduciary and social safeguards policies. They actively participated in the World Bank's supervision of the project implementation. The Ministry of Railways and CRC devoted considerable effort to complete the project design and construction on schedule, at a relatively low unit cost, and with high quality. The Ministry of Railways' efforts in forming the shareholding project companies for the project implementation ensured smooth and successful cooperation and coordination with local governments, especially on land acquisition and resettlement and in mobilizing additional counterpart financing. The Ministry of Railways collaborated with the World Bank on its policy analysis of railway sector reforms and considered the World Bank's findings and recommendations during the reform process (World Bank 2016a).

Implementing Agency Performance

6.23 The project implementing agency performance is rated **satisfactory**. As the World Bank's direct counterpart, the FCTIC (under the Ministry of Railways) and CRC managed the World Bank loan effectively, especially ensuring sound financial management and procurement in accordance with World Bank guidelines and without any delays. FCTIC also provided progress reports and other reports on time and monitored environmental and social safeguards compliance effectively.

6.24 The two railway companies managed the resettlement under the project effectively. They coordinated with local governments and ensured timely payment of compensation to affected households. The two companies were also instrumental in working with local governments to find options for improving connectivity to the new stations along the project line. They provided data on the project's performance in accordance with the project requirements.

6.25 Overall, FCTIC and the two companies responded to all project implementation issues efficiently, followed World Bank requirements, and engaged with World Bank missions. They deserve major credit for the successful implementation of this massive railway project (World Bank 2016a, para. 72). A minor shortcoming was that the project's technical assistance was not pursued (the scope of technical assistance was planned to be identified during the project's implementation). However, \$1 million from the World Bank loan was allocated to this subcomponent.

Monitoring and Evaluation

6.26 **Design.** The project's original monitoring and evaluation (M&E) design included four outcome indicators: (i) average number of pairs of passenger trains of maximum speed of 300 kilometers per hour per day, (ii) average number of pairs of passenger trains of maximum speed of 200 kilometers per hour per day, (iii) average number of pairs of freight trains per day, and (iv) average passenger travel time on the class A, 300 kilometer per hour passenger trains achieved between Shijiazhuang and Zhengzhou. These outcome indicators were clear, measurable, and appropriate, and they had baseline values and targets. However, a measure of the occupancy of the high-speed and conventional trains should have supplemented these indicators, along with indicators measuring the achievement of improved passenger transport services on the conventional line. The outcome indicator intended for measuring improvement of the catenary system maintenance on high-speed rail lines, which was added during the 2012 restructuring, did not allow an assessment of benefits directly attributable to the project's CMV component.

6.27 **Implementation.** The FCTIC (under the Ministry of Railways) and CRC provided data on baseline values, final targets, and intermediate values, and reported on project progress in accordance with the requirements specified in project documentation. Several World Bank policy notes and papers complemented this information, including assessments of intermediate outcomes for this project and several other World Bank-financed railway projects, such as assessments of passenger traffic, intermodal integration status, and agglomeration effects.

6.28 **Utilization.** According to project documentation, FCTIC and CRC used data from the M&E system to assess project progress toward achieving the project targets (World Bank 2016a, para. 29). The World Bank's policy notes and papers on intermodal integration and agglomeration effects analysis were based partly on assessing experience from this project. Based on interviews with relevant railway sector experts in China, these policy notes and papers informed relevant railway development policies and strategies.

6.29 The project M&E system collected data in accordance with its designed requirements. However, some substantial gaps in the indicators defined in the M&E design made a full analysis of the project's outcomes more challenging. The quality of the project's M&E system is rated **modest**.

7. Lessons from the Project Experience

7.1 The following lessons are drawn from the project experience:

- **Sound technical design, project preparation, and implementation management, combined with assured financial resources and effective interinstitutional collaboration, are a recipe for success for a complex HSR project.** Like the NanGuang Railway Project, the ShiZheng Railway Project was completed on time with high quality and at a relatively low cost. This success was attributable mainly to sound preliminary design, meticulous planning, and strict control over compliance with standards and specifications, for which the CRC and the Ministry of Railways deserve major credit. The project's success was also attributable to the smooth coordination between the Ministry of Railways and the CRC with local governments on land acquisition and timely provision of counterpart financing. The World Bank contributed to the project's success through its guidance and support to ensure that the project's preparation and implementation met high standards, especially on social and environmental matters, even though its financing accounted for only about 5 percent of the total project cost.
- **Effective HSR system require certain preconditions.** This and the other HSR projects in China showed that for a HSR system to be effective, a high and concentrated travel demand in an already congested corridor and customers with sufficient purchasing power are essential. This finding is confirmed by analytical work carried out under the parallel policy dialogue with the Chinese authorities. This work shows that the main prerequisites or success factors for embarking on a high-speed rail project are: (a) an already congested trunk rail corridor (or if there is no rail link, a congested transport corridor) operating in markets with strong underlying growth; (b) a corridor of exceptionally high and concentrated travel demand; (c) even if there is demand, passengers need to have the purchasing power as HSR fares are expensive compared to the conventional rail; and (d) high interconnectivity to other modes¹⁶.
- **Successful reforms in large and complex infrastructure sectors such as railways involve sustained policy changes supported through long-term policy dialogue and engagements.** When the ShiZheng Project was approved, China had already pursued many significant policy reforms in the railway sector for about 10 to 15 years while collaborating with the World Bank on capacity building and institutional development in multiple dimensions across the system. The government had also developed a framework for further reforms in the railway sector, was committed to these reforms, and asked the World Bank to provide advice on relevant international experience. The World Bank continued its policy engagements with the government on a parallel but separate path from implementation of this and other investment

projects. The World Bank's policy advice was important in informing the reforms in China's railway sector, especially the 2013 landmark reform that separated the commercial management of railway services from the railway regulatory function, and established corporations for railway services delivery.

- **Agglomeration effects are an important benefit of high-speed rail development and could be incorporated in the cost-benefit analysis of such projects.** In addition to traditional benefits, such as user time savings, operating cost savings for traffic diverted from the conventional lines, and reductions in environmental externalities, experiences of this and other projects in China and elsewhere have shown that a high-speed rail project also has significant agglomeration benefits. The magnitude of agglomeration benefits depends on local circumstances, such as industry structure, local conditions, and governance. The project appraisal did not assess the project's agglomeration benefits because the methodology for assessing agglomeration effects for HSR projects was still relatively new. The project completion report also did not assess agglomeration benefits to maintain comparability with the appraisal report. However, the IEG field mission observed signs of remarkable economic development in station cities along the ShiZheng HSR line that were more significant than those observed along the NanGuang Railway line were. If the agglomeration benefits were taken into account in the economic analysis, as in the NanGuang Railway Project, the ERR of the ShiZheng Project would be much higher.
- **Good connections of HSR lines with other transport modes and between the rail stations and urban centers are critical to achieving the full benefits of high-speed trains.** Like the NanGuang Railway Project, the experience of the ShiZheng Project again shows that an HSR line involves a major investment and requires high traffic density to be economically viable. Integration of the railways with other transport modes is important to achieving high traffic density throughout the system and high-quality services to customers. Therefore, it is important to take measures at the design stage to ensure that rail station cities have detailed plans for a timely buildup of complementary infrastructure and the provision of services necessary for good local transport connections to the railway stations—for example, reliable and safe public transport and taxi services.

¹ Much of the information in this section is based on the Project Appraisal Document for the ShiZheng Project and other related project documents.

² For example, a 2015 report by the International Railway Association and the Community of European Railway and Infrastructure Companies revealed that rail in the European Union accounted for 0.6 percent of greenhouse gas emissions through direct usage (diesel) and about 1.5 percent if emissions from electricity generation, even though it represented 8.5 percent of transport activity. By comparison, the road sector accounted for 72 percent of transport carbon dioxide emissions, and aviation and shipping accounted for 12.6 percent and 14.4 percent, respectively (UIC and CER 2015).

Loo and Li (2012) found that carbon dioxide emissions from rail transport were among the lowest of all transport modes in China.

³ For more information on China's 12th Five-Year Plan, visit http://www.china.com.cn/policy/txt/2011-03/16/content_22156007.htm.

⁴ There are no data on cost by project component in the Project Appraisal Document and the Implementation Completion and Results Report. Table C.2 in appendix C shows cost estimates by expenditure category.

⁵ The World Bank's Operations Portal

⁶ Half of the trains were 16 cars long and the other half were 8 cars long.

⁷ The amount of traffic carried over a certain transport route in a given unit of time usually computed by dividing the total passenger-kilometers by the length of the route.

⁸ Accessed on June 22, 2018 at <http://www.chinadataonline.org.libproxy-wb.imf.org/>

⁹ The cost figure is based on the latest available annual average exchange rate of 2016 from the World Development Indicators Database.

¹⁰ Based on data from 2017 China Statistical Yearbook. For more information, see <http://www.stats.gov.cn/tjsj/ndsj/2017/indexch.htm>.

¹¹ The per capita income figure for Philadelphia, Pennsylvania is from U.S. Census Bureau population estimates from July 1, 2017. For more information, see <https://www.census.gov/quickfacts/fact/table/philadelphiacitypennsylvania,districtofcolumbiadistrictofcolumbia,baltimorecitymaryland,US/PST045217>.

¹² The Independent Evaluation Group's mission was unable to obtain information on how much the governments subsidized the costs of China Railway Corporation or Amtrak tickets.

¹³ Caution is required when interpreting these survey data because the survey was conducted in August and September, when students (who tend to have less income) in China and the United States were more likely to travel (World Bank 2016b).

¹⁴ China's current poverty line is annual per capita rural net income of RMB 2,300 (in 2010 constant prices).

¹⁵ According to clarification from the World Bank project team, the operation and maintenance cost includes rolling stock depreciation, but excludes railway infrastructure depreciation. The high-speed railway infrastructure, with proper maintenance, rarely needs "to be replaced in under 100 years." The rolling stock normally has a life of about 20 years.

¹⁶ Amos, Bullock, and Sondhi, 2010.

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Appendix A. Basic Data Sheet

ShiZheng Railway Project (IBRD-75570)

Table A.1. Key Project Data

| Financing | Appraisal Estimate (\$, millions) | Actual or Current Estimate (\$, millions) | Actual as Percent of Appraisal Estimate |
|---------------------|--|--|--|
| Total project costs | 6,224.10 | 5,197.29 | 83 |
| Loan amount | 300.00 | 297.10 | 99 |

Table A.3. Project Dates

| Event | Original | Actual |
|----------------|-----------------|---------------|
| Concept review | | 06/28/2006 |
| Negotiations | 06/18/2007 | 05/06/2008 |
| Board approval | 08/21/2007 | 06/24/2008 |
| Signing | | 09/16/2008 |
| Effectiveness | 11/18/2008 | 11/18/2008 |
| Closing date | 12/31/2013 | 11/30/2015 |

Table A.4. Staff Time and Cost

| Stage of Project Cycle | World Bank Budget Only | |
|------------------------|---------------------------|--------------------------------------|
| | Staff Time (no. weeks) | Cost ^a (\$, thousands) |
| Lending | | |
| FY2006 | 4.48 | 48.28 |
| FY2007 | 27.61 | 217.94 |
| FY2008 | 8.97 | 119.64 |
| Total | 36.58 | 337.58 |
| Supervision or ICR | | |
| FY2009 | 4.37 | 90.73 |
| FY2010 | 4.1 | 54.02 |
| FY2011 | 4.42 | 59.48 |
| FY2012 | 6.65 | 90.1 |
| FY2013 | 5.15 | 74.52 |
| FY2014 | 5.46 | 86.84 |
| FY2015 | 2.44 | 26.33 |
| FY2016 | 3 | 37.36 |
| Total | 35.59 | 519.38 |

Note: ICR = Implementation Completion and Results Report.

a. Including travel and consultant costs.

Table A.5. Task Team Members

| Name | Title ^a | Unit | Responsibility or Specialty |
|----------------------|--------------------------------------|-------|-----------------------------|
| Lending | | | |
| Syed I. Ahmed | Lead Counsel | LEGAM | |
| John Scales | Lead Transport Specialist | GTIDR | Team Leader |
| Paul Amos | Consultant | GTIDR | |
| Richard G. Bullock | Headquarters Consultant | GTIDR | |
| Jianjun Guo | Senior Procurement Specialist | GGODR | |
| Ying Jin | Headquarters Consultant | GSURR | |
| Maria Luisa G. Juico | Program Assistant | GTIDR | |
| Juan D. Quintero | Consultant | GENDR | |
| Jitendra Sondhi | Headquarters Consultant | GTIDR | |
| Peishen Wang | Consultant | GENDR | |
| Lei Wu | Program Assistant | EACCF | |
| Songling Yao | Senior Social Development Specialist | GSURR | |

| | | | |
|---------------------------|--|-------|----------------|
| Chaohua Zhang | Lead Social Development Specialist | GSURR | |
| Supervision or ICR | | | |
| Gerald Paul Ollivier | Senior Infrastructure Specialist | GTIDR | Team Leader |
| Martha B. Lawrence | Senior Transport Specialist | GTIDR | Co-Team Leader |
| Syed I. Ahmed | Lead Counsel | LEGAM | |
| Richard G. Bullock | HQ Consultant ST | GTIDR | |
| Wanli Fang | Consultant | GSURR | |
| Yi Geng | Senior Financial Management Specialist | GGODR | |
| Jianjun Guo | Senior Procurement Specialist | GGODR | |
| Maria Luisa G. Juico | Program Assistant | GTIDR | |
| Jitendra Sondhi | Headquarters Consultant | GTIDR | |
| Ye Song | Consultant | EASCS | |
| Peishen Wang | Consultant | GENDR | |
| Lei Wu | Program Assistant | EACCF | |
| Ning Yang | Senior Environmental Specialist | GENDR | |
| Songling Yao | Senior Social Development Specialist | GSURR | |
| Nanyan Zhou | Consultant | GTIDR | |
| Romain Pison | Transport Specialist | GTIDR | |
| Fatima Arroyo | Operations Analyst | GTIDR | |
| Laure Albinet | Transport Analyst | GTIDR | |

Note: ICR = Implementation Completion and Results Report.

a. At time of appraisal and closure, respectively.

Appendix B. World Bank–Supported High-Speed Railway Projects in China

| Project | Speed (km/hr) | Length (km) | Project Cost | World Bank Loan (\$, millions) | Loan Approval Year | Project Completion Year | ICR Review Outcome Rating |
|---------------------------------|------------------|----------------|-----------------|--------------------------------------|--------------------------|-------------------------------|---------------------------------|
| ShiZheng Railway | 350 | 355 | 6,109 | 300 | 2008 | 2015 | Satisfactory |
| Guiyang Guangzhou Railway | 250 | 857 | 12,527 | 300 | 2009 | 2016 | Satisfactory |
| JiTūHu Railway | 250 | 360 | 6,303 | 200 | 2011 | 2017 | Satisfactory |
| ZhangHu Railway | 250 | 286 | 4,682 | 200 | 2012 | 2017 | n.a. |
| NanGuang Railway | 200 | 462 | 5,984 | 300 | 2009 | 2015 | Satisfactory |
| HaJia Railway | 200 | 343 | 5,566 | 300 | 2014 | 2020 | n.a. |

Source: Ollivier, Sondhi, and Zhou 2014 Independent Evaluation Group database.

Note: hr = hour; ICR = Implementation Completion and Results Report; km = kilometer; n.a. = not applicable.

Appendix C. Project Activities Costs

Table C.1. Project Cost by Activities Category (\$, millions)

| Activities | Appraisal Estimate ^a | Actual or Latest Estimate | Percentage of Appraisal |
|--|---------------------------------|---------------------------|-------------------------|
| Civil works | 3,090.90 | 4,086.54 | 132 |
| Goods | 1,138.80 | 433.37 | 38 |
| Land acquisition and resettlement | 217.70 | 283.83 | 130 |
| Other | 229.90 | 134.14 | 58 |
| Consulting services | 1.00 | 0.00 | 0 |
| Catenary maintenance vehicles ^b | 115.00 | 113.93 | 99 |
| Total baseline cost | 4,793.30 | 5,051.81 | 105 |
| Physical contingencies | 223.95 | 0.00 | 0 |
| Total project costs | 5,017.25 | 5,051.81 | 101 |
| Interest during construction | 342.60 | 142.07 | 41 |
| Rolling stock | 863.50 | 2.70 | 0 |
| Front-end fee (IBRD) | 0.75 | 0.71 | 95 |
| Total financing required | 6,224.10 | 5,197.29 ^c | 83 |

Source: Implementation Completion and Results Report.

Note: IBRD = International Bank for Reconstruction and Development; RMB = renminbi (currency).

a. The exchange rate at appraisal was \$1.00 = RMB 7.18 and was \$1.00 = RMB 6.68 at completion.

b. The catenary maintenance vehicles component was added and estimated at restructuring. It is included under Appraisal Estimate for comparison.

c. Total financing required does not include the rolling stock component because rolling stock was leased, not purchased. For comparison, the actual or latest estimate that includes rolling stock purchase as estimated would be RMB 40,949 million (91 percent of appraisal), and the total project cost is RMB 33,692 million (94 percent of appraisal).

Table C.2. Project Cost by Activities Category (RMB, millions)

| Activities | Appraisal Estimate | Actual or Latest Estimate | Percentage of Appraisal |
|--|--------------------|---------------------------|-------------------------|
| Civil works | 22,193 | 25,450 | 115 |
| Goods | 8,177 | 4,596 | 56 |
| Land acquisition and resettlement | 1,563 | 1,842 | 118 |
| Other | 1,651 | 1,043 | 63 |
| Consulting services | 7 | 0 | 0 |
| Catenary maintenance vehicles ^b | 826 | 761 | 92 |
| Total baseline cost | 34,416 | 33,692 | 98 |
| Physical contingencies | 1,608 | 0 | 0 |
| Total project costs | 36,024 | 33,692 | 94 |
| Interest during construction | 2,460 | 952 | 39 |

| | | | |
|--------------------------|--------|--------|-----|
| Rolling stock | 6,200 | 18 | 0 |
| Front-end fee (IBRD) | 5 | 5 | 100 |
| Total financing required | 44,689 | 34,667 | 78 |

Source: Implementation Completion and Results Report.

Note: IBRD = International Bank for Reconstruction and Development; RMB = renminbi (currency).

Appendix D. Persons Met during Project Performance Assessment Report Mission

| Name | Title | Institution |
|--|--|---|
| Government of China and the Implementing Agency | | |
| Mr. Lei Zhang | Deputy Director, International Economic and Financial Cooperation Department | Ministry of Finance |
| Mr. Baoshan Feng | Director, Foreign Capital Utilization and Overseas Investment Department | National Development and Reform Commission |
| Mr. Bo Tian | Principal Officer, Foreign Capital Utilization and Overseas Investment Department | National Development and Reform Commission |
| Mr. Haoyong Dong | Deputy Director, Materials Management Department | China Railway Corporation |
| Mr. Hongli Li | Economist and Project Officer, Materials Management Department | China Railway Corporation |
| Ms. Hong Zhu | Deputy General Manager, 7th Business Division | China International Tendering Co., LTD |
| Research Institutes and Universities | | |
| Dr. Lixin Shi | Director and Professor, Infrastructure Research Center | Institute of Economic System and Management, National Development and Reform Commission |
| Dr. Dan Zheng | Lecturer, School of Economics and Management | University of Chinese Academy of Sciences |
| Mr. Jianping Zhang | Independent Consultant | Retired director of China Railway Corporation and National Development and Reform Commission |
| Dr. Minjun Shi | Professor in Economics, School of Economics | Remin University of China, Beijing, China |
| Dr. Peihong Chen | Associate Professor in Economics, School of Economics and Management | Beijing Jiaotong University |
| Dr. Zhi Liu | Director, Center for Urban Development and Land Policy | Peking University, Lincoln Institute |
| Dr. Tie Wei | Professor in Management, School of Business | Guangxi University |
| Mr. Jingye Yuan | Associate Professor in Technical Economics, School of Physics | Guangxi University |
| Dr. Zaiqi Chen | Director and Professor, Macroeconomic Research Institute | Guangdong Social Science Academy |
| Dr. Zonghong Song | Associate Professor, Macroeconomic Research Institute | Guangdong Social Science Academy |
| Mr. Zheng Li | Assistant Professor, Macroeconomic Research Institute | Guangdong Social Science Academy |

| | | |
|---------------------------------------|---|--|
| Mr. Ming Yang | Director | New Economy Journal, Guangzhou, Guangdong Province |
| World Bank | | |
| Mr. Bekele Debele Negewo | Program Leader | World Bank Country Unit, Beijing |
| Mr. Binyam Reja | Practice Manager, Transport: Central Asia, China, and Mongolia Unit | Transport and Digital Development Global Practice |
| Mr. Gerald Paul Ollivier ^a | Lead Transport Specialist, Transport: Southeast Asia and the Pacific | Transport and Digital Development Global Practice |
| Ms. Martha B. Lawrence ^a | Senior Transport Specialist | Transport and Digital Development Global Practice |
| Ms. Hua Tan | Senior Transport Specialist | Transport and Digital Development Global Practice |
| Mr. Richard G. Bullock | Consultant, Transport: Central and North East Asia | Transport and Digital Development Global Practice |

a. Consulted by email.