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Past Successes and Future Challenges in Rural China's Human Capital

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ABSTRACT

This paper describes the current level of human capital in China and seeks to identify a number of education-related challenges that may slow down the nation's economy from transitioning to high-income status. Relying on recent census-based data from OECD for the rest of the world and using data from the 2015 Micro-Census for China, the authors show that the low levels of education of China's labour force is really a problem that has its roots in the past (in the 1970s, 1980s, and 1990s). In recent years (since 2000), China has been investing heavily in education as shown by the increasing the share of youth, including rural youth, attending high school. Despite this recent effort to raise the nation's human capital, the education system still faces several challenges in trying to provide high-quality education for all youth. First, the government must figure out a way to overcome the relatively low rates of participation in high school by rural students. Second, there is concern that many vocational schools, especially those in rural areas, cannot deliver quality education. Finally, the paper will show that many rural students may be unprepared due to poor early childhood development outcomes.

Introduction

Human capital plays an important role in promoting sustained economic development.¹ Human capital is particularly vital for nations that hope to move from middle-income to high-income status, as these nations require a workforce that can think creatively, perform non-routine tasks, and innovate to achieve long-term growth.² Given that education is the main way to increase human capital, numerous studies have stressed the importance of educational attainment rates in assessing the potential for developing nations to successfully transition into developed

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¹Donald Gillies, 'Human Capital Theory in Education', in *Encyclopedia of Educational Philosophy and Theory*, ed. Michal A. Peters (Berlin: Springer Science and Business Media, 2015), pp. 1–5; Jakob B. Madsen and Fabrice Murtin, 'British Economic Growth since 1270: The Role of Education', *Journal of Economic Growth* 22(3), (2017), pp. 229–272; John Whalley and Xiliang Zhao, 'The Contribution of Human Capital To China's Economic Growth', *China Economic Policy Review* 2(1), (2013), pp. 1,350,001.

²James. J. Heckman and Junjian Yi, 'Human Capital, Economic Growth, and Inequality in China', *National Bureau of Economic Research Working Paper Series* no. w18100 (2012); Man Xu, Xiaohong Liu, Yamei Du, Yonghua Yang and Zhenghao Liu, 'Shaanxi Guanzhong Nongcun Yingyouer Zhili Yundong Fayushuiping yu Yingxiangyinsu Fenxi' ['The Analysis of Infant's Mental and Motor Development Level and Influencing Factors in the Countryside of Shaanxi Province'], *Xi'an Jiaotong Daxue Xuebao (Yixueban)* [Journal of Xi'an Jiaotong University (Medical Sciences)] 30(2), (2009), pp. 181–184; David H. Autor, Frank Levy and Richard J. Murnane, 'The Skill Content of Recent Technological Change: An Empirical Exploration', *Quarterly Journal of Economics* 118(4), (2003), pp. 1279–1333; Paul Glewwe, 'Schools and Skills in Developing Countries: Education Policies and Socioeconomic Outcomes', *Journal of Economic Literature* 40(2), (2002), pp. 436–482.

economies.³ In particular, researchers have stressed the importance of high school (and university) educational attainment for maximising both national and individual potential in middle-income status that are trying to transition to high income in.⁴

While high levels of educational attainment are necessary to increase human capital, they alone are not enough. Students must also *learn* while they are at school to develop high-level skills. Hanushek and Woessmann illustrated that the cognitive skills of a population—acquired through achievement (not just attendance) in schooling institutions—were related to individual earnings and economic growth. In order for students to achieve in the education system, and in order for economic growth to occur, the education that students receive must be of high quality.

Besides educational quality, other factors, such as health and parenting inputs, also influence student academic achievement, and hence, ultimate outcomes.⁵ Both early childhood developmental outcomes, as well as child health and nutritional outcomes, are strongly associated with short-term and long-term educational performance.⁶ This is particularly true of developing countries, where on average children complete fewer years of schooling and learn less per year of schooling than those in developed countries.⁷ Indeed, it is now well documented that children who grow up with poor health, malnutrition, and a lack of interactive parenting are also less likely to escape poverty.⁸

In developing nations, when the educational outcomes of large portions of the population are poor due to the myriad reasons stated above, the nations meet a fate called the ‘middle-income trap’. This term refers to a stagnant condition in which nations that have reached middle-income levels of GDP (as defined by the World Bank) fail to achieve high-income status. The labour force in these nations do not acquire the human capital demanded in a higher-wage, higher value-added economy, and therefore these nations become outcompeted both by low-income countries in cheap manufacturing and by high-income countries in producing skill, knowledge, and capital-intensive products and services. As this paper will argue, in order to avoid falling into the middle-income trap, China must attain and maintain high levels of both educational quantity and quality as well as ensure that children receive necessary parental and nutritional inputs to become healthy and productive citizens in the future.⁹ This paper examines how China is doing in these aspects.

³Lei Wang, Mengjie Li, Cody Abby and Scott Rozelle, ‘Human Capital and the Middle Income Trap: How Many of China’s Youth Are Going to High School?’, *The Developing Economies* 56(2), (2018), pp. 82–103; Niny Khor, Lihua Pang, Chengfang Liu, Fang Chang, Di Mo, Prashant Loyalka and Scott Rozelle, ‘China’s Looming Human Capital Crisis: Upper Secondary Educational Attainment Rates and the Middle-Income Trap’, *China Quarterly* 228, (2016), pp. 905–926; Timothy F. Bresnahan, Erik Brynjolfsson and Lorin M. Hitt, ‘Information Technology, Workplace Organization, and the Demand for Skilled Labor: Firm-Level Evidence’, *Quarterly Journal of Economics* 117(1), (2002), pp. 339–376; Timothy Bresnahan, ‘Computerization and Wage Dispersion: An Analytical Reinterpretation’, *The Economic Journal* 109(456), (1999), pp. 390–415; David H. Autor, Lawrence F. Katz, and Alan B. Krueger, ‘Computing Inequality: Have Computers Changed the Labor Market?’, *Quarterly Journal of Economics* 113(4), (1998), pp. 1169–1213.

⁴Timothy F. Bresnahan, Erik Brynjolfsson and Lorin M. Hitt, ‘Information Technology, Workplace Organization, and the Demand for Skilled Labor: Firm-Level Evidence’, *Quarterly Journal of Economics* 117(1), (2002), pp. 339–376; Timothy Bresnahan, ‘Computerization and Wage Dispersion: An Analytical Reinterpretation’, *The Economic Journal* 109(456), (1999), pp. 390–415; David H. Autor, Lawrence F. Katz, and Alan B. Krueger, ‘Computing Inequality: Have Computers Changed the Labor Market?’, *Quarterly Journal of Economics* 113(4), (1998), pp. 1169–1213.

⁵Eric A. Hanushek, ‘Why Quality Matters in Education’, *Finance and Development* 42(2), (2005), pp. 15–19.

⁶Christine A. Powell, Susan P. Walker, Susan M. Chang and Sally M. Grantham-McGregor, ‘Nutrition and Education: A Randomized Trial of the Effects of Breakfast in Rural Primary School Children’, *American Journal of Clinical Nutrition* 68(4), (1998), pp. 873–879; Paul Glewwe, Hanan G. Jacoby and Elizabeth M. King, ‘Early Childhood Nutrition and Academic Achievement: A longitudinal Analysis’, *Journal of Public Economics* 81(3), (2001), pp. 345–368; W. Steven Barnett, ‘Long-term Effects of Early Childhood Programs on Cognitive and School Outcomes’, *The Future of Children* 5(3), (1995), pp. 25–50; Charles E. Basch, ‘Healthier Students Are Better Learners: A Missing Link in School Reforms to Close the Achievement Gap’, *Journal of School Health*, 81(10), (2011), pp. 593–598.

⁷Paul Glewwe and Edward A. Miguel, ‘The Impact of Child Health and Nutrition on Education in Less-Developed Countries’, *Handbook of Development Economics* 4, (2007), pp. 3561–3606.

⁸Sally Grantham-McGregor, Yin Bun Cheung, Santiago Cueto, Paul Glewwe, Linda Richter and Barbara Strupp, ‘Developmental Potential in the First 5 Years for Children in Developing Countries’, *The Lancet* 369(9555), (2007), pp. 60–70.

⁹Homi Kharas and Harinder Kohli, ‘What is the Middle-Income Trap, Why Do Countries Fall into it, and How can it be Avoided?’, *Global Journal of Emerging Market Economies* 3(3), (2011), pp. 281–289; Shekhar Aiyar, Romain A. Duval, Damien Puy, Yiqun Wu and Longmei Zhang, ‘Growth Slowdowns and the Middle-Income Trap’, *International Monetary Fund Working Paper* no.13/71 (2013) pp. 1–64.

A number of scholars consider high school educational attainment to be a critical milestone for the workforce to attain in countries that are trying to transition to high income.¹⁰ This is because in high school, children not only strengthen general skills (which are needed for life-long learning), but they also begin to have opportunities for developing stronger specialisation and more advanced subject-specific skills. However, despite the importance of high school for the development of human capital, in some countries (like China) high school has not been a part of compulsory education.¹¹ For these reasons, this paper focuses specifically on China's high school educational attainment rates compared with those of other nations. This paper identifies three challenges to increasing the human capital of China's rural youth: a.) disproportionately low high school attainment rates among rural students, despite recent gains; b.) poor-quality schooling at Vocational Education and Training (VET) schools; and c.) poor developmental and health outcomes of rural infants, toddlers, and elementary school-aged children).

High school education and the 'middle-income trap'

While there are a number of reasons that nations in the world have become mired in a middle-income trap, this section focuses on a human capital explanation. Why are high levels of human capital necessary when a nation is still middle-income? A major consequence that middle-income countries encounter when they have labour forces with insufficient stocks of high school educational attainment is that they fall into a state of stagnated growth mentioned earlier known as the middle-income trap.

This paper refers to these nations 'the Trapped' in contrast with the so-called 'Graduates' who successfully make the transition. Although there are a number of possible causes of the 'trap', Khor et al. argue that the defining characteristic of trapped economies is that they have deficient levels of human capital.¹² According to Khor, middle-income countries where wages are rising but where a large share of workers are deficient in human capital lose their comparative advantage, as they are outcompeted by both low-wage economies, which can manufacture goods at a lower cost, and advanced economies, which have sufficient human capital to produce high-skill innovations.¹³

There are also consequences for individuals living in a nation stuck in the middle-income trap, and these problems on the individual level can aggregate to societal problems on the whole. Students caught in the transition who do not attain high school education and therefore do not develop the necessary skills to succeed in a high-skill, high-income economy encounter low wages and unemployment, contributing to economic slow-downs for society overall.¹⁴ Without desirable job prospects, a nation's youth are more likely to become involved in informal micro-firms that can undermine the emergence of the formal economy, as well as

¹⁰Timothy F. Bresnahan, Erik Brynjolfsson and Lorin M. Hitt, 'Information Technology, Workplace Organization, and the Demand for Skilled Labor: Firm-Level Evidence', *Quarterly Journal of Economics* 117(1), (2002), pp. 339–376; Timothy Bresnahan, 'Computerization and Wage Dispersion: An Analytical Reinterpretation', *The Economic Journal* 109(456), (1999), pp. 390–415; David H. Autor, Lawrence F. Katz, and Alan B. Krueger, 'Computing Inequality: Have Computers Changed the Labor Market?', *Quarterly Journal of Economics* 113(4), (1998), pp. 1169–1213.

¹¹OECD, 'Education at a Glance 2018: OECD Indicators', *OECD Publishing*, (11 September 2018), available at: <https://www.oecd-ilibrary.org/docserver/eag-2018-en.pdf?expires=1547621929&id=id&accname=guest&checksum=A885D1B9D334620D4A3159B67ABB13F0> (accessed 16 January 2019).

¹²Niny Khor et al., 'China's Looming Human Capital Crisis: Upper Secondary Educational Attainment Rates and the Middle-Income Trap', *China Quarterly* 228, (2016), pp. 905–926.

¹³Linxiu Zhang, Eli Pollak, Ross Darwin, Matthew Boswell and Scott Rozelle, 'Are Elite University Graduates Aiding China's Transition to an Innovation-Based Economy? Results from a Career Choices Survey Among Would-be Innovators in China and the United States', *Asia-Pacific Journal of Accounting & Economics* 20(1), (2013), pp. 58–69.

¹⁴James. J. Heckman and Junjian Yi, 'Human Capital, Economic Growth, and Inequality in China', *National Bureau of Economic Research Working Paper Series* no.w18100 (2012); Eric A. Hanushek, Dean T. Jamison, Eliot A. Jamison and Ludger Woessmann 'Education and Economic Growth: It's not Just Going to School but Learning That Matters', *Education Next* 8(2), (2008), pp. 62–70.

organised crime/gangs.¹⁵ In some cases the rise of activity outside formal institutions may not only lead to an unpredictable and sometimes violent and unstable living environment, but may also create an atmosphere that is not conducive to investment and growth.¹⁶ Thus, in trapped nations, vicious cycles can appear where growth slows, increasing the unemployment rate among undereducated individuals, which then leads to more crime and instability, which then reduces investment, thereby further undermining growth.

If high levels of human capital are conducive for economies to graduate to high-income status and avoid the middle-income trap, how high must the educational attainment level of the workforce be to achieve this? Examining high school attainment rates in high-income countries, it becomes clear that the large majority of the labour forces (composed of all individuals aged 25–64) in these countries have attended high school (Table 1).¹⁷ According to the 2015 OECD, the average attainment rate of all high-income countries in 2015 was 78%.¹⁸ The rates of some of the most developed nations—the United States, Germany and Japan—are even higher, where over 90% of the labour force has attended high school. The idea is that in high-income countries, most jobs demand high-level skills and individuals who want to contribute to and thrive in the economy need to have at least the set of skills—such as math, critical thinking, science, and computer skills—that will allow them to be productively employed.

The importance of human capital in the transition from middle to high income can also be seen by examining educational attainment data of the graduates. Table 1 also shows the share of the labour force of countries that moved from middle income to high income over the past 50 years at the time that the nations were still middle income. Remarkably, in the case of those nations/territories that have successfully graduated, such as South Korea, Ireland, Israel, Taiwan, and Singapore, the levels of education of their labour forces were already high when they were still middle income. According to the empirical findings, in almost all high-income countries, including recent graduates, about three out of four of individuals in the labour force have attended high school.

Table 1. Share of labour force with at least high school education

Country	High school attainment
<i>High-income countries (2015)</i>	
United States	91
Germany	92
Japan	95
High-income average (2015)	78
<i>The Graduates—pre-transition (1980)</i>	
The Graduates average (1980)	≈72
<i>Middle-income countries (2015)</i>	
Turkey	36
Brazil	46
Argentina	42
Mexico	34
South Africa	32
Middle-income average (2015)	36
<i>Low-income countries (2015)</i>	
Low-income average (2015)	<20

Data Source: OECD, 2015

¹⁵Santiago Levy and Dani Rodrik, 'The Mexican Paradox', *Project Syndicate*, (10 August 2017), available at: <https://www.project-syndicate.org/commentary/mexican-paradox-economic-orthodoxy-low-productivity-by-santiago-levy-and-dani-rodrik-2017-08?barrier=accessreg> (accessed 16 January 2019).

¹⁶Niny Khor et al., 'China's Looming Human Capital Crisis: Upper Secondary Educational Attainment Rates and the Middle-Income Trap', *China Quarterly* 228, (2016), pp. 905–926.

¹⁷It is important to note that these rates show the percentage of the workforce in each country that has *attended* high school (attainment) but has not necessarily graduated.

¹⁸OECD, 'Education at a Glance 2018: OECD Indicators', *OECD Publishing*, (11 September 2018), available at: <https://www.oecd-ilibrary.org/docserver/eag-2018-en.pdf?expires=1547621929&id=id&acname=guest&checksum=A885D1B9D334620D4A3159B67ABB13F0> (accessed 16 January 2019).

By looking at the high school attainment rates vis-à-vis those of the nations trapped at middle income (also displayed in [Table 1](#)), the stark difference in levels of human capital between the two groups becomes clear. The average high school attainment rate in the trapped middle-income countries in 2015 was only 36%—significantly less than the high-income country average of 78% and half that of the 1980 pre-transition average of the graduates (72%). This means that before these graduates even achieved their high-income status, the share of their labour force with a high school education was already double the current average in middle-income countries.

Comparing the human capital of China with the rest of the world

The previous section established that the labour force human capital of middle-income nations lags significantly behind high-income nations, meaning that most middle-income countries are unprepared to transition to high-income status. It is yet unclear whether or not China, the world's largest middle-income economy, is prepared to make the transition. This section examines how the human capital of China's overall labour force compares with that in other nations. In fact, China's overall human capital is one of the lowest in the middle-income world. As noted above, however, since the human capital of a labour force is an asset that is the result of an investment strategy implemented over the course of several decades, it will be shown that the current government is not responsible for the low level of human capital in China.

Comparing China's human capital with that of other countries, China's overall labour force (all individuals between 25 and 64) is still undereducated by international metrics of education quality. This is true even in comparison with the other middle-income economies. [Table 2](#) utilises a report published by the Organization for Economic Cooperation and Development (OECD) entitled 'Education at a Glance' to acquire high school attainment rates in countries other than China. The China attainment numbers used in this table are calculated using the 2015 Micro-Census. This data is comparable because they were generated using similar data sources (that is, population censuses) and using similar methodologies (e.g., similar assumptions, cutoffs and definitions).¹⁹

The international comparisons reveal that China is behind the other trapped middle-income countries, as well as both high-income countries and graduates, in terms of human capital. The share of the labour force in China that has attained high school education (30%) is less than 40% of the OECD average (76%) and less than half of the G20 average (64%). China's labour force human capital, in high school attainment rates, is lower than that of all other BRICS countries, aside from India for which data is unavailable). It is even below that of Indonesia (31%), a poor country that just recently graduated to become a lower middle-income economy.²⁰ The trend holds when comparing countries by age cohort as well (25–34; 35–44; etc.—[Table 2](#)). This reveals that China still has a long way to go until it can build up its labour force's human capital so that it looks like that of a high-income nation.

Recent improvements in China's human capital: measuring increases in high school attainment rates among rural students

Although the quality of human capital of China's workforce is low on an international scale, this does not mean that China does not recognise this problem. As stated before, the low human

¹⁹In addition, just as in [Table 1](#), all of these numbers describe high school *attainment* rates (including all of those who had previously attended high school) and not graduation rates; OECD, 'Education at a Glance 2018: OECD Indicators', *OECD Publishing*, (11 September 2018), available at: <https://www.oecd-ilibrary.org/docserver/eag-2018-en.pdf?expires=1547621929&id=id&accname=guest&checksum=A885D1B9D334620D4A3159B67ABB13F0> (accessed 16 January 2019).

²⁰OECD, 'Education at a Glance 2018: OECD Indicators', *OECD Publishing*, (11 September 2018), available at: <https://www.oecd-ilibrary.org/docserver/eag-2018-en.pdf?expires=1547621929&id=id&accname=guest&checksum=A885D1B9D334620D4A3159B67ABB13F0> (accessed 16 January 2019).

Table 2. Share of the labour force that has attained at least some high school in China and benchmark countries in 2014 (Percentage, by age cohort)

Country/Country Group	25–64	25–34	35–44	45–54	55–64
China^a	30	47	31	22	16
OECD					
Average	76	83	80	74	66
Other OECD					
EU21	78	85	83	77	68
Mexico	34	46	33	28	20
Turkey	36	50	35	25	21
G20 Average	64	73	66	60	51
Argentina	m ^b	m	m	m	m
Indonesia	31	40	34	22	15
BRICS					
Brazil	46	61	48	40	28
Russia	95	95	95	96	92
India	m	m	m	m	m
S. Africa	65	77	69	52	38

Data Source: All numbers except for China, from OECD, 2015; see footnote a, below, for the source of data used for China

^aHigh school attainment in China is calculated based on the data presented in this paper from the 1% National Population Sample Survey in 2015 (2015 Micro-Census), rather than from the OECD report.

^bm = missing data.

capital of China's current labour force does not necessarily reflect the commitment of current or recent past leadership towards education. In fact, the Chinese government has announced in recent policy documents that it wants universal high school education by 2020.²¹

This section examines empirically whether or not current/recent education officials have been investing in youth as a way to raise the human capital of China's future labour force, as well as whether or not the government is making progress towards achieving universal high school education. To do so, this section closely examines changes in China's human capital over the last decade in terms of the share or quantity of 15–17 year olds attending high school. If the rate of youth that attend high school is rising, it would seem that China is trying to address the problem left by low investment in the past. The analysis is conducted using two sets of independent data: statistics from the Ministry of Education (MOE), which is reported from school officials up through the different levels of government and data from the 2015 Micro-Census, which comes from large-scale, on-the-ground household surveys conducted around China by the National Bureau of Statistics.

Using either data source, it is clear that China's high school attainment rates were still low in 2005 (Table 3). However, high school attainment rates changed dramatically after 2005. Indeed, regardless of the data set, during the 10-year stretch between 2005 and 2015, China's high school attainment rates rose significantly. The MOE reports that the attainment rate in 2015 was 87%. The Micro-Census data reflects a rate of 80%. That means that, in only ten years, the attainment rate shown by the MOE increased by 64% (87%/53%). According to the Micro-Census, that rise was smaller, though still very large overall (51% = 80%/53%). Such a steep upward trend is by any measure evidence of a remarkable achievement.

China's education officials should be proud of the significant strides they have made in the direction of universal high school attendance. The data, however, also shows that the job of achieving universal high school education is not complete and that China will need to exert significant efforts if it wishes to ultimately realise this goal. Even by the most optimistic estimates, 13% of 15 to 17 year olds did not attend high school in 2015 (according to the MOE data). As

²¹Ministry of Education of the People's Republic of China (MOE), 'Gaozhong Jieduan Jiaoyu Puji Gongjian Jihua (2017–2020 Nian)' ['The Guideline of Popularizing High School Education (2017–2020)'], Zhonghua Renmin Gongheguo Jiaoyubu, (24 March 2017), available at: http://www.moe.gov.cn/srcsite/A06/s7053/201704/t20170406_301981.html (accessed 16 January 2019).

Table 3. Share of 15 to 17 year olds with some high school attainment by urban-rural residency (or hukou) status and type of high school

Year	MOE-reported statistics (columns 1–5)					Micro-Census data (columns 6–10)				
	All	Urban	Rural	AH	VET	All	Urban	Rural	AH	VET
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
2005	53	91	43	32	21	53	90	43	32	21
2006	60	98	51	35	25	54	88	46	31	23
2007	66	100	57	37	29	56	87	48	31	25
2008	74	100	64	40	34	59	89	51	32	27
2009	79	100	69	42	38	64	98	56	33	31
2010	83	100	73	43	40	70	100	62	37	33
2011	84	100	76	44	40	73	100	66	38	35
2012	85	100	78	46	39	74	100	69	40	34
2013	86	100	80	48	38	75	98	70	42	33
2014	87	100	82	50	37	78 ^a	98	74	47	31
2015	87	100	83	51	36	80 ^a	97	77	47	33

Data Sources: MOE reports, 2005–2015; Micro-Census, 2015

Notes: The high school attainment rates in 2014 and 2015 are based on the 2015 Micro-Census, obtained by taking the average annual change in high school attainment from 2009 to 2013 and adding the average annual change to the 2013 high school attainment rate. The high school attainment rate in 2015 is calculated the same way by using years 2010 to 2014. We estimate the 2014 and 2015 numbers because it is possible that in these years there were still individuals that were 15–17 that were still in junior high school and would not enter high school until 2016. Please see more details on the calculation in Online Supplementary.

shown in the next section, the share of youth who do not attend high school poses a significant challenge to China improving its human capital, particularly because these children belong to one sub-group of its population in particular: those from rural areas.

Future challenges to raising China's human capital

Sharp increases in attainment rates are evidence that China has made significant strides in the direction of universal high school education since 2005. Despite this accomplishment, China still faces three challenges that might hinder it from raising its human capital in the future. This section examines these three challenges. First, as noted in above, there remains a significant share of 15 to 17 year olds, anywhere from 13% to 20% depending on the data set, who do not attend high school. This section will show are predominately from rural areas. Second, a significant number of rural youth that now attend high school are attending vocational education and training schools. In this section, we will show that there are concerns with the quality of education in many VET schools, especially in rural areas. Finally, for China's rural youth to be ready to attend high school and successfully learn, dramatic improvements must be made to overcome disadvantages in health, nutrition and early childhood development that rural children experience compared to their urban counterparts.

Challenges of increasing high school quantity

In considering how China will meet its goal of making education universal, a question naturally arises: which students are not attending high school? To answer this question, this sub-section looks at MOE-reported data and Micro-Census data to examine whether or not a disparity in attainment rates exists between urban and rural students. However, since neither of these datasets included breakdowns of attainment rates by residency status, urban-rural ratio estimates are taken from the China Family Panel Survey (CFPS), which reports each individual's Hukou (or residence registration) status. These data are shown in Table 3.

The data show that the remaining problem of low high school attainment is concentrated in the rural areas of China. According to both data sources (MOE and Micro-Census), virtually 100% of students with urban Hukou are attending high school. In fact, the rates of high school attainment of urban China are higher than those reported for the United States and Germany.²² The same is not true for students with rural Hukou. The MOE data show that 83% of rural 15–17 year olds attended high school, while the Micro-Census data report that number to be 77%. In simplest terms, the gap between urban and rural high school attainment rates means that for China to achieve universal high school attainment, effort must be targeted at getting the rest of China's rural youth into high school.

While rural high school attainment rates are low relative to those of urban youth, it does not mean that there has not been success in the past decades in raising the high school participation rates of rural youth. In fact, the record of increase in the rate of rural participation appears to be quite remarkable. The percentage of rural students attending high school in 2005 was only 43%. Considering that the 2015 rates are 83% (according to the MOE) and 77% (according to the Micro-Census), respectively, that means that the percentage of rural 15–17 year olds attending high school has increased between 34 (77–43%) and 40 (83–43%) percentage points in the last ten years! This surge is much higher than the rise in urban attendance. Therefore, even though there is still an urban-rural gap in high school attainment, that gap narrowed significantly between 2005 and 2015.

Challenges of increasing high school quality

Another question that arises pertains to the second aspect of education discussed in the introduction of this paper is whether the students who attend high school are actually learning? This question of educational quality is just as important as that of educational quantity in determining whether or not China's youth are learning the relevant and advanced skills and knowledge they need to succeed in a high-wage, high-skill economy.

Under the presumption that VET schools are not providing rural students with all of the skills they need to succeed, this sub-section now examines what percentage of the overall increase in attainment rates since 2005 are due to increases in VET enrolment (See more details on the assumptions in Online Supplementary). From Table 3, when looking at the MOE data, it is clear that trends in attainment rates in both academic high schools (AH) and VET schools have contributed to the overall rise in high school attainment rates. In 2005, 32% of individuals between 15 and 17 years old attended AH. During the same year, 21% of this age cohort attended VET. In other words, of the 53% of individuals that were in high school in this year, 60% (32 divided by 53) were in AH. The MOE data then reflect that between 2005 and 2015, more than half of the rise in high school attainment (19 percentage points of the 34 percentage points) came from the increase in AH school attainment rates. While the rise in VET was marginally lower (15 percentage points), because the baseline percentage was lower, the share of the rise that was from VET was still considerable and the share nearly doubled (from 21 to 36%).

To the extent that the assumptions about the relative and absolute quality of AH and VET hold true, this means that the rise in quality of China's high school level education is both strong and weak at the same time. On the one hand, assuming that AH is providing high-quality instruction, there are literally millions more children that are learning higher levels of math and science, computers, critical thinking and foreign language (skills that will be necessary for the labour force in the coming decades) than ever before. On the other hand, since VET also contributes to a large portion of the increase in high school attainment, there appears to be a share of rural high school students that might not be learning the skills they need in the future.

²²OECD, 'Education at a Glance 2018: OECD Indicators', *OECD Publishing*, (11 September 2018), available at: <https://www.oecd-ilibrary.org/docserver/eag-2018-en.pdf?expires=1547621929&id=id&accname=guest&checksum=A885D1B9D334620D4A3159B67ABB13F0> (accessed 16 January 2019); Please note that the data we use for the US and Germany have several differences from the data we use for China, which we obtained from different sources. The US and Germany data reflect rates of current school enrollment (instead of rates of having ever attended high school). In addition, these rates are for youth aged 15–19 instead of youth aged 15–17.

Where it all begins: early developmental and health issues in rural China

This sub-section examines the third challenge that may prevent China from increasing the human capital of rural children which is whether these students are simply unable to learn due to problems they encounter early on in their childhood and primary school years. To further examine this argument, this sub-section will discuss three sets of problems that are undermining the human capital of rural China's youth in three different stages of rural growth: developmental delays in infants (ages 0–3), anaemia in young children of preschool age (ages 4–6), and poor vision and intestinal worms among primary school students (ages 7–12).

Developmental delays (ages 0–3)

Early childhood development (ECD) has long-lasting effects into adulthood. Previous studies have shown the healthy development of infants and toddlers to have a direct influence on later life outcomes, such as higher levels of educational attainment, employment and income.²³ Children who are developmentally delayed, on the other hand, are more likely to place greater a burden on society, including higher rates of welfare and unemployment, higher propensities to participate in crime, and a higher likelihood of teen pregnancies.²⁴ One would expect those that are developmentally delayed as children to both have lower levels of educational attainment and have a lower ability to learn when they are in school. Overall, findings in both developed and developing countries show that malnutrition, poor health and the lack of interactive parenting investments are factors that are systematically associated with developmental delays in infants.²⁵

This sub-section reports the results of a large-scale survey of developmental delays using the Bayley Scales of Infant and Toddler Development (BSID), a widely used ECD test that measures infant development across four different areas: cognition, language, social-emotional development, and motor skills (fine and gross). Measures of developmental outcomes come from samples of randomly chosen infants and toddlers aged 24–36 months from four major rural sub-populations in

²³ Flavio Cunha and James J. Heckman, 'The Economics and Psychology of Inequality and Human Development', *Journal of the European Economic Association*, 7(2–3), (2009), pp. 320–364; James J. Heckman, Seong Hyeok Moon, Rodrigo Pinto, Peter A. Savelyev and Adam Yavitz, 'The Rate of Return to the HighScope Perry Preschool Program', *Journal of Public Economics* 94 (1–2), (2010), pp. 114–128; Orazio Attanasio, Sarah Cattani, Emla Fitzsimons, Costas Meghir, and Marta Rubio-Codina, 'Estimating the Production Function for Human Capital: Results from a Randomized Control Trial in Colombia', *National Bureau of Economic Research Working Paper Series* no. w20965, (2015); Lawrence J. Schweinhart, *The High/Scope Perry Preschool Study Through Age 40: Summary Conclusion, and Frequently Asked Questions*, (Michigan: High/Scope, 2004), pp. 1–6; Eric I. Knudsen, James J. Heckman, Judy L. Cameron and Jack P. Shonkoff, 'Economic Neurobiological, and Behavioral Perspectives on Building America's Future Workforce', *Proceedings of the National Academy of Sciences* 103(27), (2006), pp. 10,155–10,162.

²⁴ James J. Heckman et al., 'The Rate of Return to the HighScope Perry Preschool Program', *Journal of Public Economics* 94(1–2), (2010), pp.114–128; Susan P. Walker, Theodore D. Wachs, Sally Grantham-McGregor, Maureen M. Black, Charles A. Nelson, Sandra L. Huffman, Helen Baker-Henningham, Susan M. Chang, Jene D. Hamadani, Betsy Lozoff, Julie M. Meeks Gardner, Christine A. Powell and Linda Richter, 'Inequality of Early Childhood: Risk and Protective Factors for Early Child Development', *The Lancet* 378(9799), (2011), pp. 1325–1338; Paul Gertler, James J. Heckman, Rodrigo Pinto, Arianna Zanolini, Christel Vermeersch, Susan Walker, Susan M. Chang and Sally Grantham-McGregor, 'Labor Market Returns to an Early Childhood Stimulation Intervention in Jamaica', *Science*, 344(6187), (2014), pp. 998–1001; Anthony B. Atkinson and John Micklewright, 'Unemployment Compensation and Labor Market Transitions: A Critical Review', *Journal of Economic Literature* 29(4), (1991), pp. 1679–1727.

²⁵ Eric I. Knudsen et al., 'Economic Neurobiological, and Behavioral Perspectives on Building America's Future Workforce', *Proceedings of the National Academy of Sciences* 103(27), (2006), pp. 10,155–10,162.; Sophie H. Eickman, Ana C. Lima, Miriam Q. Guerra, Marilia C. Lima, Pedro I. Lira, Sharon R. Huttly and Ann Ashworth, 'Improved Cognitive and Motor Development in a Community-Based Intervention of Psychosocial Stimulation in Northeast Brazil', *Developmental Medicine and Child Neurology*, 45(8), (2003), pp. 536–541; Orazio Attanasio et al., 'Estimating the Production Function for Human Capital: Results from a Randomized Control Trial in Colombia', *National Bureau of Economic Research Working Paper Series* no. w20965, (2015); Sally Grantham-McGregor, Yin Bun Cheung, Santiago Cueto, Paul Glewwe, Linda Richter, Barbara Strupp and the International Child Development Steering Group, 'Development Potential in the First 5 Years for Children in Developing Countries', *The Lancet* 369(9555), (2007), pp. 60–70; Fath L. Parker, Alison Y. Boak, Kenneth W. Griffin, Carol Ripple and Lenore Peay, 'Parent-Child Relationship, Home Learning Environment, and School Readiness', *School Psychology Review* 28 (3), (1999), pp. 413–425; Committee on Early Childhood Pedagogy, *Eager to Learn: Educating our Preschoolers*, Eds. Barbara T. Bowman, M. Suzanne Donovan and M. Susan Burns. (Washington DC: National Academies Press, 2000), pp. 1–18.

China. These include western China rural communities; resettlement migration villages (locations to where families were relocated from more impoverished rural areas as a method of poverty reduction); central China rural communities; and migrant communities (made up by rural residents who moved to urban areas for work). In total, these four sub-populations together make up approximately 69% (26% in western rural communities + 29% in central rural communities + 13% in migrant communities + 1% in resettlement villages) of all rural infants and toddlers in China, and approximately 49% of all of China's 0–3 year olds.

Early developmental delays in cognition, language, motor, and social-emotional skills are defined as Bayley scores less than 1 standard deviation below the mean. Technically, the delay of children in rural China is defined by comparing them to US peers of the same age.²⁶ Studies that conducted BSID on toddlers of urban China show the proportions of early developmental delay ranges from 5 to 16%, which is close to the rate of developmental delay in the US.²⁷

Table 4 shows that rates of developmental delays among infants and toddlers in the four sub-populations are high. Across all measures of development, these rates exceed the normal rate that should be expected in a healthy population (15%).²⁸ Overall, 50% of infants and toddlers suffer from cognitive delays. Infants and toddlers in the western rural communities are the worst off (73%), followed by those in central rural communities (51%), resettlement migration villages (50%), and migrant communities (41%).

Social-emotional delays are even higher. Across the full sample, 58% of infants and toddlers have delayed social-emotional skills. Once again, the highest rate, 68%, is in the western rural communities. Resettlement migration villages have the second-highest rate (61%), followed by central rural communities (58%) and migrant communities (53%). This means that over half of infants and toddlers in each of the four sub-communities have delayed social-emotional skills.

Language delays were less prevalent than cognitive and social-emotional delays, though these were more than twice the normal rate found in a healthy population. Thirty-three percent (33%) of the sample suffered from some kind of language delay. Despite the high rates of delays across the other three indices, motor delays in these communities were not high in comparison to rates in healthy populations. Nonetheless, these results reaffirm that there is a large urban-rural gap in terms of early childhood development in China.

Anaemia (ages 3–6)

The literature has found strong links between subpar nutrition and poor cognitive and schooling outcomes.²⁹ Due to inadequate feeding practices, children who live in the poorest regions of developing countries often do not have appropriate diets in terms of micronutrients and

²⁶Craig A. Albers and Adam J. Grieve, 'Test review: Bayley, N.(2006). Bayley scales of infant and toddler development—third edition. San Antonio, TX: Harcourt assessment' *Journal of Psychoeducational Assessment* 25(2), (2007), pp. 180–190.

²⁷Songmin Xie, Xianyan Wang and Yingmin Yao, 'Beili Yingyouer Fazhan Liangbiao Zai Yingyouer Baojian Zhong de Zuoyong' ['The application of Bayley Scales of Infant Development in infant nursing'] *Hulixuebao [Journal of Nursing (China)]* 13(4), (2006), pp. 76–77; Man Xu et al., 'Shaanxi Guanzhong Nongcun Yingyouer Zhili Yundong Fayushiping yu Yingxiangyinsu Fenxi' ['The Analysis of Infant's Mental and Motor Development Level and Influencing Factors in the Countryside of Shaanxi Province'], *Xi'an Jiaotong Daxue Xuebao (Yixueban) [Journal of Xi'an Jiaotong University (Medical Sciences)]* 30(2), (2009), pp. 181–184; Xiaomian Sun, Yonghui Ren and Zuyou Su, 'Bayley Yingyouer Fayu Liangbiao de Yanjiu' ['Study on Bayley Scales of Infant Development'], *Zhongguo Fuyou Baojian [Maternal and Child Health Care of China]* 11, (1996), pp. 51–53; Shuhua Shi, Junxin Shi, Xuhua Guan, Jing Zhang, Meirong Hu and Xiaotian Qi, 'Yingyouer Fazhanzhuangtai ji Nengli Yingxiang Yinsu de Yanjiu' ['Analysis of influential factors of infant development'], *Zhongguo Fuyou Baojian [Maternal and Child Health Care of China]* 16, (2001), pp. 635–637.

²⁸Craig A. Albers and Adam J. Grieve, 'Test review: Bayley, N.(2006). Bayley scales of infant and toddler development—third edition. San Antonio, TX: Harcourt assessment' *Journal of Psychoeducational Assessment* 25(2), (2007), pp. 180–190.

²⁹Jere R. Behrman, 'The Impact of Health and Nutrition on Education', *The World Bank Research Observer* 11(1), (1996), pp. 23–37; Christine A. Powell et al., 'Nutrition and Education: A Randomized Trial of the Effects of Breakfast in Rural Primary School Children', *American Journal of Clinical Nutrition* 68(4), (1998), pp. 873–879; Paul Glewwe, Hanan G. Jacoby and Elizabeth M. King, 'Early Childhood Nutrition and Academic Achievement: A longitudinal Analysis', *Journal of Public Economics* 81(3), (2001), pp. 345–368.

Table 4. Developmental outcomes of infants and toddlers aged 24 to 36 months

	Full sample	Western China rural communities	Resettlement migration villages	Central China rural communities	Migrant Communities
Cognitive delay (1 = yes)	0.50 (0.50)	0.73 (0.45)	0.50 (0.50)	0.51 (0.50)	0.41 (0.50)
Language delay (1 = yes)	0.33 (0.47)	0.52 (0.50)	0.39 (0.49)	0.35 (0.48)	0.20 (0.40)
Social-emotional delay (1 = yes)	0.58 (0.49)	0.68 (0.47)	0.61 (0.49)	0.58 (0.50)	0.53 (0.50)
Motor delay (1 = yes)	0.13 (0.34)	0.13 (0.34)	0.21 (0.41)	0.14 (0.35)	0.10 (0.30)
Any one type of delay (1 = yes)	0.77 (0.42)	0.90 (0.30)	0.81 (0.40)	0.78 (0.41)	0.67 (0.47)
Any of two types of delay (1 = yes)	0.48 (0.50)	0.69 (0.46)	0.55 (0.50)	0.49 (0.50)	0.39 (0.49)
Any of three types of delay (1 = yes)	0.23 (0.42)	0.38 (0.49)	0.27 (0.45)	0.25 (0.43)	0.14 (0.35)
Four types of delay (1 = yes)	0.06 (0.23)	0.08 (0.28)	0.08 (0.27)	0.06 (0.24)	0.04 (0.19)
Observations	372	165	62	65	80

Data Source: Authors' survey

Notes: This paper calculates overall summary statistics using sampling weights for each observation. The proportions for each subpopulation in rural China are 37.7% for western China rural communities, 1.4% for resettlement migration villages, 42.0% for central China rural communities and 18.8% for migrant communities. We calculate the sampling weights using the following formula: sampling weight = proportion of subpopulation in total population/proportion of subpopulation in sample. The subpopulation proportions in the sample are the following: 86.0% for western China rural communities, 4.0% for resettlement migration villages, 3.8% for central China rural communities, and 6.1% for migrant communities. Therefore, the sampling weight is 0.44 for western China rural communities (equivalent to 37.3%/86%), 0.35 for resettlement migration villages (equivalent to 1.4%/4%), 11.1 for central China rural communities (equivalent to 42%/3.8%), and 3.08 for migrant communities (equivalent to 18.8%/6.1%).

macronutrients.³⁰ Similar results have been repeated for rural China's young children.³¹ The inadequate intake of micronutrients results in high rates of iron-deficiency anaemia among these children, which can have long-lasting detrimental effects on neurodevelopment.³² This sub-section uses both child anaemia status and anthropometric data, including wasting, underweight status, and stunting acquired through surveys in June 2017 to assess the nutritional status of approximately 1,500 children aged 3 to 6 years old in rural areas of western China.

³⁰ Reynaldo Martorell, 'The Nature of Child Malnutrition and its Long-term Implications', *Food and Nutrition Bulletin* 20(3), (1999), pp. 288–292; Susan P. Walker, Theodore D. Wachs, Julie Meeks Gardner, Betsy Lazoff, Gail A. Wasserman, Ernesto Pollitt, Julie A. Carter and the International Child Development Steering Group, 'Child Development: Risk Factors for Adverse Outcomes in Developing Countries', *The Lancet* 369(9556), (2007), pp. 145–157.

³¹ Xiaoliang Yang, Rongwei Ye, Junchi Zheng, Lei Jin, Jianmeng Liu and Aiguo Ren, 'Zhongguo 21 Xian (Shi) 3–6 Sui Ertong Pinxie yu Tige Fayu de Guanxi Yanjiu' ['The relationship Between Anemia and Physical Development Among Children at the Ages of 3–6 Years in 21 Counties of China'], *Weishengyanjiu [Journal of Hygiene Research]* 38(6), (2009), pp. 688–691; Ke Chen, Xuan Zhang, Ting-Yu. Li, Li Chen, Ping Qu and You-Xue Liu, 'Co-Assessment of Iron, Vitamin A, and Growth Status to Investigate Anemia in Preschool Children in Suburb Chongqing, China', *World Journal of Pediatrics* 5(4), (2009), pp. 275–281; Yan Li, Guangping Guo, Anping Shi, Yuping Li, Tokie Anne and Hiroshi Ushijima, 'Prevalence and correlates of malnutrition among children in rural minority areas of China', *Pediatrics International*, 41(5), (1999), pp. 549–556; Xiaoyan Wang, '3–7 Sui Ertong Yingyangxing Quetixing Pinxie Diaocha Tongjifenxi' ['Survey and Analysis of Nutritional Iron Deficiency Anemia in Children Aged 3–7'], *Zhongguo Xiandai Yisheng [China Modern Doctor]* 47(3), (2009), pp. 114–114.

³² Robert D. Baker and Frank R. Greer, 'Diagnosis and Prevention of Iron Deficiency and Iron-Deficiency Anemia in Infants and Young Children (0–3 Years of Age)', *Pediatrics* 126(5), (2010), pp. 1040–1050; Jill S. Halterman, Jeffrey M. Kaczorowski, C. Andrew Aligne, Peggy Auinger and Peter G. Szilagyi, 'Iron Deficiency and Cognitive Achievement Among School-Aged Children and Adolescents in the United States', *Pediatrics* 107(6), (2001), pp. 1381–1386; A. G. Soemantri, Ernesto Pollitt, Insun Kim, 'Iron Deficiency Anemia and Educational Achievement', *The American Journal of Clinical Nutrition* 42(6), (2009), pp. 1221–1228; Sally Grantham-McGregor and Cornilius Ani, 'A Review of Studies on the Effect of Iron Deficiency on Cognitive Development in Children', *The Journal of Nutrition* 131(2), (2001), pp. 649S–668S.

Table 5. Health outcomes of children aged 3 to 6 year olds

	Prevalence (%)	Observations
Anaemia	18.05	1,490
Stunting	2.30	1,525
Underweight	1.97	1,521
Wasting	3.83	1,516

Data Source: Authors' survey. The data were collected in June 2017, covering 187 villages, 404 towns, and 11 counties of three prefectures in rural areas of western province.

Table 5 shows that 18% of the sample was anaemic. This rate is in line with those reported in several previous studies, which have found the anaemia rates of 3- to 6-year-old children in rural China to be 19% and 24%. This rate, however, is much higher than rates found in developed countries like the United States, where the prevalence among similarly aged children have been found to be as low as 3%.³³

Fortunately, however, data also indicate that the vast majority of rural toddlers do not suffer from macronutrient deficiencies (which is reflected by low rates of stunting, being underweight, and wasting across the sample). A small minority showed any of these indicators of malnourishment: stunted children accounted for approximately 2% of the sample, as did underweight children. Wasted infants made up about 4% of the sample.

Poor vision and intestinal worms (ages 6–12)

In addition to issues during early childhood that inhibit the cognitive capabilities of rural youth such as developmental delays and poor nutrition, poor vision and intestinal parasites also hinder these children from succeeding academically. Table 6 summarises several studies that have been conducted across China related to vision problems among primary school-aged children, revealing that a substantial percentage of these children are visually impaired, and only a small minority wear corrective lenses. The prevalence of poor vision among the different samples ranged from 9% to 46%. Of these, between 15 and 28% of them wore corrective lenses. This means that 15–35% of children in these samples cannot see clearly and do not wear corrective lenses. These studies echo the results of previous studies conducted in rural China, showing that reduced vision due to uncorrected myopia is indeed a public health problem among school-aged children.³⁴

Next, Table 7 highlights the high prevalence of soil-transmitted helminthes (STH) among primary school-aged children in rural China. The results show that 42% of 2,240 sample

³³Xiaoliang Yang et al., 'Zhongguo 21 Xian (Shi) 3–6 Sui Ertong Pinxie yu Tige Fayu de Guanxi Yanjiu' ['The relationship Between Anemia and Physical Development Among Children at the Ages of 3–6 Years in 21 Counties of China'], *Weishengyanjiu [Journal of Hygiene Research]* 38(6), (2009), pp. 688–691; Ke Chen et al., 'Co-Assessment of Iron, Vitamin A, and Growth Status to Investigate Anemia in Preschool Children in Suburb Chongqing, China', *World Journal of Pediatrics* 5(4), (2009), pp. 275–281; Chi Huu Hong Le, 'The Prevalence of Anemia and Moderate-Severe Anemia in the US Population', *PLoS ONE* 11(11), (2016), pp. e166635.

³⁴Mingguang He, Wenyong Huang, Yingfeng Zheng, Li Huang and Leon B. Ellwein, 'Refractive Error and Visual Impairment in School Children in Rural Southern China', *Ophthalmology* 114(2), (2007), pp. 374–382; Mingguang He, Junwen Zheng, Yizhi Liu, Jingjing Xu, Gopal P. Pokharel and Leon B. Ellwein, 'Refractive Error and Visual Impairment in Urban Children in Southern California', *Investigative Ophthalmology & Visual Science* 45(3), (2004), pp. 793–799; Liping Li, Yue Song, Xiaojian Liu, Bei Lu, Kai Choi, Dennis S. Lam, Mingzhi Zhang, Mingwei Zheng, Yunfei Wang, Abhishek Sharma and Nathan Congdon, 'Spectacle Acceptance Among Secondary School Students in Rural China: The Xichang Pediatric Refractive Error Study (X-Pres)- report 5', *Investigative Ophthalmology & Visual Science* 49(7), (2008), pp. 2895–2902; Nathan Congdon, Yunfei Wang, Yue Song, Kai Choi, Mingzhi Zhang, Zhongxia Zhou, Zhengling Xie, Liping Li, Xueyu Liu, Abhishek Sharma, Bin Wu and Dennis S. Lam, 'Visual Disability, Visual Function, and Myopia Among Rural Chinese Secondary School Children: The Xichang Pediatric Refractive Error Study (X-Pres)', *Investigative Ophthalmology & Visual Science* 49(7), (2008), pp. 2888–2894; Paul Glewwe, Albert Park and Meng Zhao, 'A better vision for development: Eyeglasses and academic performance in rural primary schools in China', *Journal of Development Economics* 122, (2016), pp. 170–182; Emily Hannum and Yuping Zhang, 'Poverty and proximate barriers to learning: Vision deficiencies, vision correction and educational outcomes in rural Northwest China', *World Development* 40(9), (2012), pp. 1912–1931.

Table 6. Poor vision of rural students in China.

Study	Prevalence ^a	Corrected (Share of Those with Poor Vision that Have Glasses)	Age/Grade	Sample
1 ^a	24%	15%	9–12 years old Grades 4 and 5	19,934 students in rural schools of northwestern provinces
2 ^b	27%	23%	10–12 years old Grade 5	4,225 students in migrant schools of eastern coastal provinces
3 ^c	9%	12%	mean 10.6 years Grades 4 and 5	10,234 students in rural schools of southwestern and southeastern provinces
4 ^d	46%	28%	10–12 years old Grades 4–6	2,613 students in western rural schools

Notes: ^aThe definition of poor vision is uncorrected visual acuity $\leq 6/12$ in either eye.

^aXiaochen Ma, Zhongqiang Zhou, Hongmei Yi, Xiaopeng Pang, Yaojiang Shi, Qianyun Chen, Mirjam E. Meltze, Saskia Le Cessie, Mingguang He, Scott Rozelle, Yizhi Liu and Nathan Congdon, 'Effect of Providing Free Glasses on Children's Educational Outcomes in China: Cluster Randomized Controlled Trial', *BMJ* 349, (2014), pp. g5740.

^bXiuqin Wang, Hongmei Yi, Lina Lu, Linxiu Zhang, Xiaochen Ma, Ling Jin, Haiqing Zhang, Kavin S. Naidoo, Hasan Minto, Haidong Zou, Scott Rozelle and Nathan Congdon, 'Population Prevalence of Need for Spectacles and Spectacle Ownership Among Urban Migrant Children in Eastern China', *JAMA Ophthalmology* 133(12), (2015), pp. 399–1406.

^cXiuqin Wang et al., 'Cluster-Randomized Controlled Trial of the Effects of Free Glasses on Purchase of Children's Glasses in China: The PRICE (Potentiating Rural Investment in Children's Eyecare) Study', *PLoS ONE* 12(11), (2017), pp. e0187808.

^dYue Ma, Nathan Congdon, Yaojiang Shi, Ruth Hogg, Alexis Medina, Matthew Boswell, Scott Rozelle and Mony Lyer, 'Effect of a Local Vision Care Center on Eyeglasses Use and School Performance in Rural China', *JAMA Ophthalmology* 136(7), (2018), pp. 731–737.

children in seven of the poorest counties in a southwestern province were infected by some kind of STH infection at baseline. Thirteen percent of the total sample was co-infected with two kinds of STH. These findings reflect the results of other recent studies, which found the rate of prevalence to be 37–42%.³⁵ Like the case of myopic children, STH-infected children cannot maximise their learning in school and have worse health, cognitive, and schooling outcomes.³⁶

³⁵Yue Shang, 'Woguo Ertong Zhuyao Tuyuanxing Xianchongbing Jibingfudan Yanjiu' ['Burden of Diseases on Soil-Transmitted Helminth Infections Among School-age Children in China'] (Boshi Xuwei Lunwen, National Institute of Parasitic Diseases, Chinese Center for Disease Control and Prevention, 2011) (PhD diss., National Institute of Parasitic Diseases, Chinese Center for Disease Control and Prevention, 2011); Chengfang Liu, Louise Lu, Linxiu Zhang, Rrenfu Luo, Sean Sylvia, Alexis Medina, Scott Rozelle, Darvin Scott Smith, Yingdan Chen and Tingjun Zhu, 'Effect of Deworming on Indices of Health, Cognition, and Education Among Schoolchildren in Rural China: A Cluster-Randomized Controlled Trial', *American Journal of Tropical Medicine and Hygiene* 96(6), (2017), pp. 1478–1489; Chengfang Liu, Renfu Luo, Hongmei Yi, Linxiu Zhang, Shaoping Li, Yunli Bai, Alexis Medina, Scott Rozelle, Scott Smith, Guofei Wang and Jujun Wang, 'Soil-Transmitted Helminths in Southwestern China: A Cross Sectional Study of Links to Cognitive Ability, Nutrition, and School Performance Among Children', *PLoS Neglected Tropical Diseases* 9(6), (2015), pp. e0003877.

³⁶Yue Shang, 'Woguo Ertong Zhuyao Tuyuanxing Xianchongbing Jibingfudan Yanjiu' ['Burden of Diseases on Soil-Transmitted Helminth Infections Among School-age Children in China'] (Boshi Xuwei Lunwen, National Institute of Parasitic Diseases, Chinese Center for Disease Control and Prevention, 2011) (PhD diss., National Institute of Parasitic Diseases, Chinese Center for Disease Control and Prevention, 2011); Xiuqin Wang, Nathan Congdon, Yue Ma, Min Hu, Yuan Zhou, Weiqi Liao, Ling Jin, Baixiang Xiao, Xiaoyi Wu, Ming Ni, Hongmei Yi, Yiwei Huang, Beatrice Varga, Hong Zhang, Yongkang Cun, Xianshun Li, Luhua Yang, Chaoguang Liang, Wan Huang, Scott Rozelle, Xiaochen Ma, 'Cluster-Randomized Controlled Trial of the Effects of Free Glasses on Purchase of Children's Glasses in China: The PRICE (Potentiating Rural Investment in Children's Eyecare) Study', *PLoS One* 12(11), (2017), pp. e0187808; Chengfang Liu et al., 'Soil-Transmitted Helminths in Southwestern China: A Cross Sectional Study of Links to Cognitive Ability, Nutrition, and School Performance Among Children', *PLoS Neglected Tropical Diseases* 9(6), (2015), pp. e0003877.

Discussion and conclusion

This paper has shown that China's low level of labour force human capital lags behind that of other middle-income countries and prevents it from transitioning to high-income status. Using high school attainment rates to represent human capital, China is far from reaching the threshold necessary to graduate to high-income status. As of 2015 only 30% of China's workforce has attended high school, which is less than half that of high-income nations overall. This rate is even less than the average among middle-income countries (36%), placing China behind other middle-income nations status such as Turkey, Mexico, and Indonesia.

However, the low level of China's labour force human capital does not mean that the current government has not been committed to raising human capital in recent years. On the contrary, between 2005 and 2015, the overall high school attainment rate increased significantly, from 53 to 87% according to the MOE (a rise of 64%) or from 53 to 80% according to the Micro-Census (a rise of 51%). That means that in only a decade, China was able to put literally tens of millions of more students into high school.

In addition to looking at China's recent achievements in raising its human capital, this paper also explored the remaining challenges that China faces in trying to accumulate human capital to one day facilitate the nation's transition to a high-income economy. First, although high school attainment rates have improved considerably since 2005, 13 to 20% of the nation's youth still do not attend high school. This problem chiefly lies in rural areas.

Besides an urban-rural gap in high school educational quantity, a gap in quality also exists. Because much of the increase in high school attainment among rural youth over the past decade is due to the expansion of vocational education and training schools (VET), it is unclear whether some students attending high school are actually learning as much as they could. Previous literature has also shown that a large share of poor-quality VET schools lies in rural areas, meaning that many rural students may not be learning as much as they could if the quality of VET schools were improved.

Finally, rural students also encounter a host of problems much earlier in life, including high rates of developmental delays during infancy and toddlerhood, which prevents them from succeeding academically and professionally. Among a sample of infants and toddlers 24–36 months old across four major rural subpopulations (which altogether represent 69% of all of rural China), 50% had cognitive delays, 33% suffered from language delays, and 58% exhibited social-emotional delays.

In addition to developmental delays, nutritional and health problems also prevent rural Chinese youth from maximising their potential. High anaemia rates among four to six year olds indicate that young children in the countryside do not have adequate diets. Surveys also show that of students with poor vision, only between 15 and 28% of them wore corrective lenses. Meanwhile, 42% of rural children in surveys conducted by the research team are infected by soil-transmitted helminths. The existing literature has shown that these nutritional and health issues can significantly impair the ability of rural youth to succeed in school and in life.

Despite the clear barriers that rural youth face in achieving the same levels of educational success as their urban counterparts, recent empirical research has shown that simple and cost-effective interventions early in life could improve outcomes for these children. One recent study conducted in rural China found that providing weekly training to rural parents in interactive parenting practices significantly increased the cognitive development outcomes of children in the treatment group, reflecting the results of similar studies in other developing countries.³⁷ Another RCT conducted in rural China showed that providing children with chewable vitamins

³⁷Sean Sylvia, Nele Warrinnier, Renfu Luo, Ai Yue, Orazio Attanasio, Alexis Medina, Scott Rozelle, 'From Quantity to Quality: Delivering a Home-Based Parenting Intervention Through China's Family Planning Cadres', *LICOS Center For Institutions and Economic Performance Discussion Paper Series*, (2018); Orazio P. Attanasio, Camila Fernandez, Emla O. A. Fitzsimons, Sally M. Grantham-McGregor, Costas Meghir and Marta Rubio-Codina, 'Using the Infrastructure of a Conditional Cash Transfer Program to Deliver a Scalable Integrated Early Child Development Program in Colombia: Cluster Randomized Control Trial', *BMJ* 349, (2014), pp. g5785; Sally M. Grantham-McGregor, Christine A. Powell, Susan. P. Walker and John H. Himes, 'Nutritional Supplementation, Psychological Stimulation, and Mental Development of Stunted Children: The Jamaican Study', *The Lancet* 338(8758), (1991), pp. 1–5.

Table 7. Soil-transmitted helminth infection of rural students.⁴¹

Infection prevalence	Prevalence
Any soil-transmitted helminth infection (%)	41.86
Ascaris infection (%)	30.79
Trichuris infection (%)	23.82
Hookworm infection (%)	0.87
Ascaris and Trichuris coinfection (%)	12.95
Infection intensity (among samples with positive infection)	
Ascaris infection (epg)	895.83
Trichuris infection (epg)	63.80
Hookworm infection (epg)	17.66

has been shown to both increase haemoglobin levels and improve math test scores.³⁸ A third study discovered that providing free glasses and teacher incentives maintained classroom wear of spectacles in the large majority of vision-impaired children over a school year when compared to a control group.³⁹ Finally, distributing a 400-mg dose of albendazole accompanied with educational training about STH infection and prevention significantly reduced parasite infection among school-aged children in a fourth study, conducted in Guizhou province.⁴⁰ Simple interventions like these could be the key to affording rural children the chance to start off on the right foot and maximise their success in the classroom.

This paper has shown that China must significantly raise its level of human capital if it wishes to attain high-income status. Although China has made great strides in increasing the share of rural youth attending high school over the past decade, rural youth still lag behind urban youth in terms of high school attainment rates, the quality of education in VET schools, and early childhood developmental and health outcomes. China will need to pay more attention to these areas if it wishes to increase the human capital of its youth and prepare them to become productive citizens in the future.

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³⁸Max Kleiman-Weiner, Renfu Luo, Linxiu Zhang, Yaojiang Shi, Alexis Medina and Scott Rozelle, 'Eggs Versus Chewable Vitamins: Which Intervention can Increase Nutrition and Test Scores in Rural China', *China Economic Review* 24, (2013), pp. 165–176.

³⁹Yue Ma, Yujuan Guo, Yue Wang, Haoyang Li, Lina Ma, Jiangchao Jing, Yaojiang Shi, Hongyu Guan and Nathan Congdon, 'Impact of a Local Vision Care Center on Glasses Use and School Performance in Rural China', *International Journal of Environment Research and Public Health* 15(12), (2018), pp. 2783.

⁴⁰Chengfang Liu et al., 'Effect of Deworming on Indices of Health, Cognition, and Education Among Schoolchildren in Rural China: A Cluster-Randomized Controlled Trial', *American Journal of Tropical Medicine and Hygiene* 96(6), (2017), pp. 1478–1489.

⁴¹Chengfang Liu et al., 'Effect of Deworming on Indices of Health, Cognition, and Education Among Schoolchildren in Rural China: A Cluster-Randomized Controlled Trial', *American Journal of Tropical Medicine and Hygiene* 96(6), (2017), pp. 1478–1489.

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