GROWING AND SLOWING DOWN LIKE CHINA

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Abstract
This article is based on the presidential address delivered at the EEA Annual Congress 2016. It discusses China's institutional and economic transformation through the lens of the model of growth and convergence developed in Acemoglu, Aghion, and Zilibotti (JEEA 2006), which emphasizes the dichotomy between investment- and innovation-led growth. The economic reforms introduced in the 1980s and 1990s have enabled the Chinese economy to grow at historically unprecedented rates through fostering investment, reallocation, and technology adoption from abroad. The Chinese stimulus package introduced in 2008 appears to have prolonged the longevity of China's investment-driven growth beyond its optimal point. Over the last decade, China has activated the engine of innovation-led growth. The article discusses the virtues and limits of such ongoing transition, based on research in progress using firm-level data on R&D and productivity growth. Finally, it provides an appraisal of the institutional and policy reforms that are necessary for China to continue on its path of rapid convergence. (JEL: H54, O11, O16, O25, O32, O33, O53)

1. Introduction

Over the past four decades, China has transformed from a poor, closed economy to one of the major economic players in the world. China has surpassed the United States regarding the total PPP-adjusted GDP in the year 2014.[1] In terms of international

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1. See IMF estimates from the World Economic Outlook Database (April 2016) and Penn World Tables 9.0. PPP stands for Purchasing Power Parity.

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trade, it is today's world's largest exporter, outranking the United States, Germany, and Japan, which were the three largest exporters back in the year 2000. Further, China has massively reduced its poverty rate within 30 years. The fraction of the population with a daily income of less than $1.90 was almost 90% in the 1980s. By 2012, this number fell to 6.5%.[2]

The institutional framework that enabled such stellar growth was introduced in the early 1980s, when the launch of economic reforms paved the way for China's rapid increase in production and productivity. Since then, China's GDP per capita is rapidly converging to that of OECD countries, reaching 27% of the U.S. level in 2016. This convergence accelerated during the first decade of the 21st century, when China grew at unprecedented annual rates close to 10%.

With a reported official growth rate of 6.7% in 2016, the present-day convergence rate of China remains high.[3] Nevertheless, the speed of convergence has subsided since 2011, and the declining trend in growth rates is forecasted to persist in coming years. In part, this slowdown is to be expected, and in line with the prediction of standard theories of growth and convergence (see, among others, Solow 1956; Barro and Sala-i-Martin 1997; Howitt 2000). However, China has also experienced a sharp drop in total factor productivity (TFP) growth, which suggests that problems may be deeper. After years of a fast build-up of capital stock, today China faces a severe excess capacity issue in heavy industries, such as the cement or steel sector. Recent years have also been marked by growing apprehension for the housing market and the country's financial stability. With turbulences in the stock market and a boom in public and private debt, the Chinese economy is raising questions about the sustainability of its fast-converging trajectory.

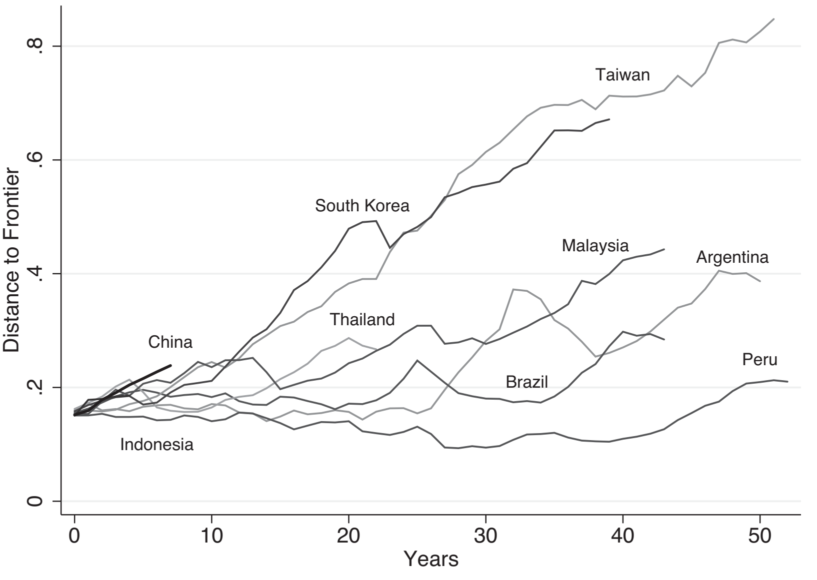
Middle-Income Traps. The possibility that China's economic success may end abruptly and that the country may fall into a middle-income trap is the subject of widespread speculation. Empirically, the concept of middle-income traps is elusive. There is no consensus among researchers about its definition and measurement. Eichengreen, Park, and Shin (2012, 2013) argue that the risky zone lies at an absolute GDP per capita level of around $16,500 in constant 2005 USD.[4] Since the entire world income distribution is shifting upward over time, an absolute threshold is difficult to rationalize. Before the British industrial revolution, for instance, countries were stuck at a much lower stationary income per capita level. A more plausible view is that, if such a

2. See World Bank Open Data (2016).

3. China's official data are often questioned. A thorough discussion of the issue is beyond the scope of this article. Although imperfect and susceptible (especially at the local level) of manipulation, Chinese statistics are broadly informative. For instance, in Alder, Shao, and Zilibotti (2016), discussed below, we use nighttime light data and find them to be highly correlated with official statistics at the city level. Many studies discussed in this article are based on micro firm-level data. The sources are referred as I go along.

4. These authors argue that slowdowns are typically associated with high growth in the earlier period, an ageing population, very high investment ratios, and undervalued exchange rates, all features that have been evoked in the case of China.

FIGURE 1. Growth trajectory of selected emerging economies.

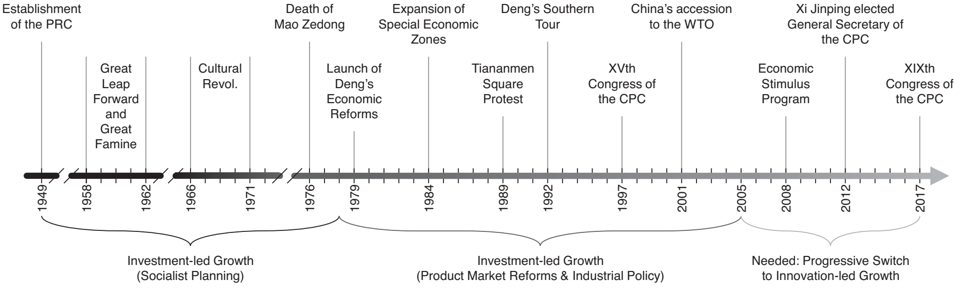


Note: $t = 0$ is the first year in which the GDP p.c. relative to the United States is larger or equal to that of China in 2007 (15%). The data is from Penn World Tables 9.0. The construction of the figure follows the approach in Aiyar et al. (2013).

threshold exists, it is defined in relative rather than in absolute terms: many developing economies get thrown off their high-growth trajectories as they approach 25%–30% of the world technology frontier, which is approximately where China stands today. Coherent with this view, Figure 1 shows the trajectory of nine emerging countries starting from the year in which their GDP per capita relative to the United States was past 0.15 for the first time, approximately China's situation in 2007. Thereafter, although South Korea and Taiwan continued to converge fast for forty years or longer, the other emerging economies experienced a slow down. This is especially remarkable in Latin American countries such as Argentina, Brazil, and Peru, but also occurred in Indonesia, Malaysia, and Thailand.

The experience of other emerging economies suggests that China may have reached a critical juncture. Will its economy follow the successful path of South Korea and Taiwan? Or will it loose steam and settle down at some middle-income level? In this article, I attempt to cast some light on these questions with the aid of economic theory and international evidence. My overarching hypothesis (whose theoretical underpinnings are discussed in Section 2) is that the process of technological and income convergence of emerging economies goes through two distinct stages. In the first stage, when the economy is far from the technology frontier, the main growth engines are physical capital investments, the imitation of more productive foreign technologies, and the reallocation of resources from less to more productive activities (e.g., industrialization). Industrial policy and other government policies can foster

FIGURE 2. Timeline with milestones of China's economic development.



Note: The dark gray color indicates the development stage in which the economy can grow fast through investment-led growth; the gray color indicates the development stage in which the economy necessitates to switch to innovation-led growth. The black color indicates the prereform period.

growth at this stage. In the second stage, when the economy has come closer to the technology frontier, it must switch on a new engine: innovation. At this stage, the government must introduce market-oriented reforms that slash anti-competitive barriers and let the cream rise to the top, that is, favor the selection of the best firms and entrepreneurs.

The Timeline of Events. Figure 2 illustrates a timeline of past events in China that played an important role in the light of my hypothesis. The black-colored line indicates a period of investment-led growth, whereas the line turns gray in the region where my hypothesis indicates that the economy would benefit from activating innovation-led growth. The first stage of economic convergence started under Mao Zedong. When established in 1949, the People's Republic of China was a very impoverished rural economy. Recent research discussed in Section 3.1 shows that even the misguided and erratic policies implemented between 1949 and 1979 could sustain some economic growth. However, China's progress remained significantly below its potential, due to rampant inefficiencies of socialist planning and to the country's isolation from the rest of the world.

The turning point was December 1978, which marked the start of market-oriented economic reforms under the aegis of Deng Xiaoping. Deng's path of implementing economic reforms without democratizing the country met some opposition in the party and in society, leading to dramatic conflicts in the late 1980s. Yet, in 1992 Deng's celebrated Southern tour ended uncertainty by affirming the irreversible commitment to promarket reforms. This event paved the way for the most important economic reforms that were introduced under Jiang Zemin's leadership: the pension reform, the housing market reform, and, most of all, a large-scale privatization of the industrial sector promoted by the 15th Congress of the Communist Party. The market economy retained many special characteristics that make today's China very different from Western capitalism (see Section 3.2). These include a strong direct presence of the state in the production activity and vigorous industrial policies (e.g., the Special Economic

Zones) aimed at promoting investments and technology adoption in specific regions and industries, and at favoring the export sector. After China's WTO accession in 2001, the pace of economic reforms subsided under the leadership of Hu Jintao (2002–2012). Yet, Hu's China could capitalize on previous reforms and attain the fastest economic growth ever experienced by modern China.

In the second half of the first decade of the Millennium, China was in the upper end of middle-income countries. At that development stage, further growth necessitates switching on the innovation engine. To what extent has this happened or is this happening? I answer this question in the second part of Section 3 and in Section 4. On the one hand, the Chinese economy significantly increased its investment in innovative activities, as can be witnessed from the boom of R&D investments, whose share of GDP is comparable today with the European Union average. On the other hand, the ongoing transformation has some ambiguous features. My analysis points at two main issues. First, the stimulus package enacted by the State Council in November 2008 appears to have reinvigorated investment-led growth by granting a renewed key role to state actors (Section 3.3). Second, the transition is subject to severe politicoeconomic constraints that are difficult to overcome within the current Chinese institutional framework. Consistent with this concern, some research in progress discussed in Section 4.3 (König et al. 2017) suggests that the boom of R&D expenditure likely hides significant inefficiencies and misallocation that limit the productivity of innovation-oriented investments. Resolving these contradictions may be critical for China to be able to sustain its full convergence and not to get stuck in a middle-income trap, especially in the face of growing uncertainties about the future of world international trade.

The rest of the article is structured as follows: Section 2 introduces a theory of investment-led and innovation-led growth and presents international evidence that supports the predictions of the theory. Section 3 discusses the sources of investment-led growth in China. Section 4 discusses China's transition to innovation-led growth. Section 5 concludes.

2. Distance to Frontier and Economic Growth

Acemoglu, Aghion, and Zilibotti (2006)—henceforth AAZ—develop a theory where throughout the course of a nation's economic development, different engines of growth become salient at different stages. At an earlier stage, when the country is far away from the technology frontier, high growth is attained by an investment-led strategy, whose cornerstones are physical capital investments, reallocation, and structural change that improve the allocation of productive resources across firms and sectors, and technological convergence through the imitation and adoption of foreign technologies. At this stage, economic growth may be aided by government interventions that selectively support some geographical areas or national champions in order to promote rapid capital accumulation and technology adoption. These discriminatory policies also have a cost, as they impose barriers on entry, thereby limiting the selection of the most productive firms and of the more able managers and entrepreneurs. However, in an environment characterized by large intertemporal wedges and market failures, benefits often outweigh costs. The high incumbency premia alleviate coordination problems and help overcome credit market and contractual frictions.

However, as an economy approaches the world technology frontier, policies that served to promote high investments eventually become a burden for sustaining further development. As the simpler technologies are adopted, imitation and the scope for further technology adoption fade away; the return to investment falls. The benefits of policies supporting insiders start fading. At this juncture, the focus on physical capital accumulation gives way to the importance of human capital and innovation.[5] New policies and institutions are called for, which aim at promoting entry, churning, and creative destruction in the economy through leveling the playing field competition. Rather than simply channeling savings to existing firms through bank intermediation, the priority becomes to create the conditions for financing innovation, for example, by strengthening investor protection and reducing entry costs for startup firms. Innovation-led growth flourishes under policies that curb corruption, promote appropriate institutions, and increase economic and political competition.

2.1. Theory

This section provides a sketch of the formal model in AAZ. Readers uninterested in the technical analysis can skip this subsection and move to the empirical Section 2.2.

The crux of the theory is the following equation describing the law of motion of technical progress in economies that are converging to the technology frontier:

$$A(\nu,t) = \underbrace{\eta(\nu,t)\,\bar{A}(t-1)}_{\text{imitation}} + \underbrace{\gamma(\nu,t)\,A(t-1)}_{\text{innovation}} + \varepsilon(\nu,t). \tag{1}$$

Here, $A(\nu, t)$ denotes the TFP of firm ν at time t; $A(t) \equiv \int_0^1 A(\nu,t)\,d\nu$ is the average country-level TFP; and $\bar{A}(t)$ is the TFP at the world technology frontier, which is assumed to be growing at the exogenous rate g. The terms $\eta(\nu,t)\,\bar{A}(t-1)$ and $\gamma(\nu, t)A(t-1)$ capture, respectively, TFP growth coming from imitation/adoption and innovation/adaptation. The term $\varepsilon(\nu, t)$ is a random variable with zero mean, capturing differences in innovation performance across firms (or sectors). The firm-specific terms $\eta(\nu, t)$ and $\gamma(\nu, t)$ depend, respectively, on the firm's investment potential and on the entrepreneur's skill. These terms play a crucial role and are discussed in detail below. Note that all firms are assumed to start every period from the same state of knowledge $A(t-1)$. This assumption simplifies the analysis. In König, Lorenz, and Zilibotti

5. Galor and Moav (2004) argue that a similar sequence characterizes the Industrial Revolution in Western Europe: physical capital accumulation was initially important but was later replaced by human capital accumulation as the prime engine of economic growth. However, their mechanism is different. They focus on frontier economies, whereas we focus on the process of convergence to the frontier of developing and emerging countries.

(2016), we consider a richer model where the knowledge base is firm-specific, that is, $A(\nu, t-1)$ replaces $A(t-1)$. That model is more realistic and is the host of additional predictions but is also more complicated insofar as it features endogenous dynamics of the distribution of TFP. The simplifying assumption introduced in (1) makes the model more tractable by abstracting from distributional complications.

We define $a\,(t) \equiv A\,(t)\,/\,\bar{A}\,(t)$ as the aggregate measure of the country's *proximity to the technology frontier* at t. Integrating (1) over ν and dividing both sides by $\bar{A}\,(t)$ (recalling that $\bar{A}$ grows at the exogenous rate g) yields

$$a\,(t) = \frac{1}{1+g}(\eta\,(t) + \gamma\,(t)\,a\,(t-1)), \tag{2}$$

where $\eta(t)$ and $\gamma(t)$ are the economy-wide averages of $\eta(\nu, t)$ and $\gamma(\nu, t)$, respectively. As long as $\gamma > 1 + g$, this difference equation implies that the economy converges fully to the frontier ($a = 1$).

In the fully microfounded model in AAZ, firms are run by overlapping generations of entrepreneurs who live for two periods and are endowed with heterogeneous abilities. A proportion π of entrepreneurs have a high ability, whereas a proportion $1 - \pi$ of them have a low ability. Whether a particular entrepreneur is of high or low ability is unknown at birth but becomes (fully) revealed by the entrepreneur's performance in the first period of her life. The total measure of firms and active entrepreneurs is assumed to be constant over time. Entrepreneurs maximize the firms' present discounted profits within their life horizons. TFP evolves according to equation (1). Entrepreneurs are credit-constrained. The constraints are more binding for young entrepreneurs who have no wealth, whereas old entrepreneurs can use their retained earnings to relax credit constraints and to finance larger investment projects. This means that old firms (i.e., firms run by old entrepreneurs) are larger.

Investments are assumed to be the carriers of technology adoption, thus larger investments imply both more production and faster TFP growth through imitation. More formally, because the investment potential depends on age (as discussed above), young firms have $\eta(\nu, t) = \eta_L$, whereas old firms attain $\eta(\nu, t) = \eta_H > \eta_L$. Innovation is assumed to be independent of firm size and to hinge instead on the entrepreneur's innate ability. More formally, $\gamma(\nu, t) = \gamma_L$ for firms run by low-ability entrepreneurs, and $\gamma(\nu, t) = \gamma_H > \gamma_L$ for firms run by high-ability entrepreneurs.

In a first-best world without credit constraints, all firms would run large investment projects, that is, $\eta(t) = \eta_H$. The selection would work as follows: young entrepreneurs of unknown ability are assigned to firms; then, entrepreneurs who proved to be of high ability would be retained, whereas low-ability ones would be replaced by young entrepreneurs. Thus,

$$\gamma\,(t) = \left(\underbrace{\frac{1}{2} + \frac{1}{2}(1-\pi)}_{\text{measure young firms}}\right) \times \left(\pi\gamma_H + (1-\pi)\,\gamma_L\right) + \underbrace{\frac{\pi}{2}}_{\text{measure old firms}} \times \gamma_H \equiv \bar{\gamma}.$$

In the first best, TFP growth stemming from both innovation and imitation is maximized.

Because young entrepreneurs are credit-constrained, the first best cannot be attained, and a trade-off between innovation and imitation arises. Two different contractual arrangements are possible in the decentralized equilibrium. In one such arrangement (*investment-led growth*), all incumbent entrepreneurs are retained until death. Thus, half of the firm population is young and small, and half is old and large: $\eta(t) = \bar{\eta} \equiv (\eta_H + \eta_L)/2$. Ability equals the unconditional average ability of entrepreneurs in the population: $\gamma(t) = \underline{\gamma} \equiv \pi\gamma_H + (1-\pi)\gamma_L$. This arrangement minimizes the effect of credit constraints at the cost of a worse selection of firms. In the other arrangement (*innovation-led growth*), only high-skill entrepreneurs are retained as in the first best. High selection implies that $\gamma(t) = \bar{\gamma}$. However, this comes at the cost of a smaller average firm size due to the fact that a larger proportion of firms is young. More formally, $\eta(t) = \underline{\eta}$, where

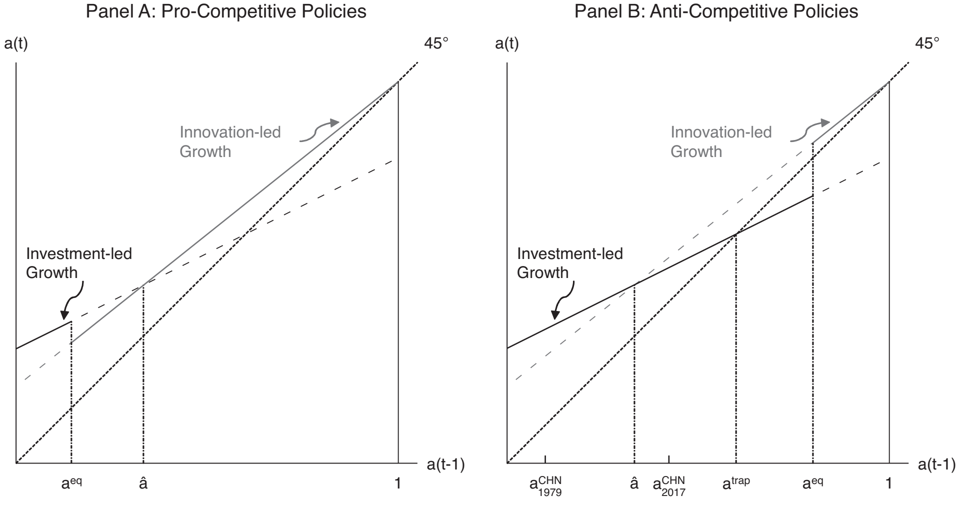
$$\underline{\eta} \equiv \left(\underbrace{\frac{1}{2} + \frac{1}{2}(1-\pi)}_{\text{measure young firms}} \right) \times \eta_L + \underbrace{\frac{\pi}{2}}_{\text{measure old firms}} \times \eta_H .$$

To sum up, in an equilibrium with investment-led growth, firms are on average older and run larger projects. This yields more imitation, that is, a higher η. Conversely, with innovation-led growth, firms are on average younger, and only the best ones survive. However, young entrepreneurs are more heavily financially constrained, implying lower investments. This equilibrium features more churning, selection, and innovation, that is, a higher γ. Equation (2) implies that the importance of innovation for TFP growth increases as an economy approaches the technology frontier. This creates a comparative advantage of imitation (innovation) at earlier (later) stages of the process of technology convergence.

To see this comparative advantage more formally, define $\hat{a} \equiv (\bar{\eta} - \underline{\eta})/(\bar{\gamma} - \underline{\gamma}) \in (0,1)$. Then, Figure 3 shows that, for all $a(t-1) < \hat{a}$, growth is maximized under investment-led growth, whereas for all $a(t-1) > \hat{a}$, growth is maximized under innovation-led growth. If one assumes, in addition, that $g \equiv \underline{\eta} + \bar{\gamma} - 1$, then innovation-led growth delivers full convergence to the technology frontier.

Which regime (or sequence of regimes) is chosen in a decentralized equilibrium hinges on the optimal contractual arrangement between firms and financiers, which is discussed in detail in AAZ. Here, I summarize the results. The equilibrium follows the same sequence as the growth-maximizing policy: far from the technology frontier, the economy embarks onto an investment-led growth trajectory; then, at some point, denoted by a^{eq} in the figure, the economy switches into innovation-led growth. Generically, a^{eq} is different from $\hat{a}$. Because of the interplay of different frictions, a^{eq} can be lower or higher than $\hat{a}$. The resolution of this ambiguity is affected by policy. In countries adopting procompetitive policies (as in Panel A of Figure 3), incumbent firms' profits are lower, implying a small incumbency advantage in credit

FIGURE 3. AAZ model: comparison between two policy regimes.



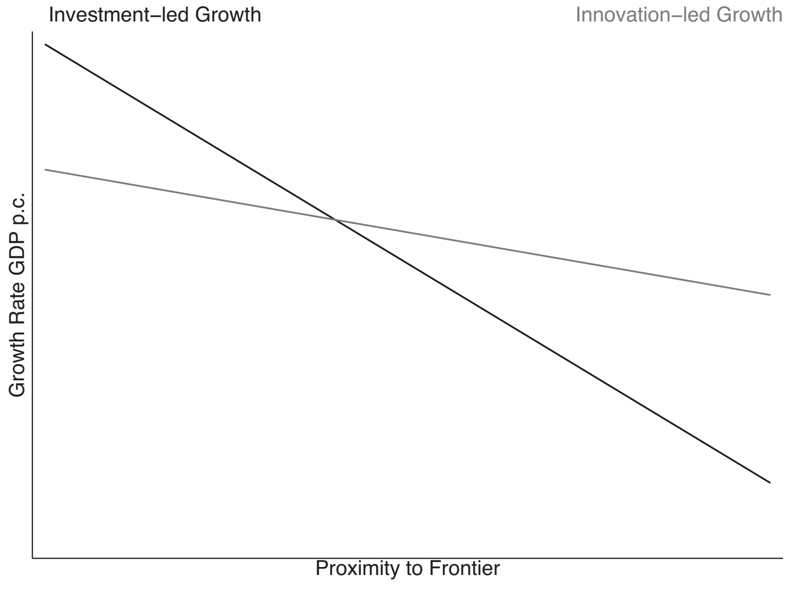
Note: The left panel shows the case of an economy that does not maximize growth at an earlier stage of development because of the lack of support to insider firms. The right panel shows the case of an economy that does not maximize growth at a later stage of development because of anticompetitive policies, and gets stuck in a middle-income trap (a^{trap}).

markets. Then, a^{eq} is typically lower than $\hat{a}$. These economies experience growth rates below their potential in the range $a \in [a^{eq}, \hat{a}]$, due to large credit market wedges. In contrast, countries adopting and retaining vigorous industrial policies that impose barriers to entry grant large advantages to incumbents. In these countries, a^{eq} tends to be higher than $\hat{a}$, as in the case represented in Panel B of Figure 3. In this case, the growth rate falls below its potential when $a \in [\hat{a}, a^{eq}]$. Worse than that, the economy fails to converge to the frontier and gets stuck in a middle-income trap, denoted by a^{trap}.

More generally, the theory predicts that countries adopting industrial policies or other anti-competitive measures may grow fast at an early stage of development. However, if they fail to reform these policies in order to promote selection at a later stage, they risk a sharp growth slowdown and possibly fall into middle-income traps. Figure 4 delivers the same information as Figure 3 but emphasizes the relationship between growth rates and proximity to frontier. At earlier stages of development, countries adopting an investment-led growth strategy may even grow faster. However, sticking to an investment-led growth strategy for too long harms growth at a later development stage.[6] This is the prediction that is compared with the international empirical evidence in the next section.

6. Figure 4 shows neither the region of low *a*s where all economies choose the investment-led strategy nor the region of high *a*s where all economies choose the innovation-led strategy. Instead, it focuses on the intermediate range of *a*s where countries with a procompetitive policy choose innovation-led growth whereas countries with an anticompetitive policy choose investment-led growth.

FIGURE 4. Growth and proximity to frontier.



Note: The figure shows the prediction of the theory for the growth rates of two economies that, because of different policy regimes, follow an investment-led (black) and an innovation-led (gray) growth strategy, respectively.

2.2. *International Evidence*

Using a sample of nonfrontier countries (i.e., non-OECD countries and countries that only joined the OECD in the 1990s), AAZ show that economies in which firms face high barriers to entry perform well if they are far away from the technology frontier. However, close to the technology frontier (measured by the GDP per worker relative to the United States), growth is faster in countries whose institutions promote a level playing field competition through low barriers to entry. In AAZ, countries are classified into having high or low barriers to entry according to the "number of procedures to open a new business" variable from Djankov et al. (2002). The panel regression estimated in AAZ then takes the following form:

$$g_{i,t} = \alpha_{0,HB} HB_i + \alpha_{0,LB} LB_i + \alpha_{1,HB} \left(\frac{y_{i,t-1}}{y_{\text{U.S.},t-1}} \times HB_i \right) + \alpha_{1,LB} \left(\frac{y_{i,t-1}}{y_{\text{U.S.},t-1}} \times LB_i \right) + d_i + f_t + \varepsilon_{i,t}, \quad (3)$$

where the dependent variable is a country's GDP per worker growth between $t-1$ and t (one period being a five-year interval). The independent variables include a dummy for high and low entry barriers each, the proximity to the frontier for high- and low-barrier countries at the beginning of the time interval, as well as a full set of country and time fixed effects. Estimating this equation yields a coefficient $\alpha_{1,HB}$ that is significantly more negative than $\alpha_{1,LB}$. High-barrier countries may converge at a faster speed while they are far from the frontier (although the difference in the estimated coefficients is not estimated precisely) but experience substantially slower convergence as they approach the technological leader.

We also consider an alternative specification with a continuous interaction:

$$g_{i,t} = \beta_0 + \beta_1 B_i + \beta_2 \frac{y_{i,t-1}}{y_{\mathrm{U.S.},t-1}} + \beta_3 \left(\frac{y_{i,t-1}}{y_{\mathrm{US},t-1}} \times B_i \right) + d_i + f_t + \varepsilon_{i,t}, \qquad (4)$$

where B_i is a continuous measure of barriers to entry. We find a negative estimate of β_3, indicating a more negative effect of barriers as economies approach the technology frontier.[7]

Building on AAZ, I use more recent data to show that the pattern documented in AAZ is robust. In addition, I consider the effect of alternative institutional variables that should play a role according to the theory. I focus on a sample of non-OECD countries using data between 1965 and 2014.[8] The regression specifications are the analogs of equations (3) and (4), featuring three different institutional characteristics (and a longer time span) in place of the barrier measure used in AAZ.[9] Specifically, I consider a different measure of barriers to market entry, an index of corruption, and R&D expenditure as a share of GDP. The following discusses each of the three measures used in our estimation and presents the main results.

Barriers to Market Entry. To start with, I consider entry barriers. Figure 5 shows graphically how growth rates decline with the proximity to the technology frontier for high- and low-barrier countries.[10] Countries are classified according to the World Bank variable "total number of procedures required to register a firm" from the World Bank

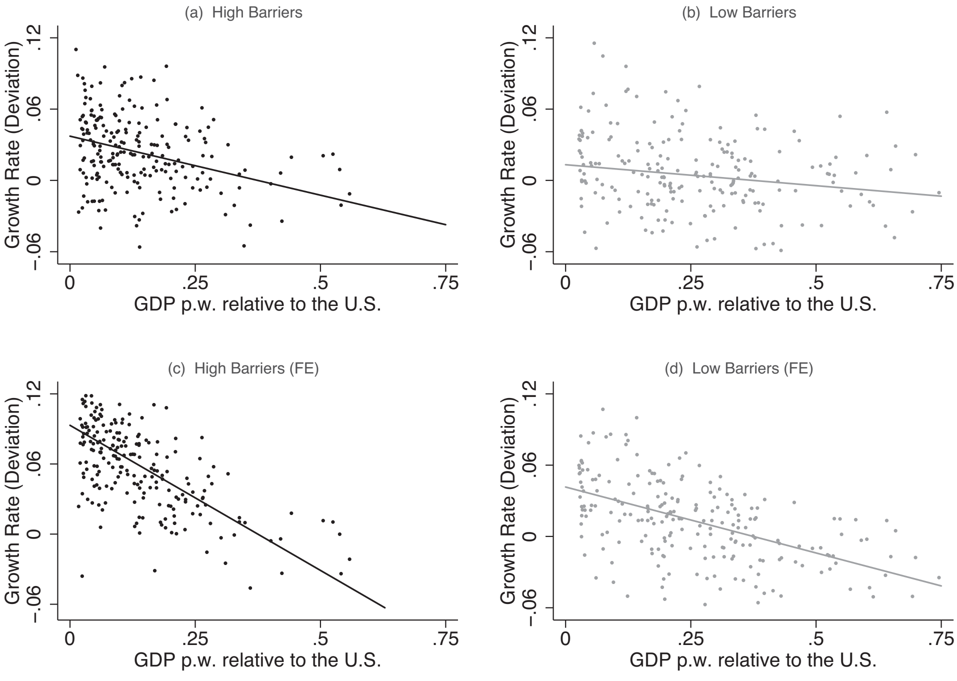
7. Vandenbussche, Aghion, and Meghir (2006) detect a similar pattern in human capital intensity and composition. In particular, they find that high-skill human capital labor (measured by the number of years of tertiary education) has a higher growth-enhancing effect closer to the technology frontier, suggesting that as economies become more innovation- and knowledge-based, the endowment of highly educated workers (rather than the average human capital) becomes essential to sustaining high growth.

8. The sample comprises 43 non-OECD countries plus Chile, Israel, Korea, and Mexico, which are today OECD members but joined after 1993 and are therefore regarded as emerging economies. The selection is based on the focus of the theory on nonfrontier economies, although most results are robust to the inclusion of OECD economies. The data on GDP per worker are from Penn World Tables 9.0. Data on education, which is included as a control variable in certain specifications, are from the Barro and Lee Educational Attainment Dataset.

9. Like in AAZ, the institutional measures are considered to be time invariant in the estimation. This important limitation stems from data constraints: there is limited time variation for these measures, and data is generally only available for recent years. More precisely, the measure of barriers to entry is only available since 2004, the corruption index since 1995, and the R&D measure since 1996. Even for the recent years, the data are incomplete. Therefore, I rely on country averages. All results must be interpreted as correlations rather than causal effects.

10. This figure should be compared with Figure 4. High-barrier countries are countries that insist on investment-led growth, whereas low-barrier countries are countries that opt for more innovation-led growth.

FIGURE 5. Growth and proximity to frontier in countries with high and low barriers to market entry.



Note: The upper panel shows the correlation between growth and proximity to frontier after subtracting a group fixed effect for sub-Saharan African countries, broken down by above- and below-median barriers. The lower panel shows the correlation between growth and proximity to frontier after subtracting country fixed effects, broken down by above- and below-median barriers.

Doing Business Project (2004–2016).[11] This measure is a proxy for the hurdle required by an entrepreneur to be able to start a new business, and hence for the protection incumbents receive in an economy. If administrative barriers make it harder for new companies to enter the market, competition and creative destruction are low. High-barrier countries therefore tend to pursue investment- rather than innovation-driven growth. As they approach the technology frontier, the scope of investment-driven growth diminishes, and convergence slows down.

The estimation results for Equation (3) are shown in the top panel of Table 1, which reports the coefficients of interest $\alpha_{1,HB}$ and $\alpha_{1,LB}$. Columns (1) and (2) include a group fixed effect for sub-Saharan African countries, whereas columns (3), (4), and (5) control for a full set of country fixed effects. Accordingly, the top panel of Figure 5 plots GDP per worker growth net of the estimated group fixed effect, whereas the bottom panel of Figure 5 plots GDP per worker growth net of the estimated country

11. The World Bank now reports this measure broken down for men and women. For ease of comparison, I report the measure for men. The results are unchanged if one takes the average between men and women.

TABLE 1. Growth, proximity to frontier, and barriers to market entry.

	(1)	(2)	(3)	(4)	(5)
	OLS			IV	
	Panel A (1965–2014): Dep. variable is growth rate of GDP per worker Measure: World Bank Barriers				
Proximity × high barriers	−0.094	−0.079	−0.243	−0.513	−0.297
	(0.024)	(0.015)	(0.058)	(0.082)	(0.070)
Proximity × low barriers	−0.040	−0.048	−0.116	−0.140	−0.141
	(0.013)	(0.018)	(0.025)	(0.033)	(0.027)
P-value diff. int. coef.	0.040	0.122	0.047	0.000	0.039
Country FE	NO	NO	YES	YES	YES
Contr. for education	NO	YES	NO	NO	YES
Number of obs.	456	423	456	414	384
R-sqr	0.30	0.38	0.25	0.15	0.21
	Panel B (1965–2014): Dep. variable is growth rate of GDP per worker Measure: World Bank Barriers				
Barriers	−0.000	−0.000			
	(0.001)	(0.001)			
Proximity	−0.014	−0.015	−0.087	−0.105	−0.097
	(0.019)	(0.022)	(0.050)	(0.059)	(0.048)
Proximity P barriers	−0.005	−0.005	−0.007	−0.012	−0.008
	(0.003)	(0.003)	(0.007)	(0.008)	(0.006)
Country FE	NO	NO	YES	YES	YES
Contr. for education	NO	YES	NO	NO	YES
Number of obs.	456	423	456	444	413
R-sqr	0.15	0.19	0.24	0.16	0.20

Notes: Standard errors are in parentheses. The dependent variable is the average growth rate of GDP per worker for five-year intervals (1965–1970, 1970–1975, ..., 2005–2010). The last interval covers four years (2010–2014). The independent variable proximity to frontier is the ratio of the country's GDP per worker to the GDP per worker in the United States, both calculated at the beginning of each period. The independent variable barriers in Panel B is each country's average for the World Bank variable "procedures required to register a new firm" over all years between 2004 and 2016. The independent variable high barriers (low barriers), which is interacted with proximity to frontier in Panel A, is a dummy variable taking the value one for countries with a procedure number larger or equal to the median value for all countries, and zero if smaller. The control variable for education is the average years of schooling in the male population over 25 at the beginning of each period. Standard errors are clustered in Columns (1) and (2). All columns include time fixed effects. Columns (1) and (2) include a dummy for sub-Saharan Africa. In Panel A, Columns (4) and (5), the interactions between proximity to frontier and the dummy for high and low barriers are instrumented using one-period lags of the same variables. In Panel B, Columns (4) and (5), both the main effect of the proximity to frontier and its interaction with barriers are instrumented using one-period lags of the same variables.

fixed effects.[12] Visually, one can see that the slope coefficients of the regression lines in the left panels are significantly more negative than those in the corresponding right

12. The figures and the regression tables display the effects of barriers, corruption, and R&D intensity on convergence, as measured by the *slope* of the regression lines displayed in the figures. Because of the country (or group) fixed effects and time dummies, the levels are not informative (the growth rates in the three figures are normalized for visual convenience).

panels, indicating that the growth performance deteriorates faster as economies with high barriers approach the technology frontier. Following AAZ, the last two columns in Panel A of Table 1 are based on an IV approach, where proximity to frontier is instrumented by its one-period lag. Finally, columns (2) and (5) control for education. The relationship between proximity to frontier and growth is in most cases significantly more negative for high-barrier than for low-barrier countries.

In Panel B of Table 1, I follow the specification in (4) with a continuous measure of barriers, interacted directly with proximity to frontier. In particular, B_i stands for the number of procedures necessary to open a new business in country i. The coefficient of interest, β_3, is always negative (although marginally statistically insignificant). This confirms that growth is lower in high-barrier countries when these are close to the technology frontier.

Corruption. As a second indicator for the discriminatory support that insider firms receive, I consider a measure of corruption. I measure corruption with the Corruption Perceptions Index by Transparency International.[13] This index describes the perceived level of corruption in a country's public sector. In part, such a measure captures general rent extraction from bureaucrats that depresses growth irrespective of the stage of development (see, e.g., Mauro 1995). However, I also expect it to be correlated with special privileges accorded by the bureaucracy to connected firms, which preclude level playing field conditions. As such, corruption acts as a barrier to free competition. As I discuss below, China is the primary example of a country where a high tolerance for corruption has allowed connected firms and local politicians to share the rents generated by local protection. Section 3 below argues that this system of local monopolies may have actually promoted rather than deterred investments.

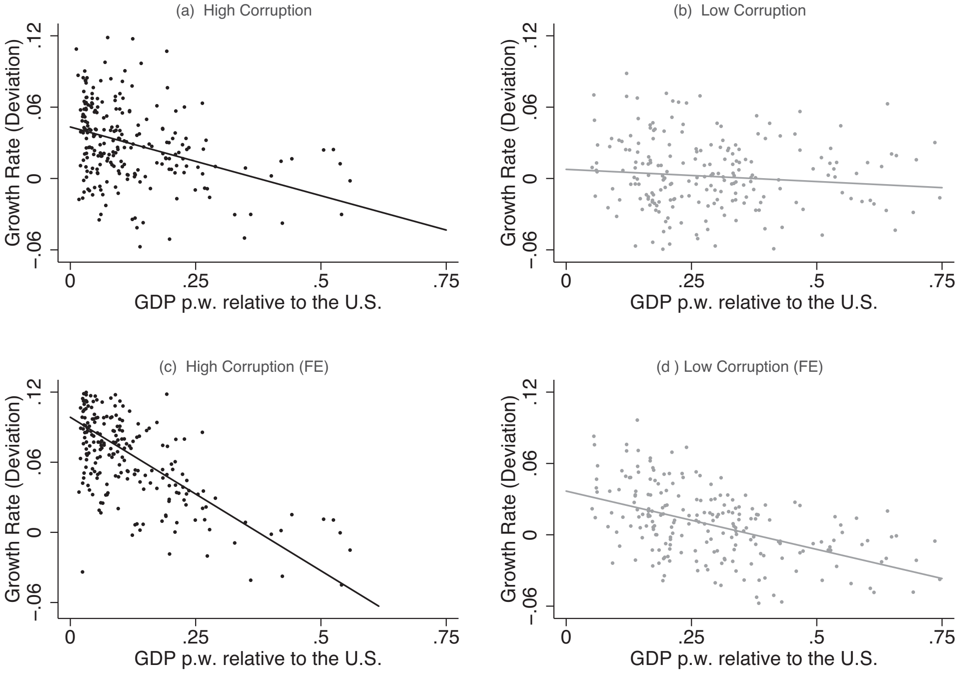
Consistent with the prediction of AAZ, Figure 6 shows that the effect of corruption is similar to that of administrative barriers to market entry: the performance of countries with high levels of corruption deteriorates significantly faster as they approach the technology frontier. In contrast, the convergence effect (i.e., the decline in the growth rate) is milder in low-corruption countries.

The results are confirmed by the regression analysis in Table 2, which is the analog of Table 1. In all specifications of Panels A and B, the coefficients have the expected pattern. All coefficients in Panel A are highly significant, whereas in Panel B the pooled regressions yield marginally insignificant coefficients, which turn highly significant when country fixed effect are included.

The analysis thus far suggests that as countries approach the world technology frontier, their growth process benefits from reforms reducing barriers to market entry and corruption. AAZ also predicts that middle-income countries should ignite the engine of innovation. With this motivation, I now proceed to investigate the correlation

13. The Corruption Perceptions Index assigns high values for clean countries and low values for corrupt countries (i.e., it is an inverse measure of corruption). For ease of interpretation, in the estimation we use the negative of this index, so that high values correspond to corrupt countries, whereas low values correspond to clean countries.

FIGURE 6. Growth and proximity to frontier in countries with high and low corruption.



Note: The upper panel shows the correlation between growth and proximity to frontier after subtracting a group fixed effect for sub-Saharan African countries, broken down by above- and below-median corruption. The lower panel shows the correlation between growth and proximity to frontier after subtracting country fixed effects, broken down by above- and below-median corruption.

between R&D intensity (a standard proxy for the innovative investment activity) and growth at different stages of the convergence process.[14]

R&D Expenditure. I measure the propensity to innovate by R&D expenditure as a percentage of GDP (source: World Bank, based on UNESCO). Although this is an outcome variable, the theory in AAZ postulates that R&D intensity is affected by policy and institutional arrangements (level playing field competition, subsidies to R&D, etc.). As Figure 7 shows, low R&D intensity is accompanied by a faster deterioration of the growth performance as countries approach the technology frontier. In contrast, the slowdown of the convergence process is far less accentuated in countries with a high R&D intensity.

Panel A of Table 3 confirms the results of the figure in terms of both the sign ($\alpha_{1,HB}$ is smaller than $\alpha_{1,LB}$) and the statistical significance of the relationships. The results in Panel B are more ambiguous. In the pooled regressions without country fixed

14. Clearly, in this case the potential endogeneity of R&D is a very severe concern. In all cases, I interpret the evidence as correlation.

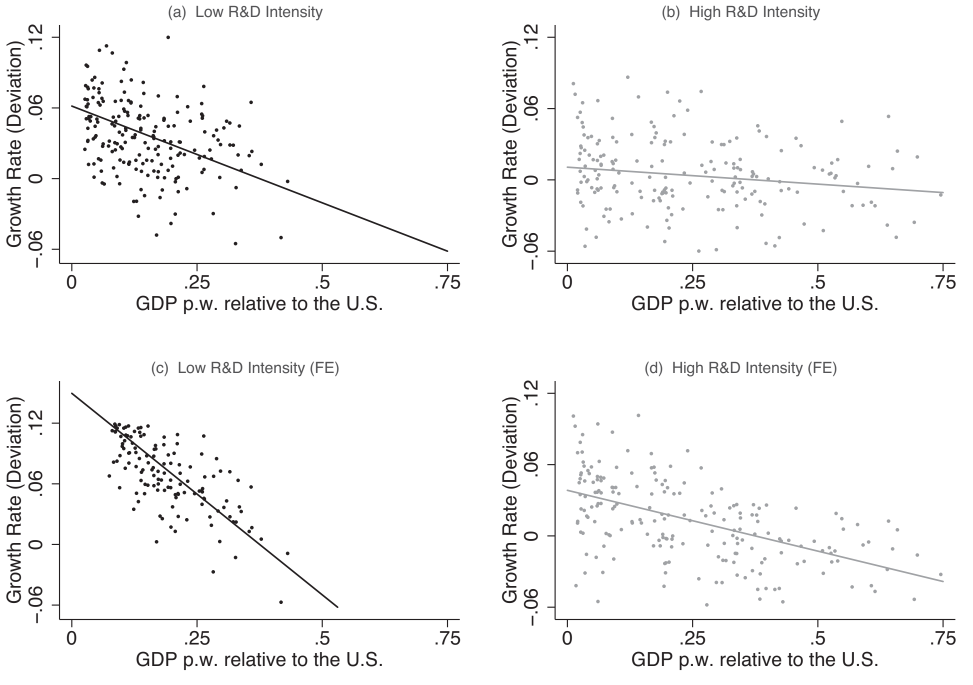
TABLE 2. Growth, proximity to frontier, and corruption.

	(1)	(2)	(3)	(4)	(5)
	OLS			IV	
	Panel A (1965–2014): Dep. variable is growth rate of GDP per worker Measure: Corruption Perceptions Index				
Proximity × high corruption	−0.109	−0.097	−0.256	−0.517	−0.302
	(0.027)	(0.020)	(0.058)	(0.080)	(0.069)
Proximity × low corruption	−0.028	−0.035	−0.109	−0.132	−0.134
	(0.010)	(0.014)	(0.023)	(0.029)	(0.024)
P-value diff. int. coef.	0.005	0.005	0.019	0.000	0.021
Country FE	NO	NO	YES	YES	YES
Contr. for education	NO	YES	NO	NO	YES
Number of obs.	467	434	467	424	394
R-sqr	0.30	0.38	0.25	0.16	0.21
	Panel B (1965–2014): Dep. variable is growth rate of GDP per worker Measure: Corruption Perceptions Index				
Corruption	−0.005	−0.006			
	(0.002)	(0.002)			
Proximity	−0.115	−0.099	−0.278	−0.475	−0.315
	(0.032)	(0.027)	(0.061)	(0.075)	(0.063)
Proximity × corruption	−0.007	−0.005	−0.024	−0.049	−0.028
	(0.005)	(0.003)	(0.009)	(0.011)	(0.009)
Country FE	NO	NO	YES	YES	YES
Contr. for education	NO	YES	NO	NO	YES
Number of obs.	467	434	467	455	424
R-sqr	0.16	0.22	0.25	0.15	0.20

Notes: Standard errors are in parentheses. The dependent variable is the average growth rate of GDP per worker for five-year intervals (1965–1970, 1970–1975, ..., 2005–2010). The last interval covers four years (2010–2014). The independent variable proximity to frontier is the ratio of the country's GDP per worker to the GDP per worker in the United States, both calculated at the beginning of each period. The independent variable corruption, that is interacted with proximity to frontier in Panel B, is each country's average (inverse) Corruption Perceptions Index over all available years between 1995 and 2011 (although observations for more recent years are available, they are calculated by a different method). The independent variable high corruption (low corruption), which is interacted with proximity to frontier in Panel A, is a dummy variable taking the value one for countries with a corruption level larger or equal to the median value for all countries, and zero if smaller. The control variable for education is the average years of schooling in the male population over 25 at the beginning of each period. Standard errors are clustered in Columns (1) and (2). All columns include time fixed effects. Columns (1) and (2) include a dummy for sub-Saharan Africa. In Panel A, Columns (4) and (5), the interactions between proximity to frontier and the dummy for high and low corruption are instrumented using one-period lags of the same variables. In Panel B, Columns (4) and (5), both the main effect of the proximity to frontier and its interaction with corruption are instrumented using one-period lags of the same variables.

effects, the coefficient of the interaction term has the wrong (negative) sign. However, the coefficient of the interaction term is positive and significant in the regressions with country fixed effects. Thus, the growth performance of economies with a high propensity to do R&D is significantly stronger close to the technology frontier. Or, equivalently, low-R&D-intensity countries suffer a more pronounced slowdown as

FIGURE 7. Growth and proximity to frontier in countries with high and low R&D intensity.



Note: The upper panel shows the correlation between growth and proximity to frontier after subtracting a group fixed effect for sub-Saharan African countries, broken down by above- and below-median R&D intensity. The lower panel shows the correlation between growth and proximity to frontier after subtracting country fixed effects, broken down by above- and below-median R&D intensity.

they approach the technology frontier. Hence, the results of panel regressions with country fixed effects are in line with the theory.

What lessons can be drawn for China from the international evidence? For at least two decades, China has been the stereotypical case of an imitating economy with high investment rates. Formal barriers were kept very high (as documented below), and corruption has been rampant. Political connections are essential to running a successful business. In the following sections, I discuss extensively how during this period China benefitted from the technology transfer coming from foreign direct investments (FDI), the internal reallocation of productive resources, and various economic reforms that encouraged high investment. Then, I argue that, as the gap with the technology frontier shrinks, China is today confronted with diminishing returns from the growth strategy pursued thus far. My thesis is that if it insists on policies supporting insiders and on pushing public investments, China may expose itself to the risk of a middle-income trap. The continuation of a high-growth trajectory then hinges on the transition from investment-driven to innovation-driven growth, which in turn necessitates reforms and new policies encouraging markets and competition, on the one hand, and the downsizing of the role of the state, on the other hand.

TABLE 3. Growth, proximity to frontier, and R&D intensity.

	(1)	(2)	(3)	(4)	(5)
	OLS			IV	
	Panel A (1965–2014): Dep. variable is growth rate of GDP per worker Measure: R&D Expenditure				
Proximity × low R&D	−0.162	−0.145	−0.378	−0.733	−0.433
	(0.038)	(0.029)	(0.067)	(0.104)	(0.089)
Proximity × high R&D	−0.035	−0.048	−0.108	−0.132	−0.138
	(0.010)	(0.016)	(0.026)	(0.033)	(0.026)
P-value diff. int. coef.	0.002	0.002	0.000	0.000	0.002
Country FE	NO	NO	YES	YES	YES
Contr. for education	NO	YES	NO	NO	YES
Number of obs.	416	383	416	378	348
R-sqr	0.33	0.43	0.27	0.18	0.25
	Panel B (1965–2014): Dep. variable is growth rate of GDP per worker Measure: R&D Expenditure				
R&D	0.018	0.019			
	(0.004)	(0.003)			
Proximity	−0.048	−0.041	−0.214	−0.313	−0.223
	(0.024)	(0.021)	(0.040)	(0.053)	(0.043)
Proximity × R&D	−0.016	−0.020	0.051	0.081	0.044
	(0.010)	(0.009)	(0.024)	(0.030)	(0.024)
Country FE	NO	NO	YES	YES	YES
Contr. for education	NO	YES	NO	NO	YES
Number of obs.	416	383	416	405	374
R-sqr	0.16	0.21	0.25	0.18	0.23

Notes: Standard errors are in parentheses. The dependent variable is the average growth rate of GDP per worker for five-year intervals (1965–1970, 1970–1975, ..., 2005–2010). The last interval covers four years (2010–2014). The independent variable proximity to frontier is the ratio of the country's GDP per worker to the GDP per worker in the United States, both calculated at the beginning of each period. The independent variable R&D in Panel B is each country's average R&D expenditure as a percentage of GDP over all available years between 1996 and 2014. The independent variable high R&D (low R&D), which is interacted with proximity to frontier in Panel A, is a dummy variable taking the value one for countries with an R&D expenditure larger or equal to the median value for all countries, and zero if smaller. The control variable for education is the average years of schooling in the male population over 25 at the beginning of each period. Standard errors are clustered in Columns (1) and (2). All columns include time fixed effects. Columns (1) and (2) include a dummy for sub-Saharan Africa. In Panel A, Columns (4) and (5), the interactions between proximity to frontier and the dummy for high and low R&D are instrumented using one-period lags of the same variables. In Panel B, Columns (4) and (5), both the main effect of the proximity to frontier and its interaction with R&D are instrumented using one-period lags of the same variables.

Figure 3 (Panel B) can be used to summarize graphically the thesis developed in the following sections: back in 1979, China was a very poor economy with an enormous technological gap relative to the world frontier (i.e., $a_{1979}^{CHN} < \hat{a}$). At that point, investment-led growth was the more appropriate strategy. However, today's China may have overcome the critical juncture (i.e., $a_{2017}^{CHN} > \hat{a}$). The policies that had been successful so far may have by now become a liability for future growth and expose China to the risk of converging to the middle income trap a^{trap}.

3. Investment-Led Growth in China

3.1. Investment-Led Growth in Mao Zedong's China

Until 1500 AD, China had been the most technologically advanced region worldwide. After centuries of splendor under the Song and Ming dynasties, China experienced a marked decline under the Qing (1644–1912) rule. Repeated military reversals and political unrest weakened the imperial government throughout the XIXth Century, leading to the overthrow of the emperor and the proclamation of the Republic of China in 1912. However, the republic proved to be fragile, and soon became a failed state that precipitated into civil wars, anarchy, and foreign occupations.

In 1949, after the end of the Sino-Japanese war and at the time of the communist uprising, the newly established People's Republic of China was an impoverished economy dominated by traditional subsistence activities. Mao's regime initially restored law and order under a unified control over the country. However, the communist regime soon imposed major economic and social turbulence. Agriculture was first collectivized as of 1951. Few years later, Mao launched the "Great Leap Forward," an ambitious plan intended to modernize and industrialize China according to Stalin's sovietic model. Its chaotic implementation contributed to a famine that killed about 30 million people (Li and Yang 2005; Meng, Qian, and Yared 2015). After a period of reconstruction under the aegis of Liu Shaoqi, the ephemeral pacification gave way to a new wave of radicalism inaugurated in 1966 by the Cultural Revolution, whose proclaimed goal was to suppress capitalism and traditional Chinese values. After Mao's death in 1976 and the ensuing defeat of the Gang of Four, Deng Xiaoping gained control over the Communist Party. He repudiated the Cultural Revolution, and in 1978 launched a program of economic reforms to increase the productivity in agriculture and launch industrialization under new bases.

Abstracting from the major humanitarian suffering it caused, what is the economic legacy of Mao's regime? The common wisdom is that Mao's regime was ineffective even relative to Soviet Russia. A recent paper by Cheremukhin et al. (2015) challenges this view, documenting that a significant amount of investment-driven growth and reallocation took place under Mao. For instance, the average annual GDP growth in real terms amounted to 5.7% during the time period between the Great Leap Forward and the introduction of the economic reforms (1966–1975). Using a two-sector neoclassical growth model, they simulate the development of the Chinese economy when holding intersectoral capital and labor market distortions (*wedges*) constant at 1953 levels and compare this counterfactual to the actual data. The authors go on and show that the economic performance of China under Mao is as good (or as bad) as that of Soviet Russia under Stalin. In particular, TFP growth in manufacturing was an important driver of growth already in the prereform period.

TABLE 4. Pre- versus post-reform growth.

	Annual growth rate (%) 1966–1975	1978–2012
Real GDP	5.7	9.4
Labor force	2.5	1.5
Labor share in agriculture	– 1.2	– 2.2
Capital stock	7.9	10.2
Manufacturing TFP	2.0	4.4
Agricultural TFP	2.4	3.9
Intersectoral wedges	– 1.8	– 3.7

Notes: The data are obtained from Tables 1 and 8 in Cheremukhin et al. (2015), pp. 13 and 39.

This study shows that a primitive form of investment-led economic growth was already on its way during the time between Mao's Great Leap Forward and the onset of economic reforms. The Chinese economy was so poor at the time of the communist revolution that even misguided policies could ignite investment-led growth. Nonetheless, the growth performance was modest compared to the stellar speed of convergence that followed the introduction of economic reforms under Deng Xiaoping. As illustrated in Table 4 (based on Cheremukhin et al. 2015), the time after 1978 is marked by significantly higher average annual GDP growth, higher capital growth, and higher manufacturing and agricultural TFP growth, as well as a faster reduction of intersectoral wedges.

The impressive acceleration in TFP growth, the fast reduction of intersectoral wedges, and the resulting increase in economic growth that China has experienced after 1978 can be attributed to the introduction of various economic reforms under Deng Xiaoping. The following discusses the most important of these reforms in more detail and their role in boosting investment-driven growth in post-1978 China.

3.2. Investment-Led Growth in the Post-Reform Period

With the onset of economic reforms in 1978, China experienced a momentous economic liberalization that catapulted the Chinese economy onto a trajectory of historically unprecedented growth and rapid convergence toward the technology frontier.

Before discussing the reforms that triggered the change of gear, it is useful to point at the paramount transformation in the system of career incentives within the Communist Party. This change is no less important than the de jure institutional changes that occurred in China during the last four decades.

Under Mao Zedong, political selection was mainly driven by ideological loyalty and patronage. Although patronage is by no means alien to the post-reform Chinese political system (Shih, Adolph, and Liu 2012), it now goes together with a significant meritocratic selection. A number of empirical studies show that the chances of promotion of provincial leaders to higher positions of responsibility in the government or party hinge on their success in achieving high economic growth in their province (see, e.g., Maskin, Qian, and Xu 2000; Bo 2002; Li and Zhou 2005). Jia, Kudamatsu, and Seim (2015) reconcile the two views by arguing that in today's China *both* performance in office and connections with top politicians matter—the two factors being complements rather than substitutes. They measure performance by the real GDP growth of the province that each leader rules. Connections are established using the curriculum vitae of Communist Party officials: a provincial leader is connected if he used to work in the same branch of the party or the government in the same period as one of the top central leaders in the Standing Committee (where the encounter must happen before the politicians become leaders, so they can be regarded as exogenous). The authors find that connections have a sizeable and statistically significant effect on the probability of promotion. This establishes that patronage is important. However, its effect is entirely driven by strongly performing provincial leaders, whereas weakly performing leaders are unlikely to be promoted irrespective of their connections. Thus, patronage alone does not suffice for a successful political career. Rather, connections and performance are complements in the promotion of provincial leaders.

In conclusion, although patronage may have a distortionary effect, once combined with a sufficient weight on meritocracy it can still lead to the selection of competent leaders. Anecdotal evidence confirms their findings: the career of the current president Xi Jinping is said to have been aided by the very high growth rate (an annual 14%) of the Zhejiang province at the time in which he was the provincial leader in the early 2000s.

3.2.1. Agricultural Reforms. The first policy reform implemented under the leadership of Deng Xiaoping was the introduction of a Household Responsibility System in rural areas to replace the existing system of collective farming. Under the Household Responsibility System, farmers were given full authority over their agricultural output once they fulfilled a procurement quota. The concept of deferring the authority over agricultural output to households was first implemented by subnational governments in a small number of Chinese provinces. As the decollectivization of agriculture proved to be a very successful way to improve agricultural output in the regional experiments, the Household Responsibility System was officially introduced on a national level in 1981 (Xu 2011). The reform spread quickly, and already by 1984 99% of China's rural households took part in the new system (Lin 2012).

The reform triggered an exceptional increase in agricultural output, which went up by over 61% between 1978 and 1984. According to McMillan, Whalley, and Zhu (1989), 78% of agricultural productivity growth can be attributed to the Household Responsibility System and its effect on farmers' economic incentives. The relaxation of controls also allowed farm households to reallocate resources from agriculture to non-agricultural activities, with a significant positive effect on household income growth (Yang 2004). The success of agricultural partial liberalization encouraged China's leadership to extend the experiments with economic reforms to urban areas.

3.2.2. Industrial Policy and Technology Transfer. Since the 1980s, the Chinese government has progressively abandoned the rigid socialist planning to introduce a market-based industrial system that laid the foundations for the manufacturing boom of the mid-1990s. This was far from a swift conversion to a free market creed. Like Japan and Korea in earlier decades, China engaged in a proactive industrial policy to promote specific sectors or firms. This strategy had several components. Selected industries and key projects were targeted by subsidies and other forms of financial support aiming to achieve both import substitution and export promotion. FDI were invited under various constraints of local content requirement (namely, a large share of materials and inputs had to be made in China). Technology transfer was often an explicit condition for granting market access—accompanied by selective forms of tax exemptions.

Place-based policies were equally important. In particular, Special Economic Zones (SEZ) were a pillar of China's industrial policy. This policy provides special privileges to designated city areas, exempting them from many restrictions regarding labor markets, FDI, ownership of firms, and export controls, as well as conceding more autonomy to local political leaders. Lower land leasing rates and tax incentives were also part of the policy. SEZ were established gradually. In 1980, the SEZ status was granted to Shenzhen, Zhuhai, and Shantou in the Guangdong Province, Xiamen in the Fujian Province, and the entire province of Hainan. In 1984, the special status was extended to 14 coastal cities; in 1992, it was extended further to all inland provincial capitals. This form of industrial policy represents a combination of liberalization and discrimination. Its main objective was, on one hand, to increase investments in manufacturing and, on the other hand, to exploit agglomeration externalities and favor the imitation and adoption of more advanced technologies through the attraction of FDI. Thus, it was a pillar of an investment-led growth strategy.

There is a long-standing debate about merits and flaws of place-based industrial policies. A common concern is that they can induce beggar-thy-neighbor phenomena, namely, the policy triggers a concentration of economic activity in the treated areas at the detriment of other locations (see, e.g., Givord, Rathelot, and Sillard 2013). However, some studies document positive effects of place-based policies on economic outcomes (see, e.g., Criscuolo et al. 2012; O'Keefe 2004). Lin (2012) argues that industrial policy promotes growth and development when it is used to strengthen a country's comparative advantage. A successful industrial policy is, in his view, the key reason behind China's success. The reason why other countries' industrial policies failed is that they were geared to protect weaker sectors—in a sense weakening their comparative advantages.

In a recent empirical study (Alder et al. 2016), we quantify the effect of SEZ on the economic development of the target areas in China.[15] Using a difference-in-difference

15. In this study, we use data from the *China City Statistical Yearbooks (1988–2010)* published by China's National Bureau of Statistics. We complement the information with three other city statistical collections. First, the *New China City in 50 Years Statistical Collection*; second, the *New China in 60 Years Provincial Statistical Collection*; third, the *China Population Census* for the years 1990, 2000, and 2010.

estimation in the spirit of Aghion et al. (2008) that exploits the variation in industrial policy in a panel of 276 Chinese cities over 23 years (1988–2010), we estimate that a 20% differential increase in the GDP level can be attributed to the granting of a SEZ status. The positive growth effect stems mainly from higher investment, from both domestic and foreign firms, although there were also some sizeable positive effects on TFP growth. These findings are in line with the view that SEZ were important in stimulating investment-led growth. For instance, the capital-labor ratio increased by 13%.[16] Population also increased by 10%, and there is some evidence of a positive effect in the average years of schooling of the population. Our results are robust to several controls, such as using nighttime light instead of official statistics and controlling for differential prereform trends in various ways.[17]

The main difficulty with the interpretation of these results is that they identify differential effects rather than the average effect of the industrial policy. In other words, the treated cities could have grown *at the expense* of neighboring non-treated cities. In Alder et al. (2016), we address the issue by proposing a plausible model of cross-city spillovers. Namely, we postulate that the extent of spillovers decreases with the distance from a SEZ, as potential beggar-thy-neighbor effects are likely to be especially important in areas close to the treated one. Overall, we find evidence of positive rather than negative spillover effects. Namely, the proximity to SEZ appears to be associated with a crowding-in rather than a crowding-out effect.[18] A decomposition of the effects into spillovers in investment, TFP, and population shows that spillovers in TFP play the largest role. The most likely channel is FDI and the ensuing technology transfer through imitation.

The importance of this channel is confirmed by the findings of Wang (2013), who finds that SEZ significantly increase FDI, and of Sheng and Yang (2014) who emphasize the effect of institutional reforms in attracting FDI and their effect on processing exports. On a less positive ground, Brooks, Kaboski, and Li (2017) find that SEZ favored collusive behavior of firms and noncompetitive pricing.

Attracting foreign investments was indeed one of the explicit goals of the policy, as Chinese leaders viewed the absorption of foreign technology as a pillar of the investment-led growth strategy. Holmes, McGrattan, and Prescott (2015) label this

16. The increase in the capital–labor ratio goes up 34% in a restricted sample of inland provincial capitals. In the early 1990s, the government decided to grant the SEZ status to all inland capital cities during the following years. This subsample is especially interesting since the choice was based on a strict administrative criterion, being as such less susceptible to endogeneity and selection issues in the choice of the location of SEZ. Although capital cities might have been different from other cities as a group, these differences can be controlled for in the analysis.

17. These results are echoed by the recent work of Lu, Wang, and Zhu (2016). They examine Chinese firm-level data and document significant short-run effects of SEZ on employment, capital, and on the number of firms. The main limitation is that their data relies on a short time span, from 2004 to 2008.

18. We estimate spillovers using different empirical strategies and different measures of distance (geodesic kilometer distance between the city centers, driving time between two cities, topographic measures). Using these distance measures we find that being further away from the closest SEZ is associated with a lower level of GDP. We also use a measure of exposure to a SEZ that is based on market access, with similar results.

a quid pro quo policy: multinational firms are required to transfer technology to China in return for market access. Using a quantitative multicountry dynamic general equilibrium model, they argue that China has reaped sizeable welfare benefits from holding on to this policy. Similar conclusions are reached by Acemoglu, Gancia, and Zilibotti (2015), where we study the effect of offshoring on technological change, growth, and inequality with the aid of a two-country model of directed technical change calibrated to China and the United States. In this paper, we assume that U.S. firms endowed with superior technology can (at some cost) relocate to China, where they benefit from lower wages. Although the study focuses mainly on the effect of offshoring on the direction of technical change and on wage inequality in the United States, the analysis also reveals some interesting normative and positive implications for China. In particular, we find that an exogenous fall in the cost of offshoring (e.g., due to the entry of China in the WTO, which imposes higher standards of protection of intellectual property rights) yields large welfare gains for China. Another interesting implication is that, when offshoring is initially low, the fall in offshoring costs raises skill premia both in the origin and destination countries. These predictions are consistent with the evidence that in China the college premium increased until 2008.

3.2.3. Investment-Led Reallocation. A large share of growth in China is accounted for by reallocation. Cheremukhin et al. (2015) show that the reduction of intersectoral wedges is an important source of economic growth, as in the prereform period, China suffered not only from a severe technological backwardness, but also from a massive resource misallocation.

There are two key production wedges. First, less productive rural areas (especially agricultural production) still attract a large share of productive inputs. In 1980, at the start of economic reforms, 80% of the Chinese population lived in rural areas (which is about the same as in 1960), whereas that share is down to 44% today.

The key policy friction is the system of *Hukou* that limits the possibility for citizens to choose where to register as residents. Although today it is legal for registered rural residents to live and work in urban areas, nonresident workers do not have access to important social benefits such as health care or public education for their children. This friction restricts mobility from rural to urban areas, with important welfare implications. Using a model à la Eaton and Kortum (2002), Tombe and Zhu (2017) show that reducing internal migration costs (e.g., through the reform of the *Hukou* system) could yield large welfare gains. Large welfare gains are also found by Ma and Tang (2016), who structurally estimate a spatial trade model in the spirit of Allen and Arkolakis (2014).

The rural–urban friction also has important effects on labor mobility and employment flows at business cycle frequencies. In Storesletten et al. (2017), we incorporate a version of the classic model of Lewis (1954) into a transition model with capital deepening à la Acemoglu and Guerrieri (2008). In our model, as investment-led growth progresses, more people move to urban areas. The model has interesting implications at business cycle frequencies. In industrialized nations, workers flow in and out of unemployment in response to economic fluctuations. In China, on the contrary, we observe large movements to and from rural areas dominated by lowly attached nonresident workers, who cannot count on safety nets when living in cities. Total employment is rather stable. Arguably, the stabilizing employment effect of this fluctuating population may be among the reasons why the government is reluctant to drastically reform of the *Hukou* system.

A no less important wedge concerns the distribution of productive inputs (i.e., capital and labor) across firms in the urban sector (Hsieh and Klenow 2009). In China, until the mid-1990s, industrial production was dominated by State-Owned Enterprises (SOE), with a small share of foreign-owned enterprises. Private enterprises first appeared in rural areas in the 1980s as "Township and Village Enterprises" (see, e.g., Che and Qian 1998). Then, privatization extended to the urban sector. Initially, the authorities tolerated the development of firms owned and run by Chinese private entrepreneurs. The turning point was the 15th Congress of the Communist Party of China held in 1997, which gave its blessing to a new economic regime of open competition between private firms and SOE. The congress also established the principle of "*grasping the large firm, letting go of the small one*," namely, the state should retain control over large (and arguably more efficient) SOE while relinquishing it over smaller and less productive SOE. The partial withdrawal of the state took various forms: from restructuring, merging, and corporatizing some firms, to outright privatizing others, and to shutting down others. The reallocation process that was initiated turned out to be dramatic: between 1998 and 2008, the employment share of domestic private firms in manufacturing rose from around 5% to over 60%.

In Song, Storesletten, and Zilibotti (2011), henceforth SSZ, we emphasize how this process took place under the shadow of important financial frictions. In particular, while exposed to competition from private firms, SOE continued to have an easier access to external financing, especially bank loans granted mostly by large state-owned banks. Private entrepreneurs were (and, to a large extent, still are today) heavily financially constrained, and had to rely on retained earnings or credit provided by family and friends to finance their investments (Riedel, Jin, and Gao 2007). Because private firms are on average more productive, the reallocation triggered a massive productivity growth. As entrepreneurs grew richer, they could invest in their growing business, causing a progressive shift of labor and capital from shrinking less productive SOE to more productive domestic private enterprises. An important feature of the model is that this reallocation is consistent with a moderate wage growth that remained below the average productivity growth. Once again, the mechanism is similar to that of the Lewis model (see also Ventura 1997): the reserve of financially unconstrained less productive firms (i.e., the SOE) keeps wage growth low during the transition, strengthening the incentives to invest in private firms. This is what we label *growing like China*: Reallocation yields (total factor) productivity growth as a mere by-product of investments even in the absence of innovation or technical change. In reality, the two sources of growth—reallocation and technology adoption—complemented each other. The question for economic theory is then: how important has reallocation been relative to technology adoption?

To answer this question, SSZ calibrate the macroeconomic model so that the speed of employment reallocation from SOE to private firms matches its empirical counterpart.[19] Then, we calculate the evolution of aggregate TFP in manufacturing. Our model predicts an annual TFP growth rate of 5.9% for the period 1998–2005, in line with the earlier estimates of Bosworth and Collins (2008) and Brandt, Biesebroeck, and Zhang (2012). Finally, we decompose the TFP growth rate into the part that is due to technology adoption and the part that is due to reallocation. We find that about 70% of the 1998–2005 TFP growth in our model is driven by reallocation from old, inefficient SOE to new more efficient private firms. Note that the model implies an average wage growth of 5% per year, which is sizeable but below labor productivity growth, in line with the mechanism described above.

An interesting feature of the Chinese investment-led boom is that the reallocation process also triggered a significant improvement in the performance of the surviving SOE. The reason is twofold. First, as we argue in SSZ (Section IV), SOE were subject to different policies across sectors: the Ninth Five-Year Plan exposed SOE to competition in labor-intensive industries, while forcing mergers and restructuring of SOE in capital- and technology-intensive sectors such as petrochemicals, railway, and telecommunication.[20] The stated objective of the policy was to help large SOE be competitive internationally—similar to the Korean *chaebol* in earlier decades. This strategy meant that many surviving SOE enjoyed a significant monopoly power in their respective industries. The increasing efficiency and productivity of the labor-intensive industries increased the demand for capital-intensive goods in upstream sectors, thereby increasing the profits of the monopolized SOE.

Second, China's reforms in the manufacturing sector induced a positive selection of surviving SOE. Hsieh and Song (2015) document that there was a convergence between the productivity of SOE and domestic private firms between 1998 and 2007. The privatization reform implied improved governance and performance of SOE and increased competition between SOE and private firms. State-owned firms displayed faster TFP growth than their privately owned counterparts and managed to catch up entirely in terms of labor productivity. However, there was no significant convergence in the productivity of capital, suggesting a persistent capital market wedge. Interestingly, Hsieh and Song (2015) show that the improvement in the performance of SOE had very limited effects on aggregate growth. The reason is that better performing SOE

19. The main data source used in Song et al. (2011) is the Annual Survey of Industries from China's National Bureau of Statistics (NBS). The survey, which runs from 1998 to 2007 and for 2012, includes the universe of Chinese industrial firms (manufacturing, mining, and construction) with sales revenues above 5 million RMB. The unit of observation is a registered firm. Information is available for a large number of statistics including ownership structure, value of sales, employment, wage bill, investments, R&D expenditure, and so forth. This dataset is used in many studies including, among others, Brandt et al. (2012), Hsieh and Song (2015), Beerli et al. (2014), and König et al. (2017), reviewed below. It is generally regarded as a reliable data source.

20. Our argument is developed further by Li et al. (2015), who write a model where SOEs monopolize upstream industries, whereas downstream industries are open to private competition.

partially crowded out the reallocation of capital and labor toward more productive private enterprises.

3.2.4. Crony Capitalism and Local State Capacity. Private enterprises are so far the hero of China's economic growth. Yet, one should refrain from a hagiography of the entrepreneurial class. Although ownership matters, in China the border between private and public ownership is often a thin line. Official classifications are based on threshold ownership, and many firms that are classified as private are in fact jointly owned by private and state entities, sometimes through opaque financial holding companies. In addition, especially for large private firms, success hinges on a combination of entrepreneurial skills and political connections. Incumbent firms, be it private or public, are often sheltered from the competition of entrants by powerful barriers.

This is what Bai, Hsieh, and Song (2016a) label crony capitalism with Chinese characteristics.[21] Starting a new business in China involves countless administrative obstacles and is an extremely time-consuming process. It takes on average 272 days to start a new firm. In 2015, the World Bank Doing Business Project ranks China 136th in the "starting a business" category, which is about on the same level as Nigeria. Private firms that make their way through the red tape thrive because they can establish a strong monopoly power. Barriers to entry are not the only weak economic institution: the business sector is also subject to weak property rights protection as well as shaky policy commitment.

According to Bai et al. (2016a), the key to success for China in past decades has been the combination of a strong local state capacity with a diffuse entrepreneurial spirit, which acts as an imperfect replacement for good economic institutions. In particular, local party and government organizations de facto have the power to let firms go around the formal barriers. What makes China different from other developing countries is that local leaders have strong authority and can solve the firms' problems without running the risk of being overruled by other layers of the bureaucracy. A high tolerance for corruption is part of the mechanism: bribes give incentives to local governments and politicians for clearing the way to connected private businesses. This removes uncertainty about the future. Connected firms can count on the dominance over local markets under the jurisdiction of the party or government authorities that they deal with. This stability makes firms willing to invest. It is important to note that one of the reasons behind the success of this crony capitalism model is that competition is not blocked nationwide. Different cities, authorities, and agencies compete in *selling* firms attractive local monopoly rents. Strong local protectionism is consistent with competitions across locations.

These dynamics can be extremely advantageous for private entrepreneurs. As a result, politics and economics are gradually melting together, illustrated by the fact that a growing number of private entrepreneurs join the Communist Party and even become members of the People's Congress and Political Consultative Committee (Bai

21. The term crony capitalism is also used with reference to China in Pei (2016).

et al. 2016a). Wang (2014) documents that private entrepreneurs are less positive about a transition to democracy than are workers and other socioeconomic groups, as the former are the main beneficiaries from the current system.

The discussion of Bai et al. (2016a) can be related to the international evidence presented in Section 2, where I showed that corruption, high barriers to entry, and discriminatory policies do not necessarily harm growth at earlier stages of economic development. Consistent with those stylized facts, crony capitalism has been successful in stimulating investments in China. However, by hindering the development of a level playing field competition, it limits creative destruction and innovation-led growth, and tends to fall into fast-decreasing returns as the economy approaches the technology frontier. Interestingly, Xi Jinping's recent anticorruption campaign poses a threat to the existing model. However, unless the campaign goes accompanied by other reforms of formal economic institutions, it is dubious that it will foster a more openly competitive system. The result may rather be choking off investment-led growth.

3.3. Investment-Led Growth in Recent Times

Thus far, I have discussed policies and institutions that supported investment-led growth since 1979. In 2008, at the apex of China's economic boom, a large external shock hit China: the global financial crisis. At the outset, this event was expected to have major effects on China's economic development: exports plunged, many urban jobs got destroyed, and growth slowed down sharply. In response, the Premier of the State Council Wen Jiabao called for a stimulus that is "big, fast, and effective." Although the stimulus plan was meant to be an anticyclical government policy, it turned out to have persistent effects on growth and on the growth strategy of China. For this reason, I discuss it in some detail.

In November 2008, the State Council announced a two-year stimulus package, which was implemented with great energy and in record time. The Chinese economic stimulus plan comprised four parts: an investment program worth RMB 4 trillion (around USD 600 billion), an expansionary monetary policy, tax cuts, and subsidies for SOE through the State-owned Assets Supervision and Administration Commission. It was the largest stimulus package in the world, overpassing the efforts of the United States by around three times (Wong 2011).

Within the investment program, most of the funds were intended to be invested in infrastructure, but also in health, education, affordable housing, or environmental investments. A share of 38% poured into public infrastructure, such as railways, roads, airport construction, or irrigation systems. At the same time, the People's Bank of China eased its credit restrictions, lowered the lending rate, and loosened several regulations within its nine-step plan for financial reform (Wong 2011). The most important area of relaxation concerns the financing of local governments, which were allowed to borrow from the financial sector through local financing vehicles.

The short-run effect of the stimulus package was remarkable: China recovered from the downturn in 2008, attaining growth rates of 8.7% in 2009 and 10.4% in 2010. Wage growth accelerated, infrastructure improved, and aggregate investments boomed owing to easy credit. The aggregate investment rate soared by 5 percentage points between 2008 and 2013 up to 47%. The boom in domestic demand shrank the trade surplus. However, already by mid-2009 some observers had begun to worry about the nature of this growth and its consequences. Easily accessible credit helped, for instance, to fuel an asset bubble in housing and land, whereas the huge local investments made people think about unsustainable local government debts (Wong 2011).

The assessments of the medium-term consequences of the plan are diverse, and the jury is not over yet. Wen and Wu (2014) take a Keynesian perspective and argue that the fiscal expansion was decisive for the continuing Chinese success. In their view, SOE played a key role in generating a "*significant countercyclical force against the meltdown of total exports and aggregate demand*" (p. 3). SOE act like an automatic fiscal stabilizer: in normal times they are profit maximizers, whereas in recession they can boost production and investments. In their view, the lower efficiency of the SOE is a price well worth paying for their stabilizing role. This study is also optimistic about the excess capacity that the stimulus plan generated. "*Ex post, most of the public sector losses resulting from inventory buildups and inefficient investment in 2009 have been repaid by the consequent continued booming economy. Alternatively, had the SOE not acted swiftly, the entire economy might have been crushed by the trade collapse and the consequent costs might have been very dear*" (p. 4).

Bai et al. (2015) reach opposite conclusions and argue that the fiscal expansion and the ensuing investment boom had a number of first-order side effects from which the Chinese economy still suffers today. They document that the investment boom is mainly driven by investment in (especially nonresidential) structure, whereas investment in equipment grew 3.3 times less by 2013. Thus, investments were not a major carrier of technological progress. In line with the goal of the stimulus package to invest a large share of its funds in infrastructure, firms in this sector suddenly got easier and cheaper access to credit, explaining the surge in structure investment. On the one hand, these investments boosted the loan rates faced by firms in other sectors, thereby crowding out their investment demand. On the other hand, the relaxation of credit regulation contributed to the boom of debt-financed investments of local governments' pet projects. To curb credit expansion, China's monetary authorities tightened liquidity regulation. This led to the rise of shadow banking, which, in turn, fueled the credit boom (Hachem and Song 2016). Bai, Hsieh, and Song (2016b) document that off-balance sheet companies (local financing vehicles) financing local governments were the lion's share of the credit boom, and kept expanding their activities well after the official end of the program in 2010, being responsible for a 5 percentage point increase in the aggregate investment rate.

Bai, Liu, and Yao (2015) argue that the boom in construction also raised the demand for low-skill workers, causing a reversion in the trend of skill premia, which had been on the rise until 2008. The college premium fell from 0.474 to 0.393 within four years. This was a result of differential development across sectors. Between 2008 and 2012, the average wage growth in the low-skilled construction sector amounted to 72%, but was only 47% in the high-skilled IT sector. This pattern can be explained with the increasing demand for low-skilled labor due to its intensive use in the infrastructure sector, hence, causing a decline in the skill premium. Although desirable on the ground of containing inequality, this development calls into question the transition toward a knowledge-based economy and risks reducing the incentives for further human capital acquisition.

Last but not least important, the manufacturing sector experienced a decline in the average return to capital and TFP growth, a finding also confirmed by Wei, Xie, and Zhang (2016). Bai et al. (2015) find a positive relationship between skill intensity and the average return to capital for the years 2009/2010, compared to 2007/2008, when the relationship was negative. Under the given circumstances, firms with lower skill intensity were able to receive funding at substantially lower costs, and invested large amounts of capital facing decreasing returns.

In conclusion, the stimulus package, even though it helped China to take shelter from the Great Recession, significantly distorted the development trajectory of the Chinese economy. From the point of view of the argument developed in this article, the boom of public investments strengthened investment-led growth and delayed the transition to innovation-led growth. The easy credit was not channeled to innovative start-up businesses but rather favored large firms in traditional sectors (e.g., mining and construction) and local governments. The decline in the share of SOE that had been associated with growth-enhancing reallocation was reversed. Finally, the boom led to excess capacity in many key sectors, which paves the way to another set of costly state interventions to shut down unproductive plants and support workers with safety nets in the afflicted areas.

4. Innovation-Led Growth in China

Up to recent years, the lion's share of China's economic development can be attributed to high investment rates, the reallocation of resources between sectors and between firms within a sector, and the adoption technologies that were invented abroad. Policies fostering investment-led growth have proven very successful in kick-starting China's convergence and securing high growth rates for more than three decades. With increasing development, however, this engine of growth is deemed to lose steam. Coherent with this view, Chinese growth rates have been stalling since 2012, accompanied by a falling return to investments and diminishing productivity growth as discussed in the previous section. According to the theory in AAZ, when the potential for investment-driven growth declines, a new growth engine must be ignited. Investment and technology adoption should increasingly be replaced by a more innovation-oriented growth strategy. In terms of Figure 3 in Section 3, China may have crossed the critical junction.

The recognition that China needs a change to the driving forces of economic growth has increasingly become part of the discourse of the political elite. The aspired transition toward innovation-based growth is embodied in various official documents and statements, such as, for example, the National Innovation-driven Development Strategy Outline issued in June 2016. In this ambitious document, China presents a long-term strategy comprising three major steps: by 2020, innovation should have increased significantly; by 2030 China should take on the lead among the innovation-oriented countries; and by 2050, it should transform into the world's scientific and technological innovation powerhouse. The outline stresses that China has to continue to open up and reform its economic institutions, wherein especially intellectual property rights represent an important pillar of strengthening innovation-driven growth.

The 13th Five-Year Plan (2016–2020) sets targets and implementation strategies to achieve the first of the three steps. The plan underlines the importance of promoting research in strategic and frontier fields as well as business start-ups. Further, it emphasizes the need to create an organizational system that is able to incentivize innovation and to build a nation that is rich in human capital. The salience of these themes is witnessed by their resonance in speeches given by the main political leaders. In his speech at the G20 Summit in September 2016, Xi Jinping emphasized that China will unswervingly pursue innovation-driven development and called for the creation of an innovative world economy. Similarly, Li Keqiang argued that innovation is the most important driver for development and, thereby, necessarily has to take on a central role in China's development strategy.[22]

It is dubious whether these ambitious plans can work within the country's existing political and economic institutions or are rather destined to remain mere wishful thinking. Consider two critical areas. First, the current weak level of investor protection is a barrier to financial development that hinders start-up business and innovation (e.g., venture capital). The second delicate area is the establishment of an independent judiciary system. Consider a hypothetical conflict between a new entrant firm and an incumbent firm that is under the protective wing of a local committee of the Communist Party. Under the current rule of law, it is unthinkable for the entrant to challenge existing politically connected powerhouses. The fear of future conflicts exercises a powerful disincentive to new start-ups. Second, political censorship imposes a heavy burden on the circulation of ideas that has large economic costs. Think of the ban on the use of Google. Although many firms and individuals can find their way around the regulation—many people access Google via VPN in China—state control over citizens' lives is an important barrier to the development of an economic system where churning and new ideas are the main drivers of economic growth. The same notion of level playing field competition in the business arena may sound suspicious as it is likely to spill over to other aspects of society, such as generating demand for political competition beyond the single-party monopoly of power.

One might object that crony capitalism has not prevented the emergence of new successful innovative firms, such as Alibaba, Baidu, Huawei, Lenovo, and Tencent. These young giants represent examples for innovative firms that managed to operate and grow successfully, even within the rigid Chinese system. Are these success stories evidence that China can turn, or even, has already turned into an innovation-led growth

22. See the report on the Work of the Government during the Fourth Session of the 12th National People's Congress on March 5, 2016.

economy? Not entirely. The success of these firms often hinges on a combination of exceptional entrepreneurial talent of their leaders and of the support from the government and, in some cases, of the military (see, e.g., Einhorn 2014; Peilei 2006). The existence of national champions—a typical trait of investment-led growth (as in the case of Korean *chaebol*)—leaves open the question about the extent to which innovation is diffusing throughout the network of Chinese firms. To uncover this, one must move from case studies to the formal evidence for the population of Chinese firms. This is what I turn to in the next section.

4.1. Innovation-Led Growth and R&D Expenditure

China has experienced an impressive surge in aggregate R&D expenditure. It is a positive outlier in terms of R&D investments. The international evidence shows a strong positive correlation between the R&D share of GDP and the GDP per capita level. Consistent with this pattern, today's emerging economies typically invest a much smaller share of their domestic product in R&D than do industrialized economies, most of them around 1% or even below. In the 1990s, China was a typical emerging economy, with an average R&D-to-GDP ratio below 1%.[23] Since 1999, however, China's aggregate R&D expenditure has been booming (see Figure 8). Today, it accounts for about 2.1% of GDP.[24] Although still lower than in the United States, Germany, and Japan, China's R&D share of GDP is comparable to (and even slightly higher than) the average ratio in the European Union, and is significantly higher than that of mature economies such as Italy, Spain, and the United Kingdom. Such a high R&D investment makes China a stand alone among middle-income economies. Interpreting R&D expenditure as a measure for its innovative intensity might suggest that China is indeed undergoing the transformation toward an economy driven by innovation.

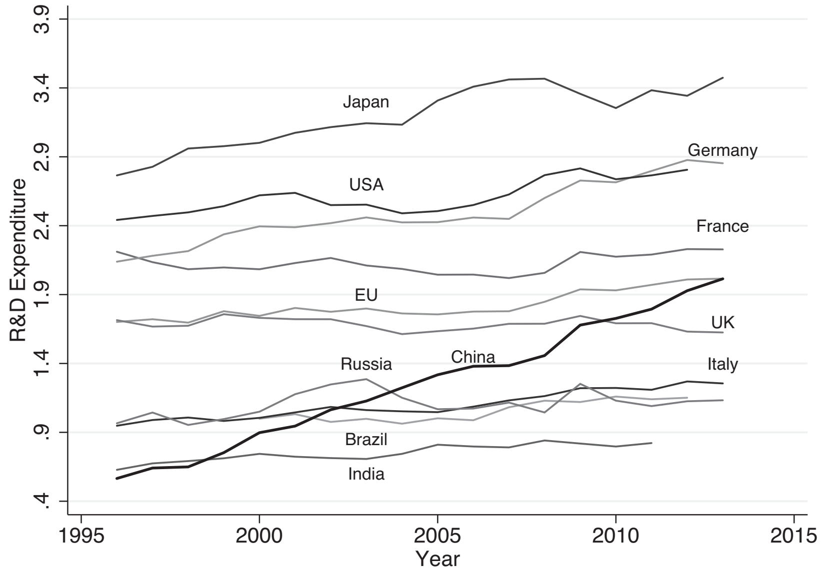
However, one should not forget that R&D expenditure measures a country's investment effort rather than its innovating success. In a country like China, the boom in R&D expenditure could well be the result of state intervention. As discussed above, the Chinese political authorities are eager to promote innovation. Subsidies and political pressure may also give rise to unintended and harmful responses, such as SOE simply classifying more expenses as R&D than before, or, worse, directing resources toward nonproductive R&D. In short, nothing guarantees that R&D is as productive as in frontier economies.[25]

23. According to OECD (2016) data, the average R&D expenditure in China was 0.69% of GDP between 1991 and 2000.

24. See World Bank (2016).

25. A separate related question is whether R&D is an appropriate measure of innovation in a middle-income country. Much of the R&D conducted by Chinese firms may be still directed to reverse engineering foreign technologies or adapting them to the conditions prevailing in China. I do not postulate here that innovation in converging economies necessarily aims at pushing the world technology frontier. Rather, I find it useful to distinguish serendipitous technology adoption that comes as a by-product of the investment

FIGURE 8. R&D expenditure in % of GDP.



Note: The figure shows the evolution of R&D expenditure in % of GDP for selected countries. The data is from the World Bank World Development Indicators (2016).

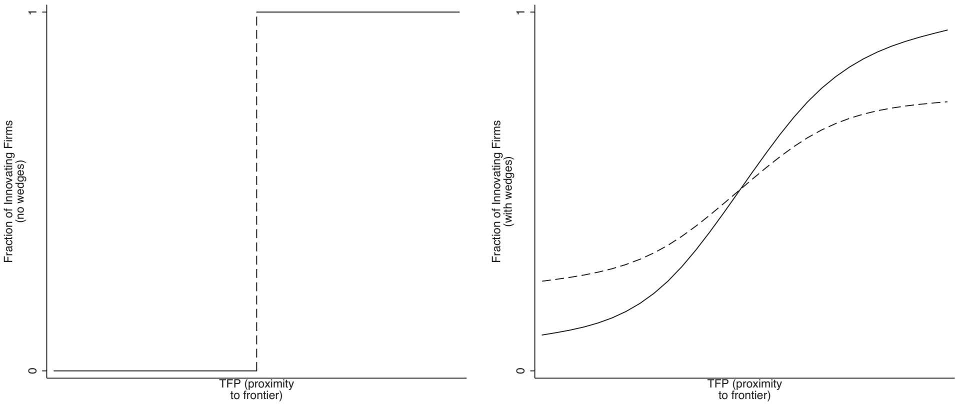
My discussion below focuses on three questions. First, are firms doing R&D growing faster than firms not doing R&D? Second, which firms benefit most from R&D investments? Third, is there evidence of misallocation of R&D effort? To answer the third question, I will lay out a theory of efficient allocation of R&D expenditure.

4.2. R&D Expenditure and Productivity

In König, Lorenz, and Zilibotti (2016), we provide a theoretical framework for examining the relationship between R&D expenditure and productivity on the firm level. We develop a model of endogenous growth and endogenous firm dynamics in which the entire productivity distribution shifts over time. The shift is the result of firms' endeavor to improve technology by either engaging in innovation/adaptation—which is mapped to R&D expenditure in the data—or by imitating the technology that is already used by other domestic firms. The choice between these two strategies is driven by profit maximization. For firms choosing to innovate, the outcome of the innovation process is stochastic, as in Aghion and Howitt (1992). Although in reality

process from the adaptation of more sophisticated foreign technology, which I view as an innovative activity. For instance, Chinese car producers serving the domestic market may be more interested in containing costs than in providing customers with sophisticated optional devices. With this in mind, I regard R&D expenditure as a proxy for investments in technology advancements that move the *Chinese* technology frontier.

FIGURE 9. Fraction of innovating firms in an economy with and without wedges.



Note: The left panel shows the predicted probability that firms engage in innovation as a function of their proximity to the frontier in the model of König et al. (2016). The right panel shows the predicted probability that firms engage in innovation as a function of their proximity to the frontier in the model with distortions that affect firms' decisions to imitate versus innovate.

the expected productivity of R&D hinges on firm-specific characteristic (e.g., human capital), König et al. (2016) abstract from ex ante heterogeneity and assume that all firms face a fixed expected productivity growth rate if they choose to innovate. Alternatively, firms can choose to imitate other firms. In this case, they are randomly matched with a sample of other firms, from which they can choose the one with the highest productivity. Then, they close part or all of the technology gap by imitating the firm with which they are matched.

The crux of the theory is that the expected productivity of imitation, contrary to that of innovation, depends on the firm's ranking in the productivity distribution. Laggard firms have a comparative advantage in imitating since they are likely to be matched with firms that offer a large imitation potential. Instead, highly productive firms cannot hope to learn much from other firms, and therefore have a comparative advantage in innovating. König et al. (2016) assume that neither activity entails a cost—an assumption that aids tractability. However, because firms cannot do both imitation and innovation, there is an opportunity cost in making either choice. The theory can be extended to environments where R&D investments are costly, and where unsuccessful innovating firms can also do imitation, albeit with a lower ex-ante productivity.

We prove formally that firm dynamics converge to a productivity distribution described by a *traveling wave* with Pareto-distributed tails, which is consistent with the empirical productivity distributions observed for different industrialized countries. It is also broadly consistent with the productivity distribution of Chinese firms.

Ceteris paribus, the theory predicts that it is optimal for firms above a certain productivity threshold to engage in innovation, whereas firms below this productivity threshold should pursue imitation, as shown in the left panel of Figure 9. If a firm is very unproductive, it has vast opportunities to imitate, and, hence, it is efficient for the firm to seize these opportunities. For a high-productivity firm, on the other hand, the more efficient strategy consists of engaging and investing in innovative activities.

However, other factors may affect firms' decisions. In current work in progress (König et al. 2017), we augment the model of König et al. (2016) by postulating that the allocation of resources is distorted by wedges—such as capital market distortions, market power, or firm-specific R&D taxes and subsidies. These wedges (that can be estimated from the data) distort the efficient allocation of R&D across firms. For instance, highly productive firms whose growth is constrained by capital market distortions may be unable (or less prone) to invest in R&D. A scenario that is especially relevant for China is one where R&D is mandated by the government to SOE. As Chinese SOE tend to have a lower productivity than private firms, this forced allocation of R&D creates an innovation-specific wedge rendering the distribution of R&D across firms suboptimal, thereby resulting in inefficiently low average growth. The larger the allocative distortions, the lower will be the cross-firm correlation between productivity on the one hand and the propensity to do innovation rather than imitation on the other hand.

The logic of this argument also implies that among the high-productivity firms, one should see firms doing R&D significantly outperform firms not doing R&D. In contrast, the pattern is ambiguous—and possibly even reversed—among low-productivity firms. If some low-productivity firms receive large subsidies for doing R&D, this can induce their management to divert firm resources from more efficient uses and slowdown their productivity growth.

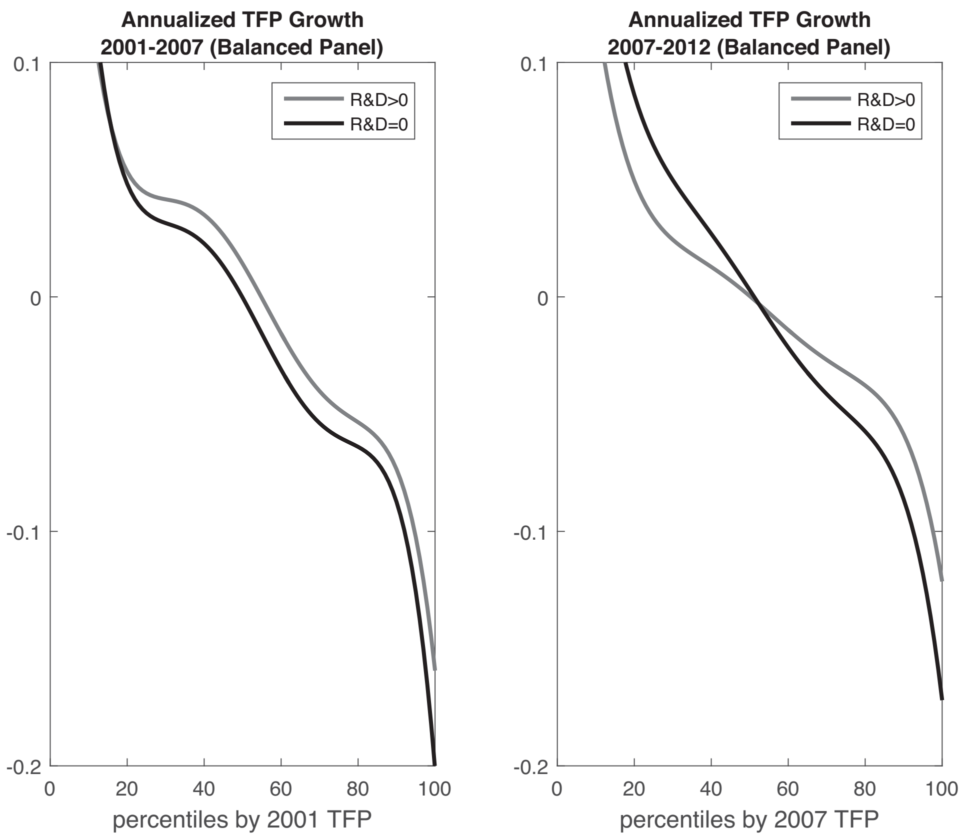
4.3. *Allocation and Efficiency of Chinese R&D Expenditure*

In König et al. (2017), we evaluate the predictions of the theory using Chinese firm-level productivity annual data from 2001 to 2012 and two cross-sections of R&D data (2001 and 2007).[26] The data are from the NBS Annual Industrial Survey, described in footnote 19. Here, I summarize the findings for the extensive margin (doing vs. not doing R&D), although similar results obtain along the intensive margin. All figures below show deviations from the three-digit industry average:

1. Firms investing in R&D experience, on average, faster future productivity growth. Figure 10 plots the annualized average TFP growth over the period t, $t + \Delta t$ (vertical axis) broken down by percentiles of TFP level in year t (horizontal axis). More specifically, in the left panel of Figure 10, I split the sample into firms investing and not investing in R&D in 2001, and show separately for each of the two groups the (normalized) TFP growth rate in the 2001–2007 period. For most

26. The paper in progress performs a structural estimation of the model aiming to provide a quantitative fit of the data. In this section, I only discuss some descriptive statistics and interpret them in the light of the qualitative predictions of the theory. Note that an exemption from the JEEA data policy has been obtained about Figures 10 and 11, which are from König et al. (2017). I thank my coauthors for allowing their reproduction in this paper.

FIGURE 10. R&D as a predictor of future growth.

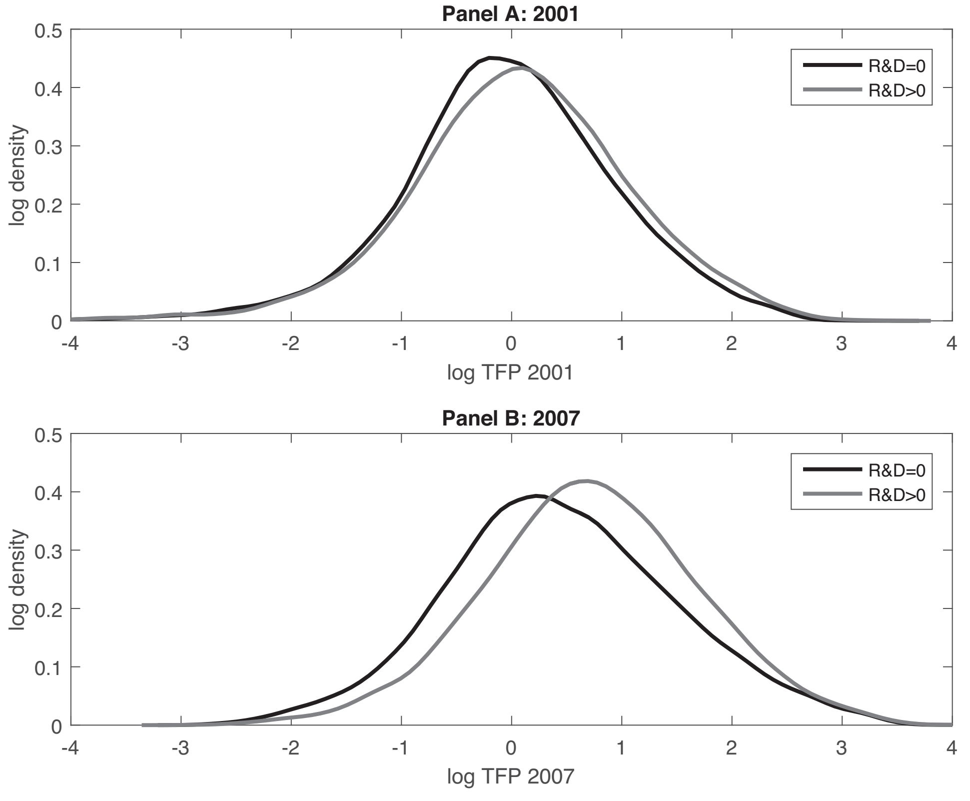


Note: The left panel shows the average TFP growth rate in the period 2001–2007 for Chinese firms doing R&D (gray) and not doing R&D (black) in 2001 at different percentiles of the TFP distribution in 2001. The right panel shows the average TFP growth rate in the period 2007–2012 for Chinese firms doing (gray) and not doing R&D in 2007 at different percentiles of the TFP distribution in 2007. The data are from König et al. (2017).

percentiles, TFP growth is higher for firms investing in R&D. In the right panel, I show the corresponding evidence based on the R&D investment behavior in 2007 and the (normalized) TFP growth rate in the 2007–2012 period. Once again, on average, firms doing R&D attain a higher TFP growth rate than firms not doing R&D. Interestingly, in the later period the positive effect of R&D on growth is stronger for high-TFP firms, and turns negative for firms below the 45th percentile. This is well in line with the prediction of the theory.

2. High-TFP firms are more likely to do R&D. Moreover, firms with higher investment and output wedges are less likely to do R&D. Further, ownership matters: ceteris paribus, SOE have a higher propensity to engage in R&D than privately held firms, suggesting that ownership is a driver of misallocation.

FIGURE 11. Correlation between TFP and doing R&D in 2001 and 2007.



Note: The upper (lower) panel shows the TFP distribution in 2001 (2007) for Chinese firms doing R&D (gray) and not doing R&D (black). The data are from König et al. (2017).

3. Over time, misallocation declines. The top panel of Figure 11 shows that already in 2001 firms investing in R&D have, on average, a higher TFP than firms not investing in R&D. However, the difference is small. The propensity to do R&D increases much more with TFP in 2007, as depicted in the bottom panel of Figure 11; there, the productivity distribution for firms investing in R&D is clearly situated to the right of that for firms not investing in R&D. According to the theory outlined above, the difference between 2001 and 2007 indicates that the allocation of R&D has improved over time: Although in 2001 the allocation was largely driven by size and ownership, the sorting was driven more by TFP in 2007.

We compare the evidence for Chinese firms with that for Taiwanese firms in the period 1988–1993. Although Taiwan was already richer in 1988 than China is today, it is not possible to go back even further due to data constraints. The signs of the correlations discussed above are the same in Taiwan as in China (both confirming the theoretical predictions), but the relationships are much stronger for Taiwanese firms. On the one hand, R&D is a stronger predictor of future productivity growth in Taiwan than in China. On the other hand, Taiwanese firms are more significantly sorted by initial productivity into investing in R&D. Namely, in Taiwan more than in China, it is the high-productivity firms that engage in innovative activities. Interpreted from the lens of the model, this implies that there is more R&D misallocation in China in 2001–2007 than in Taiwan in 1988–1993. Similarly, the relationship between R&D and future productivity growth is far stronger for Taiwan, and particularly so for high-TFP firms.

All in all, our study of the relationship between R&D and firm productivity reveals that the boom in Chinese R&D expenditure is associated with an improvement in the allocation of R&D. However, the allocation of R&D in China (2001–2007) is significantly more distorted than in Taiwan (1988–1993). Part of this misallocation is associated with SOE doing significantly more R&D than private enterprises. The reduction of this misallocation is an important hurdle that China will have to surmount in order to reap the full benefits of innovation-driven growth.

4.4. Domestic-Demand-Led Productivity Growth

China's economic growth has been largely export driven. However, China has an enormous potential coming from the growing domestic demand of a very large country. This potential is still underexploited, as Chinese households have been extremely thrifty over the past decades.[27] However, this is changing. The growing middle class is already an important source of demand of consumer goods, and its size is going to grow in the future. An interesting question is whether R&D investments are higher in sectors whose domestic demand is expected to grow more.

This question is tackled by the study of Beerli et al. (2017), which is motivated by two streams of literature. On the one hand, under nonhomothetic consumer preferences, changing income distributions lead to changes in the composition of domestic demand. Boppart (2014) and Alder, Boppart, and Müller (2017) show that this shift in demand is a driver of structural change. Although these papers focus on broad economic sectors, structural change also affects the demand of individual consumer goods. On the other hand, recent theories of directed technical change, including, among others, Acemoglu and Zilibotti (2001), Acemoglu (2002), Acemoglu, Gancia, and Zilibotti

27. The Chinese saving puzzle is the subject of a recent literature that we review more extensively in Storesletten and Zilibotti (2014). The aggregate saving rate is as high as 50% in recent years, whereas the household savings as a fraction of disposable income is about 30%. The literature has highlighted the importance of a variety of factors. Chamon and Prasad (2010) argue the case of the shifting burden of health, education, and housing expenditures from the state to individuals; Liu, Winter, and Zilibotti (2013) emphasize the effect of housing market liberalization; Rosenzweig and Zhang (2014) focus on high housing costs and intergenerational shared housing; Choi, Lugauer, and Mark (2014) underscore the importance of precautionary savings; Song and Yang (2012) discuss technological factors that have flattened the age-profile of earnings, inducing high life-cycle savings; Banerjee et al. (2014) and Choukhmane, Coeurdacier, and Jin (2016) draw attention to the importance of fertility policies, which increased savings by reducing the number of children who can potentially provide old-age transfers when parents retire.

(2012), and Gancia, Müller, and Zilibotti (2013), predict that market size is a driver of R&D investments. Our hypothesis in Beerli et al. (2017) is that growth and changes in income distribution differentially affect the potential market size of different durable goods. Over time, Chinese consumers demand more cars and fewer bicycles or rice cookers.

The empirical strategy of Beerli et al. (2017) is related to the work of Acemoglu and Linn (2004), who study directed technical change in the pharmaceutical industry. The challenge to identification is that supply-side shocks affecting R&D investments in a particular durable good industry may cause an expansion in sales, for example, by reducing the cost of production and the equilibrium price. Thus, one needs to single out exogenous demand shifters at the product level. Acemoglu and Linn (2004) do so by forecasting the future market size for different drugs by studying demographic trends that affect the demand of specific drugs (e.g., cardiovascular diseases). In the same spirit, in Beerli et al. (2017) we use a measure of potential market size based on the changes in GDP and income distribution in the presence of nonhomothetic preferences. Our crucial assumption is that consumers purchase particular goods when they reach good-specific threshold income levels. Since the markets for each of the durable goods that we considered are small relative to the total Chinese economy, macroeconomic trends are assumed not to be affected by industry-specific supply shocks. The potential market size of a particular consumer durable (e.g., cars) can then be used as an instrument for the actual future market size in a given industry to study its effect on innovation decisions.

With this IV strategy, we find that a one percent increase in potential market size raises future total factor productivity by 0.27% and future labor productivity by 0.42%. Moreover, potential market size is a strong predictor of the actual market size in the first-stage regression. This causal effect implies that Chinese manufacturing firms in industries in which market sizes are expected to grow in the future improve their technology significantly more than firms in industries where markets are expected to stagnate. In addition, the former are also more active when considering other indicators of innovative activity.

By documenting the interplay between the growing middle class and innovative activities by firms in the Chinese economy, these findings highlight the role that China's domestic consumer goods market can play in its transition from investment-led to innovation-led growth. As the size of the Chinese home market can be expected to increase even further in the future, it will be an important contributing factor to sustaining high growth and transitioning to an innovation-based economy.

4.5. Patents

Another measure of innovation is patents. In China, patents have boomed big time, but the significance of this observation has often been questioned on the grounds of the low average impact of Chinese patents. Interestingly, a recent study by Wei et al. (2016) shows that the boom in the number of Chinese patents has been accompanied by an increase in their quality. For example, foreign citations of Chinese patents grew at a rate of 33% per year between 1995 and 2005, and even accelerated to 51% a year after 2005. Similarly, Wei et al. (2016) document that during the same period, the number of Chinese patents that were approved by patent offices in developed countries grew by 28% yearly.

The same study also studies patenting activities across different industries to gain some insight into the different factors that can drive innovation. A driver of innovation lies in the significant increase in the real wage in China, which has grown by more than 10% a year since 2003 (Ge and Yang 2014). This development appears to have induced labor-intensive sectors to develop new technologies that can substitute the relatively cost-intensive labor. Indeed, between 1998 and 2009, the fraction of patents granted to labor-intensive firms compared to capital-intensive firms has increased from 55% to 66%.

4.6. Demographic Trends and Human Capital

China is undergoing a major demographic transition. The old-age dependency ratio is expected to grow from 13% in 2015 to 35%–40% in 2045. The effect of an ageing population on the propensity to innovate of an economy is speculative. One can conjecture that young people are more innovative, and thus a decrease in the share of young workers deters innovation. Another issue is the distortive burden imposed by a large old-age dependency ratio. The financing of China's pension system has been the subject of a large literature. Feldstein and Liebman (2008) and Dunaway and Arora (2007), among others, argue that in lack of radical reforms, the Chinese economy will suffer major distortions to finance its pension system in the coming years. These distortions may affect innovation.

It is tempting to compare China to Japan, which has suffered a pronounced growth slowdown along with a fast-ageing population since the 1990s. However, caution is in order. First, it is not clear that in Japan there is a causal link between the two observations. Second, China and Japan are structurally very different. Japan's GDP per capita is 2.7 times larger than China's. Moreover, China still has great scope for growth through transition, reduction of distortions (Brandt, Tombe, and Zhu 2013), and internal migration, all elements that are either missing or less important in Japan than in China.

Song et al. (2015) provide a thorough assessment of the ageing phenomenon, with the aid of a model of demographic transition that takes into account the ongoing migration from rural to urban areas. Their conclusions are less bleak than those of earlier studies. Their model takes into account not only the evolution of fertility and mortality rates but also the age-specific migration rates from rural to urban areas. The latter is based on the assumptions that (i) the age- and gender-specific migration rates from rural areas remain fixed at the historical level; (ii) once migrants move to an urban area, their fertility and mortality rates are the same as those of urban residents. Their estimates imply that the urban population increases from 770 million today to its long-run 1.2 billion level in 2050. In contrast, had there been no migration, the urban population would have already started declining in 2008. Moreover, the projected urban old-age dependency ratio is significantly lower than the national average, since migrants are typically young (thus, conversely, rural areas suffer a more significant increase in population ageing).[28] This is important for two reasons. First, most of the innovation originates in urban areas. Therefore, if an older population is going to be less innovative, the negative effect of demographic trends on innovation is mitigated significantly by internal migration. Second, the Chinese pension system covers almost exclusively urban workers, so its sustainability hinges on the urban old-age dependency ratio.

Another important offsetting factor is human capital accumulation. Since the seminal contribution of Nelson and Phelps (1966), economists believe in a strong complementarity between innovation and the human capital intensity of societies. Thus, the accumulation of human capital can be a catalyzer of the transition toward innovation-led growth. In China, human capital has increased tremendously. The tertiary enrolment rate in China amounts to 39% in 2014, whereas in 1995 this rate was below 5%, to highlight only one example.[29] Chinese colleges and universities admit about 7 million students every year, of which more than one third are enrolled in science and engineering. More than 500,000 Chinese students studied abroad in 2015, implying a year-on-year increase of 13.9%. The potential contribution of these highly qualified workers to innovation and the growth of a knowledge-based economy should not be underestimated.

In summary, the data suggest that (i) although the share of working Chinese will decline in coming years, the decline is less dramatic in urban China; (ii) the new labor market entrants will be much more educated than the retiring workers. What is the net effect of all the forces? In Song et al. (2012, 2015), we provide a tentative forecast of the future convergence rate of China, which includes the contribution of further technology catch-up, human capital accumulation, and population dynamics. According to those estimates, China has the potential to grow at a rate of 6.5% between 2012 and 2040, with a significant contribution of human capital (0.8% per year) due to the entry of more educated young cohorts in the labor force. In this scenario, the GDP per worker in China will be 73% of that of the United States by 2040, remaining broadly stable thereafter. For comparison, today's GDP per capita of Taiwan is 84% of the US level, whereas Japan has a relative GDP per capita of 68%. Thus, according to this forecast, China would settle down in between. This long-term forecast is by necessity speculative, and we regard it as a best-case scenario in which China suffers no major politicoeconomic setback and successfully transitions into innovation-led growth.

28. The migration rate peaks at age fifteen, being 15.3% for females and 12.2% for males. Then, it falls gradually with age, becoming insignificant after age forty.

29. See the World Bank indicator *gross tertiary enrolment rate* (2016).

5. Conclusion

The future of the Chinese growth miracle is a topic of great international interest and of intense debate and speculation. Any forecast based on neoclassical growth models must imply that growth will slow down. Therefore, the real question is how fast growth will decrease. Based on the theory of economic convergence in AAZ, I have argued that the answer hinges on the ability of China to ignite the engine of innovation-led growth. This, in turn, depends on the willingness of its political leadership to engage in a new season of economic reforms similar to those that changed the course of the country's history first in the early 1980s, and then in the mid-1990s. During the first decade of the millennium, China has capitalized on the benefits of those reforms. More recently, growth rates have declined, though the slowdown has so far been contained by powerful injections of public resources—especially investments in infrastructure since 2008. However, China is currently facing the distortionary effects of these policies.

Although there is still scope for transitional growth through the reduction of a number of wedges (rural-urban migration, further decline in the relative share of state-owned enterprises), the benefits from specializing in low-value-added production have by now been largely exhausted. The economy is moving toward higher-value-added production and, hence, must move up the technology ladder. Tertiarization is also happening fast: the share of services increased from 33% in the mid-1990s to over 50% today. This means that the focus of economic reforms and liberalization must shift toward the service sector. The best-case scenario is a transition that leads Chinese people to enjoy within the next quarter of a century living standards comparable with those enjoyed by advanced East Asian economies such as Japan, Korea, and Taiwan. Clearly, this depends on a number of concomitant factors such as the evolution of international trade and international relations. Recent political events raising the possibility of a significant surge of protectionism in the United States could, for instance, harm the future growth of China.

I have reviewed some firm-level empirical evidence suggesting that a transformation toward innovation-led growth is on its way. However, there is also a significant misallocation of R&D expenditure. Successfully managing the transition to innovation-led growth is the key to preventing a more severe slowdown. A top-down strategy where innovation is sustained by a combination of subsidies, guidelines, and public investments in technology parks is likely to generate a large misallocation of R&D effort and to be deemed to failure. Rather, China should further emphasize reforms and financial development in order to make innovation a market-based outcome. A crucial step is to improve investor protection, which goes hand in hand with establishing an independent judicial system. Naturally, however, these are areas in which necessary reforms may clash with the constraints imposed by the current political system.

There are trade-offs between sustainable high long-run growth and short-term objectives. There are signs that in recent years, the insistence on ambitious short-term goals such as keeping the annual growth rate above 6% may have had a sullying effect on economic performance. Instead, it might be wiser for China to realize the required structural reform and tolerate lower growth rates in coming years for the goal of sustaining fast convergence in the coming decades.[30]

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30. To some extent, this narrative appears to find its way to the political elite. The recent fifth session of the 12th National People's Congress (NPC) has set a target economic growth of "around 6.5%." Although I view this target as overly ambitious (especially, in light of the difficult perspective for international trade relations), it is slightly lower than the earlier target of "6.5%–7%." This suggests that the Chinese leadership signals a willingness to tolerate somewhat lower growth in the near future. The NPC also emphasizes the commitment to pursuing reform and opening up. In particular, Premier Li Keqiang has called for more support of innovation and entrepreneurship, identifying the creative potential of its citizens as China's biggest asset for sustaining medium-high economic growth in the future (see Xinhua news, "Premier Li urges efforts to boost innovation for new growth momentum," March 6, 2017). How this will translate into policy measures will only become clearer in the coming months.

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Supplementary Data

Supplementary data are available at *JEEA* online.