China's Investment Rate: Characteristics and Implications

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China's rapid economic growth over the past forty years was in good part driven by capital accumulation, with, in recent years, investment taking up almost half of aggregate expenditures. This paper documents the role of investment in driving economic growth in China, questions how much longer China can sustain a high investment rate, and critically examines arguments suggesting an end to the investment boom. The size of the Chinese economy allows investment to remain broad-based across all economic sectors, with little specialization. The foreign share of investment in China nowadays is negligible and the China growth story thus has become a domestic one.

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E01 Measurement and Data on National Income and Product Accounts and Wealth, Environmental Accounts
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O11 Macroeconomic Analyses of Economic Development
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Highlights
* Investment has been an important driver of China's economic growth
* The experience of other countries as well as policies in China suggest that China's investment rate continues to be relatively high for another ten to twenty years
* Concerns about a rising capital-output ratio, excessive debt funding of investment, and inefficiency of investment due to state ownership are overblown
* The sectoral patterns of investment indicate a process of completion of a comprehensive economic structure resembling that of today's developed economies
* The small share of foreign investment in all investment in China implies that China's economic growth story has become predominantly a domestic one

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Abstract: China's rapid economic growth over the past forty years was in good part driven by capital accumulation, with, in recent years, investment taking up almost half of aggregate expenditures. This paper documents the role of investment in driving economic growth in China, questions how much longer China can sustain a high investment rate, and critically examines arguments suggesting an end to the investment boom. The size of the Chinese economy allows investment to remain broad-based across all economic sectors, with little specialization. The foreign share of investment in China nowadays is negligible and the China growth story thus has become a domestic one.

1. Introduction

Between 1978 and 2017, the size of the Chinese economy grew by an average annual 9.5 percent in real terms. Much of this economic growth can be accounted for by investment. The share of investment in economy-wide output, measured as the share of gross fixed capital formation (GFCF) in aggregate expenditures, rose from 0.12 in 1952 to 0.30 in 1978 and 0.46 in 2013, before falling back to 0.43 in 2017 (Figure 1).

Investment policies have always featured prominently in the economic policies of the People's Republic of China. The Chinese government influences the amount of investment by directing fiscal funds into investment or by channeling credit to government-supported investment projects. It uses administrative tools to incentivize or dis-incentivize investment, for example in the residential real estate sector. It conducts industrial policy through sectoral investment guidelines. It influences investment decisions via indirect macroeconomic policy tools, such as interest rate policy and tax policies. This means that further economic growth, driven by investment, is in good part a policy choice.

[Figure 1 about here]

Creating growth through investment has worked well for China in the past. Now, as major infrastructure and real estate construction cycles have run their course and the investment rate

has peaked, questions arise as to if a high investment rate will persist in the future. A rising capital-output ratio, unsustainable levels of debt, and state inefficiency are often cited as handicaps. At the same time, a disaggregated examination of the investment data provides interesting insights into what is happening with China's investment.

The analysis that follows draws on time series data as well as some cross-country data. Obvious comparison countries for China are the neighboring East Asian economies that have experienced high growth rates at some point during their development process. At times, a further comparison is drawn to the U.S. as the benchmark of a post-industrial economy and to Germany as a developed economy with a manufacturing focus similar to that of China.

2. How investment drives economic growth in China

Demand-side analysis allows identification of what drives economic growth in the short run. Supply-side analysis reveals the long-run drivers of economic growth. On both accounts, investment is crucial for economic growth in China.

2.1 The short run: demand-side analysis

In the short run, from the point of view of aggregate demand, any *additional* expenditures on investment goods imply additional economic activities. Annual real growth in aggregate expenditures and thereby in gross domestic product (GDP) can be decomposed into growth of the three components: consumption (including government consumption), investment (including government investment), and net exports.

Figure 2 shows a relatively stable annual contribution of consumption to economic growth in China, of on average 5.4 percentage points per year from 1979 through 2017. The contribution of net exports fluctuates tremendously, with a long-run average of 0.2 percentage points per year. The national accounts measure of investment, gross capital formation (GCF)—i.e., gross fixed capital formation (GFCF) plus a typically very small volume of inventory investment—contributed 4.0 percentage points per year while exhibiting quite some variation in its contribution from year to year. Although consumption's average

annual contribution to growth is larger than that of GCF, throughout the 2000s GCF is as important as consumption for determining each year's economic growth rate.

[Figure 2 about here]

This is different from the U.S. and Germany. In the U.S., following a slightly different growth decomposition in the official statistics, private consumption played a much more important role for economic growth: it contributed 1.9 percentage points to the average annual real GDP growth rate of 2.7 percent in the period 1978-2017. Gross private domestic investment contributed 0.6 percentage points, net exports negative 0.1 percentage points, and government consumption 0.3 percentage points. In Germany, the average annual contribution of GCF to economic growth in the period 1992-2017 was zero (with 1992 being the first year for which the data are available). The average annual real GDP growth rate of 1.3 percent was driven by consumption (0.9 percentage points) and net exports (0.4 percentage points).[1]

Two findings stand out. First, from a short-run (annual) point of view, investment plays a much larger role for economic growth in China than it does in the U.S., let alone in Germany. Second, investment's annual contribution to economic growth is much more volatile than that of consumption. A government focused on stable annual real GDP growth will want to use its policy tools to influence the volume (and growth) of investment.

2.2 The long run: supply-side analysis

From a supply-side point of view, annual investment adds to the existing physical capital stock. GDP is produced using the services provided by the accumulated physical capital stock, labor, and a third factor that represents everything that is not captured by capital or labor inputs ("total factor productivity," TFP).

Figure 3 shows China's annual real GDP growth rates and their decomposition into the growth of capital, labor, and TFP. In the long-run analysis covering 1979-2015, labor growth contributed only 0.9 percentage points to the average annual 9.6 percent real GDP growth rate. TFP growth contributed 4.8 percentage points, and capital growth 3.9 percentage points.

[1] For the U.S. and the German data see https://www.bea.gov/iTable/index_nipa.cfm and https://www.destatis.de/EN/Homepage.html.

While in the early years of reform, growth in labor contributed up to two percentage points to annual real GDP growth, the contribution of labor has virtually vanished by 2015. The growth in China's labor force is about to turn negative. As a result, all future growth will have to come from TFP growth and capital accumulation.

[Figure 3 about here]

Policy makers do not have available a channel through which to predictably influence TFP, a residual that captures everything from institutional factors to the education level of the labor force and the rate of capacity utilization. While one might envisage a causal relationship between market-enhancing economic reforms and TFP growth, the precise nature of the relationship is unclear (what kind of reforms matter, how big is the impact, what is the time lag?). Pursuing TFP growth through specific government policies in order to achieve stable GDP growth thus is not a reliable policy.

What remains is capital accumulation: more physical capital of the same quality, or capital of better quality.[2] The government's "Made in China 2025" policy, for example, targets innovation and thereby investment in higher-value ("better") capital. Some types of investment may yet have positive externalities (such as network effects) which can lead to TFP growth.

3. China invests a lot for good reason

At first sight, China's investment rate at close to half of GDP appears exorbitantly high. However, in a cross-country comparison China's investment behavior comes as no surprise.

Figure 4 shows the share of GCF in GDP for a selection of countries. For comparability, all data are taken from the Penn World Tables (PWT 9.0), which cover the years 1950 (or later) through 2014.[3] The data in the Penn World Tables are in purchasing power parity (PPP) terms, i.e., adjusted for price differences between countries.

[2] Capital accumulation captures embodied technological progress (in form of capital of better quality, and thereby of higher value). Firms do not buy an abstract concept of technology and a piece of pig iron, with the pig iron then miraculously transformed by the abstract concept of technology into a robot.

[3] China's recent investment rates reported in Figure 4 exceed those reported in Figure 1. The Penn World Table data are in purchasing power parity terms and make adjustments to the official Chinese data. (The adjustments have been questioned by Holz, 2006.)

In China, the share of GCF in GDP rose from 5-10 percent in the early 1950s to approximately 15 percent by the late 1970s. It hovered around 20 percent until the mid-1990s and then gradually rose to the current level of close to 50 percent.

In Japan, the ratio peaked at the 40 percent mark in 1973, then gradually fell back to just above 20 percent in 2014. Around its peak, the ratio stayed at a high level of around 35 percent for more than two decades. In South Korea, the ratio peaked repeatedly around the 40 percent level between the late 1970s and the mid-1990s, with continued high ratios until today. In Taiwan, the ratio peaked at just above 30 percent in the 1970s and stayed around 25 percent thereafter.[4]

There appears to be a pattern whereby developing economies experience a period of rising levels of investment relative to GDP. Invariably, the ratio of investment to GDP peaks and falls back, but the turn-about tends to be prolonged (measured in decades). Germany fits this pattern, too, albeit at an earlier point in time. The U.S. may have experienced a peak in its investment rate prior to the period covered by the Penn World Tables.

China thus is no different from other economies in take-off. China is exceptional only in the years 2008-2014 (with data availability ending in 2014). The U.S. financial crisis of 2008 triggered an economic stimulus package in China targeting infrastructure investment. China's extraordinarily high investment rate since 2008, thus, may simply reflect the use of investment policy as a tool of macroeconomic stabilization. The high investment rates then are the outcome of a—likely temporary—reliance on investment to achieve economic growth goals.

Viewed differently, countries undergoing a process of economic development tend to have a relatively high investment rate at low levels of economic development (Figure 5) China fits the pattern well, except for the post-2007 stimulus period when China's investment rate reached exceedingly high levels. Regarding the duration of high investment rates, Figure 5 also shows that China's investment rate is likely to remain relatively high until China's

[4] Taiwanese investment in (mainland) China is not included in Taiwan's GCF.

output per employee has almost doubled. At an annual seven percent real GDP growth rate, that would take another ten years.

[Figure 4 and Figure 5 about here]

The pattern of a first rising, then falling investment rate is supported by a demographic rationale. For the case of China, with the one-child policy starting in 1980, the share of employees in the population rose (due to relatively fewer children), leading to more income and thereby more savings, which are then invested. The demographic transition has now entered the second phase, when the share of employees in the population falls (as relatively more people retire), and savings and investment come under pressure. A countervailing force, however, is a shrinking labor force in absolute terms, which provides incentives for substitution of capital for labor (i.e., continued investment).

A factor that supports strong investment in the future is continued urbanization. Between 1995 and 2016, China's urbanization rate (share of urban population) has risen from 29.0 to 57.4 percent. If the near-linear trend of the past continues into the future, an 80 percent urbanization rate will be reached in fifteen years' time.[5] The increases in the urbanization rate over the past twenty years went hand in hand with society-wide investment in residential housing that accounted for approximately one-fifth of total investment, slightly decreasing over time.[6]

Much scope for further investment stems from the fact that the amount of capital per employee in China is still relatively low. Compared to the U.S., China has a relatively growing investment volume (in comparable prices), rising from approximately 14 percent of US investment in 1978 to a 2.3-fold multiple of the U.S. value by 2014. In the same period, China's accumulated capital stock rose from 9 percent of the U.S. value to a 1.3-fold multiple. However, the amount of capital *per employee* in China is still far below that in the U.S., rising from 2 percent of the U.S. value in 1978 to 24 percent in 2014.[7] Thus, even

[5] The urbanization rate of the U.S. in 2017 was 82 percent and that of Germany 76 percent (Central Intelligence Agency, *The World Fact Book*, at https://www.cia.gov/library/publications/the-world-factbook/geos/us.html, accessed 18 April 2018).
[6] See *Statistical Yearbook* 2017, p.31, for urbanization data, and p. 295 for residential housing investment data (which only start in 1995).
[7] The same patterns hold in a comparison to Germany, except that U.S. investment and capital stock are four times higher than Germany's, in line with the differences in population and employment.

though investment and the capital stock in China are large, China is lagging far behind in terms of capital per employee, with a still four-fold gap in 2014.

4. Potential issues with investment-driven growth

Across the countries examined in the previous section, a high investment rate is invariably positively correlated with economic growth. China's investment-growth nexus, however, has been viewed as problematic in a number of respects: it takes an increasing amount of new capital to produce an extra unit of output (making future growth more expensive), much of investment is debt-financed (and not sustainable due to the interest burden on debt), and investment is state driven (and therefore not efficient).

While the analysis so far has focused on the national income accounts concept of investment, namely GFCF (and GCF), detailed sectoral, funding, and ownership-based investment data for China are only available for the investment measure "Fixed Asset Investment" (FAI). GFCF equals FAI, plus a few minor items (including imputed items), less the purchase of old structures and old equipment (which are included in FAI but not in GFCF).[8] The discussion in the following assumes that the FAI proportions by sector, funding source, and ownership form equally hold for GFCF.

4.1 Capital-output ratio: no long-term rise and no cross-country anomaly

A standard issue in development economics is the over time rising capital-output ratio or, in its marginal form, the rising *incremental* capital-output ratio (also known by its acronym ICOR): to produce an additional unit of output requires more additional capital than the previous unit of output did, implying that it will be ever harder for China to achieve economic growth through investment. Yet this widely accepted truism is not as straightforward as it may appear.

[8] The transition in the official data between the two concepts is problematic. ZHU, ZHANG, and LIU (2014) argue that the official FAI values imply higher values of GCF than the official ones; in a revision (2016) they question the quality of FAI values and focus on their conjecture that official GCF is obtained as residual. With consumption underestimated by approximately ten percentage points (ZHANG and ZHU, 2013, 2015), the official GCF values represent over-estimates.

Capital-output ratios may well exhibit an upward trend over time, but this trend is not uniform and can even reverse (Figure 6).[9] The most striking changes, in accordance with standard expectations, occurred in Japan and in South Korea, with their capital-output ratios in 2011 and 2014 about three times higher than those of the early 1950s. China's capital-output ratio quadrupled. In contrast, the capital-output ratio of the U.S. has remained rather stable over time, with even a slight decline. Capital-output ratios have also varied drastically across countries in the past, with the U.S. ratio twice that of Japan in the 1950s and 1960s. By the 2000s the capital-output ratios of all countries have converged. That makes sense in that firms competing in global markets likely use similar production technologies across countries.

Capital-output ratios tend to vary more systematically, positively, with development level (Figure 7). Yet the association is weak with the absence of a positive association for the U.S. China is a far outlier (high ratios at an early development stage). The cross-country data also show that low levels of development can come with a wide range of capital-output ratios; for a given value of GDP per employee, the highest capital-output ratio can be twice the lowest capital-output ratio.

[Figure 6 and Figure 7 about here]

The *incremental* capital-output ratio (ICOR) is yet more difficult to interpret. When annual changes in output are close to zero, the incremental capital-output ratio (change in capital divided by change in output) can assume values that go into the thousands. Removing outliers and taking three-year differences does create an upward trend for the incremental capital-output ratio over time (except for the U.S., where the trend is downward); the same holds with respect to the level of economic development.

What is new is that China's capital-output ratio (incremental or not) is relatively high—compared to the other economies—at low levels of economic development. A critic may argue that China's high capital-output ratio reflects inefficiency. If that is so, then the

[9] The data are from the PWT 9.0, except for Japan, for which PWT 8.1 data are used following communication with the PWT support team and acknowledgment of errors in Japan's capital data in the PWT 9.0. Big (yet unquestioned) discrepancies in capital stock data between PTW versions also occur in the case of China.

inefficiencies have at least been around for a long time given China's history of socialist development through central planning and the ensuing "investment hunger," i.e., a focus on capital accumulation almost irrespective of efficiency.

China's capital stock could also be systematically overestimated because in a rapidly developing economy physical assets may experience a much higher rate of (unexpected) obsolescence, not reflected in the depreciation rate, due to fast technological progress. China's capital stock is certainly relatively high due to the relatively high share of (capital-intensive) heavy industry in GDP. And it's hard to argue that China's cut-throat competitive private enterprises have nothing better to do than pile up useless capital.[10]

The conclusion is that a quick look at an aggregate capital-output ratio, incremental or not, conveys very little long-run information: capital-output ratios can go up or down over time (in this sample more up than down). Across countries, the same level of economic development can come with very different capital-output ratios.

4.2 Investment does not lead to unsustainable debt levels

Another common concern is that investment in China is the cause of severe and unsustainable levels of indebtedness. Overall debt in China has risen to, depending on source, 250-330 percent of GDP, and that in turn may raise questions about the sustainability of investment.

Comprehensive treatments of debt in China already exist and are not the subject of this paper.[11] Suffice to say that absent a large volume of foreign debt there is no obvious trigger for a financial crisis as the central bank can always create whatever liquidity is needed. Aggregate debt is exactly that, a measure of total debt of households, firms (financial and

[10] In general, capital-output measures suffer from severe deficiencies. (i) Relating capital changes to output changes is problematic because capital values depend on such measures as the depreciation rate, which in turn depends on such factors as climate, tax regulations, and planned obsolescence. Variations in depreciation rates etc. affect capital but not output, softening any relationship between capital and output. (ii) Capital stock calculations, in particular those constructed for cross-country comparisons, typically assume a *uniform* depreciation rate across countries. But what if China's capital stock is in heavy industry and depreciates over 50 years, while a comparison country's capital stock is in software and depreciates over 5 years? If one assumes that one unit of investment leads to one additional unit of output in both countries, i.e., the two countries perform identically in terms of additional output derived from additional capital, then the application of a uniform depreciation rate across countries will show China's capital-output ratio to be many times higher than that of the comparison country. In other words, equally efficient use of investment leads to vastly different capital-output ratios due to different depreciation rates associated with different types of investment.

[11] For one such comprehensive treatment, see Shih (2017).

non-financial), and the state; it is balanced by total assets that accumulate to approximately 900 percent of GDP.[12] None of these debt and asset measures have an immediate impact on investment. This is not to deny that a high debt-to-GDP ratio may constitute a warning signal, but hypothesizing possible singular events and speculating on their likelihood of occurrence and on their effects is not the topic of this paper.

The detailed investment data show that the share of credit in the financing of investment in 2016 was only 11 percent (Figure 8). An 11 percent debt-financed share of investment is exceedingly small.

The shares of "own" and "other" funds were 67 and 16 percent (and that of foreign funds 0.4 percent).[13] One caveat, however, is that "own" funds include—besides "private capital" (*ziyou zijin*) of firms and institutions (presumably retained earnings)—funds collected from other units. Thus, some of the "own funds" could have been obtained by, for example, issuing bonds. The funding statistics offer no breakdown. "Other" funds cover everything not included in the other four categories, from "funds collected from society" and funds collected from individual people to donations and transfers from other units.

Shadow financing of investment via "own" or "other" funds is likely limited. First, the proportions of "own" and "other" funds in total investment financing has always been high, even before the days of shadow financing (Figure 8). If earlier years had known no shadow financing and all recent increases in "own" and "other" funding were due to shadow financing, then 10-20 percent of today's investment financing is possibly due to shadow financing.

Second, data on total social finance—not limited to investment financing—show that newly issued trust loans, entrusted loans, bankers' acceptances, and corporate bonds in 2016 accounted for 6 percent of GDP.[14] Under an unrealistic assumption that all of these funds

[12] See, for example, https://www.bloomberg.com/graphics/2016-china-debt/, accessed 23 May 2017.
[13] The share of state budget appropriations was 6 percent (down from 28 percent in 1981, the first year for which the data are available).
[14] The highest percentage in GDP was reached in 2013 with 12 percent (and around 11 percent in 2010 and 2012, and 8 percent in 2011), up from 2 percent in 2005. *Statistical Yearbook 2015*, pp. 58 and 635.

financed investment, approximately 12 percent of investment was funded via these channels (since approximately half of aggregate expenditures are investment).

None of these alternative funding sources are necessarily unsustainable. There is nothing intrinsically wrong or limiting about loans extended by trust companies (with new lending in 2016 equal to 3 percent of GDP), entrusted loans (1 percent), bankers' acceptances (negative 3 percent), or enterprise bonds (4 percent). Widespread reports of non-repayment of such borrowing could be an indicator of unsustainability, but have so far not occurred. There is also no danger of foreign creditors calling in their loans: virtually all of China's investment financing is sourced domestically. Foreign funds in 2016 accounted for just 0.4 percent of all investment financing, down from a peak of 12 percent in 1996.[15]

[Figure 8 about here]

4.3 Investment is not simply state-driven

The final concern is that investment in fixed assets is driven by the state, and that because state ownership is less efficient than private ownership, investment in China is not as productive as it would be if it were solely by private enterprises. The data on investment according to the registration form or ownership of the investing unit—vs. *source* of investment *funding* in the previous section—tell a different story.

First, categorizing investing units by registration status (Figure 9), investment in state-owned units accounts for only 21 percent of investment in 2016, a big drop from the 82 percent share in 1980 (the first year, for which these time series data are available). Investment by private units accounted for 33 percent of all investment, and investment by shareholding units for another 36 percent. The remainder (10 percent) was undertaken by collective-owned enterprises, foreign-funded enterprises, Hong Kong / Macau / Taiwan ("HKMT") enterprises, "joint" enterprises, and "others."

[15] In 2016, foreign funding accounted for more than 2 percent of total funding in just two out of the approximately 100 second-digit sectors: communication, and other electronic equipment (5.3 percent), and instrument manufacturing (2.1 percent); another three sectors reached between one and two percent. For the data see *Statistical Yearbook 2017*, pp. 314-7.

One caveat is that shareholding units include some state-controlled listed stock companies and partially state-owned limited liability companies. This means that state ownership may extend beyond the category "state units." For the subset of "investment, excluding by rural households," in 2016 accounting for 98 percent of total investment, a purely ownership-based breakdown is available. The share of state-owned and state-controlled enterprises (SOSCEs) in 2016 was 36 percent compared to a private share of 49 percent. The shares of collective, HKMT, and foreign-funded enterprises were 3, 2, and 2 percent (Figure 10), while an implicit residual (total less all individually listed ownership categories) amounted to 8 percent. In other words, enterprises under some form of state control in 2016 accounted for about one-third of investment. That is down from close to one-half a decade earlier.[16] Furthermore, state investment is concentrated in public goods sectors, with the state share of investment in manufacturing in 2015 being only 7 percent. This means that any efficiency concerns related to state ownership must be limited to a very small share of the non-public goods economy.

[Figure 9 and Figure 10 about here]

Second, there is a temptation to equate state investment with inefficiency. In the aggregate, the state sector may well be less efficient than the non-state sector, as Brandt and ZHU (2010), among others, find. Yet, at the very least, one has to distinguish between the remnant of unreformed, traditional state-owned enterprises, and state-owned enterprises that have undergone the transition to the "modern enterprise system" and may not perform much differently from private enterprises. Even when the efficiency of investment in the state sector is wasteful, it may still have positive externalities ranging from employment maintenance to supporting growth in other enterprises. Categorically viewing state investment as inferior appears too simplistic.

5. What does China invest in?

[16] As explained in Holz (2019), the 2016 uptick in the state share likely is a statistical artifact.

A multitude of FAI data allow analysis of the distribution of investment across sectors, identification of the sectors in which investments grows fastest, analysis of the distribution of investment per employee across sectors, and evaluation of the role of foreign firms.

5.1 Sectoral distribution of investment

Four-fifths of investment in China is concentrated in just five out of the 19 first-digit economic sectors: in 2016, manufacturing alone accounted for 31 percent of investment, followed by real estate (23 percent), environment and public facilities (11 percent), transport, storage and post (9 percent), and utilities (5 percent). Compared to 2010, there has been a gradual trend away from manufacturing and real estate towards a broader distribution of investment across sectors. The 1.0 percent share of IT (information transmission, computer services and software) in both 2010 and 2016 appears quite small; the share of science grew from 0.5 to 0.9 percent.[17]

Comparable investment data for the U.S. are not available. In the case of Germany, only GFCF data are available (the more desirable measure of investment to begin with). In 2016, manufacturing and real estate together accounted for half of all investment in Germany, as they do for investment in fixed assets in China (albeit with inverse proportions in the German case, real estate accounting for 31 percent and manufacturing for 19 percent). In Germany, investment is less concentrated across sectors than in China; IT accounts for 4 percent of GFCF, and science for 3 percent. The comparison between Chinese and German investment patterns suggests that China is not unusual and that the sectoral trends apparent in China between 2010 and 2016 likely reflect a movement towards a more developed economy pattern.[18]

5.2 In which sectors does investment grow fastest?

[17] For the data, see the NBS database.
[18] For the German data, see https://www.govdata.de/suchen/-/details/destatis-service-81000-0115 (accessed 6 May 2018). In the case of the U.S., neither the Bureau of Economic Analysis nor the Bureau of Labor Statistics offer data on investment (or GFCF) by industry.

Detailed sector investment data covering approximately 1200 (first- through fourth-digit) sectors are available for urban investment in 2003–2010, and covering 1400 sectors following a new sectoral classification system for "investment, except by rural households" in 2012, 2014, and 2015. Focusing on the thirty fastest-growing sectors in the periods 2003-2010, 2012-2014, and 2014-2015, typically fourth-digit sectors, the following patterns emerge.[19]

First, over the three periods, the thirty fastest-growing sectors account for an ever smaller share of investment: 1.7 percent in 2010, where one would expect 3 percent (30 divided by approximately 1000 fourth-digit sectors), 0.34 percent in 2014, and 0.09 percent in 2015. This suggests that fast-growing investment in a particular sector primarily serves to develop a previously small, likely underdeveloped sector, reflecting a catch-up process or the completion of an industrial structure more than any kind of specialization.

Second, the sectoral focus shifts over time. In the first period the fastest-growing sectors are almost equally distributed across the economy; industry accounts for half of the fastest-growing sectors with 6 mining sectors, 8 manufacturing sectors, and 1 utility sector. By the second period, none of the mining or utilities sectors makes it into the group of 30 fastest-growing sectors, and only 6 manufacturing sectors do. More of the fastest-growing sectors now are in financial intermediation, leasing and business services, and "culture, sports and entertainment." "Water conservancy, environment, and public facilities" newly enters with three sub-sectors. In the third period the number of industry sectors is reduced to 5 marginal manufacturing sectors,[20] the same number as in agriculture (of which 3 are cash crops: sugar plantation, banana and other subtropical fruits, and spice crops). IT with 2 sectors and science with 2 sectors newly enter the 30 fastest-growing sectors. Almost one-third of the 30 fastest-growing sectors are accounted for by 3 finance and 6 leasing and business service sectors.

This implies a broad-based shift of investment growth out of mining and manufacturing and into the tertiary sector, reflecting a gradual structural change towards the tertiary sector,

[19] To illustrate the specificity of these sectors, the first ten (following the official classification system) of the thirty fastest-growing sectors in 2003-2010 were: tobacco cultivation, bamboo harvesting, inland fishery, antimony ore mining, aluminum mining and dressing, magnesium dressing, other commonly used non-ferrous metals, other precious metals mining and dressing, radioactive metal ore mining, and guns and similar appliances.

[20] These are hemp-dyeing, enamel sanitary ware, fishery machinery, special instruments for agriculture, and instrument repair.

accompanied by commercialization of agriculture. The Chinese economy thereby follows a common progression in economic development.

5.3 Sectoral distribution of investment per employee

China's investment and employee data can be matched for 2010 (the year of the last population census) at the level of the approximately one hundred second-digit sectors. In many of these second-digit sectors, investment per employee was relatively small (Figure 11). It is high only in traditionally capital-intensive sectors such as the extraction of petroleum and natural gas, production and distribution of electric power and heat power, railway transport, the real estate sector, and management of public facilities.

China's 36 mining and manufacturing sectors tend to systematically receive relatively high levels of investment per employee (Figure 12, left side), with an approximately normal distribution of sectors across investment size per employee. As long as manufacturing continues to be a major pillar of the Chinese economy, the investment rate continues to be high.

Germany with its 28 mining and manufacturing sectors exhibits a rather similar distribution of investment per employee as China, except for a more distinct peak in the case of Germany (Figure 12, right side, covering the year 2013 when the German data are richest). With the Euro categories chosen to roughly match the RMB categories, the similarity of the distributions suggests that China's industrial structure approaches that of a more developed economy.

[Figure 11 and Figure 12 about here]

5.4 The role of foreign firms

In 2015, foreign-funded enterprises accounted for 2.0 percent of total investment, and firms from Hong Kong / Macau / Taiwan (HKMT) for another 2.4 percent, down from their peaks of eight and five percent around 1996-1998. Is investment by these non-domestic firms possibly located in the most promising growth industries, or providing crucial technology to China? Across the approximately 100 second-digit sectors, non-domestic firms' investment share is highest in the following five sectors:

"computer, communications, & other electronic equipment manufacturing" (21 percent),
internet and related services (17 percent),
"other" financial industry (17 percent),
automotive manufacturing (15 percent), and
leasing industry (11 percent).[21]

These five sectors are indeed biased towards technology or potential growth, but the non-domestic share in investment in these sectors is nowhere near dominant. Non-domestic firms don't breach the 10 percent barrier in any other promising sectors (from software and information technology to science and research related sectors).

6. The importance of size

China's size is a new phenomenon in the study of developing economies. South Korea tried to develop a broad industrial base but soon began to specialize. Taiwan quickly abandoned plans for broad-based economic growth and focused on developing areas of comparative advantage, in many instances focusing on niche markets. However, for China there are as yet no signs of significant specialization, rather to the contrary.

Viewed from an international perspective, focusing on comparative advantage makes little sense for China: world demand may simply not be big enough to support any substantial degree of specialization in China. For example, for some electronics products China may already be the dominant world supplier, without, however, the electronics manufacturing industry dominating the Chinese manufacturing sector. If world demand has driven specialization in production by China, then in the Chinese economy the resulting degree of

[21] Across the approximately 1400 first- through fourth-digit sectors, non-domestic firms' investment share is highest in the following five third- and fourth-digit sectors: futures market management services (84 percent), integrated circuit manufacturing (69 percent), "other" rail transport equipment manufacturing (45 percent), video recording and playback equipment manufacturing (44 percent), and automobile manufacturing (40 percent). For the data see *Investment Yearbook 2016*, Table 2.1.10; the coverage is "investment, excluding by rural households."

specialization is barely noticeable. Consequently, one can expect to see ongoing investment across virtually every sector of the Chinese economy.

If the experience of more developed economies is anything to go by, labor-intensive low value-added jobs will eventually move to less developed countries. The Chinese leadership is pushing broad-based innovation in China—with significant support for the development of artificial intelligence, robotics, and other sectors, as outlined, among others, in the 2015 policy "Made in China 2025"—in an attempt to reach the technological frontier and to create high-value added jobs. That requires continued investment.

7. Conclusions

The key findings are: Investment has been an important driver of economic growth in China both in the short and in the long run. China's high investment rate is in line with the experiences of other East Asian economies, and a relatively large volume of further investment is needed to catch up with developed economies in terms of capital per employee. Various concerns about the level of investment do not necessarily suggest an impending drastic reduction in the investment rate. China is investing across all sectors of the economy, leading to broad-based economic development rather than specialization, and China's sectoral investment patterns match those of a developed economy.

China's investment rate can be expected to fall with further economic development, following the historical trajectories of other countries. Yet the experience of other countries also suggests that the investment rate, before declining significantly, tends to stabilize at a high level for one to two decades. Given the decline in the Chinese labor force, the relatively large size of capital-intensive industry, and policy incentives to innovate and rationalize, China's investment rate may well remain at a relatively high level for a longer period of time.

Future investment in China is not 'more of the same.' Differential technological progress leads to changes in investment patterns across sectors. Previously less developed, or niche sectors increasingly become the target of an over-proportional share of investment. The Chinese government via its industrial policies favors investment in specific industries.

As long as economic growth features prominently in annual and five-year plans, investment will also continue to play an important role in ongoing economic policy. Through numerous administrative measures, from varying the rules for real estate property (or second property) purchases to guided interest rates and favored (or dis-favored) sectors for investment, the Chinese leadership ensures that annual investment is on track to achieve annual growth targets.

While China is often viewed as having reached middle income status—or, more likely, an amalgam of high income islands within a larger lower-middle income sea—the patterns identified in this paper provide no evidence of a "trap." Although the investment rate has peaked, the absolute value of investment continues to grow, as does capital per worker and thereby output per worker. If China's sectoral investment patterns already now closely follow those of Germany then, once China's capital stock per worker has reached Germany's level (and educational levels approach those in Germany and supporting institutions develop), there would seem little room for China's income levels to remain a fraction of those of Germany.

A striking development is the drastic drop over the past twenty years in the share of investment by foreign firms (to currently approximately 4 percent of investment), leaving foreign investment concentrated in a very few sectors and even then playing no more than a minor role. It is hard not to conclude that China's growth story today is predominantly a domestic one.

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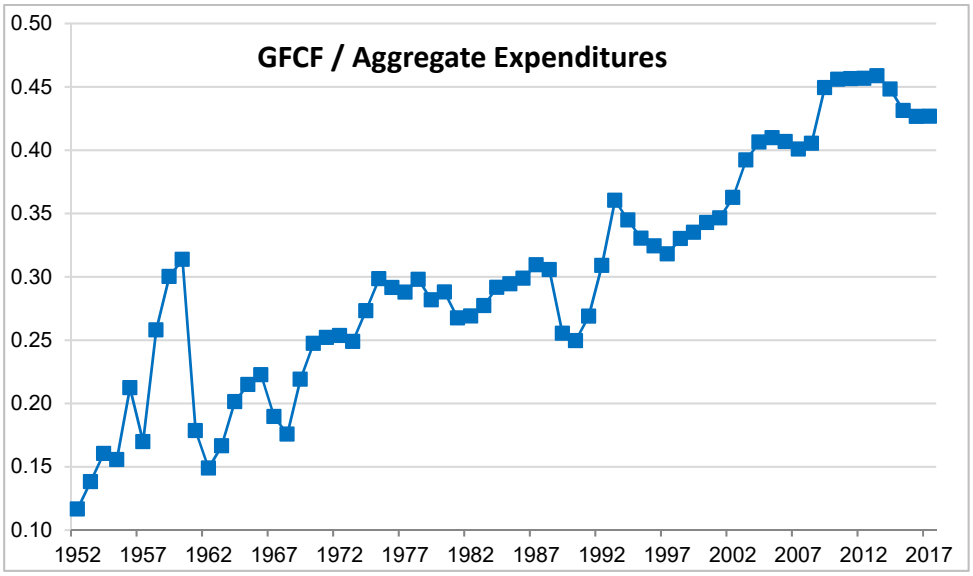
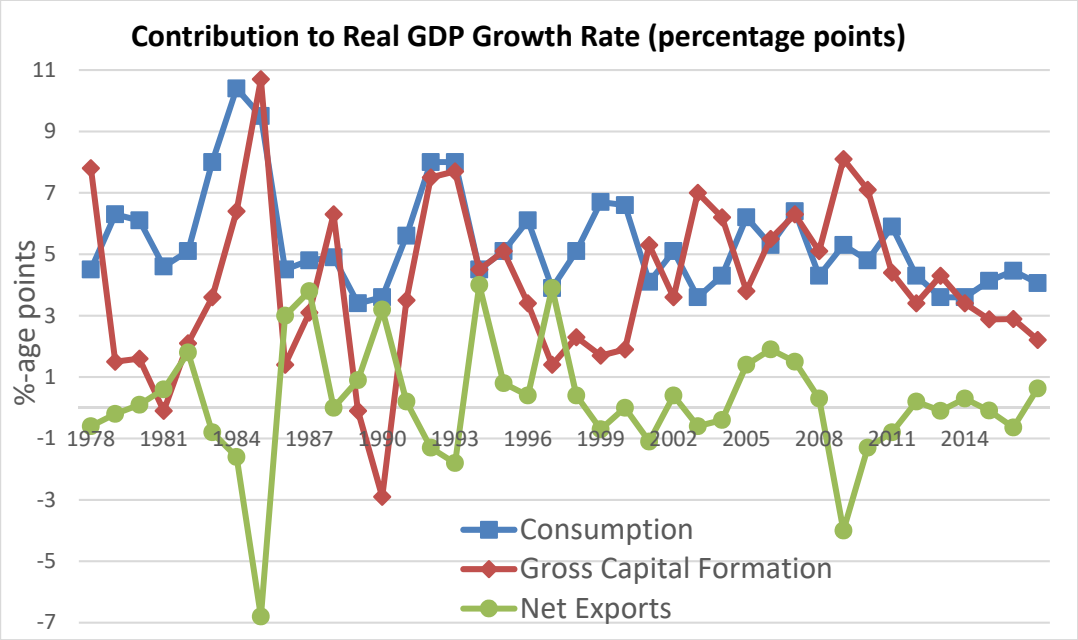


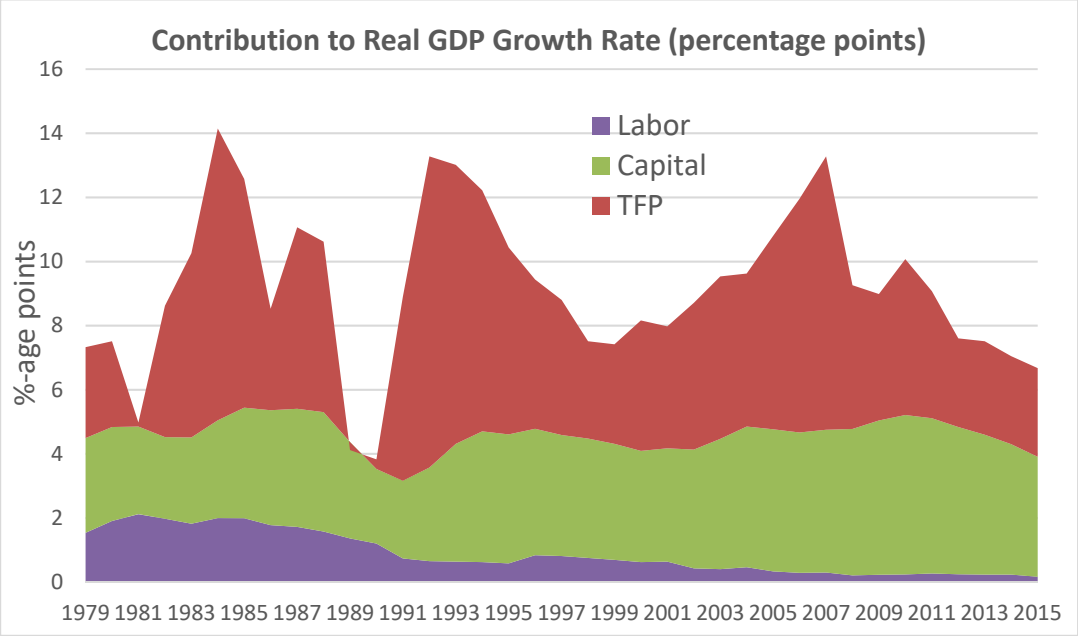
Sources: *Sixty Years*, *Statistical Yearbook*, NBS database, CEIC.

Figure 1. Gross Fixed Capital Formation Relative to Aggregate Expenditures



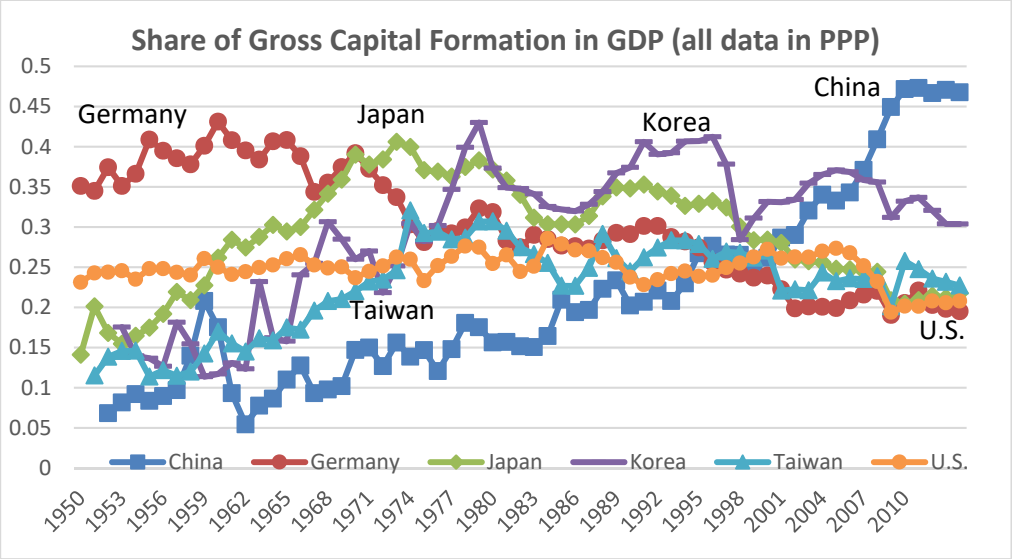
Sources: *China Statistical Yearbook 2016*, CEIC.

Figure 2. Annual Contributions to the Real GDP Growth Rate



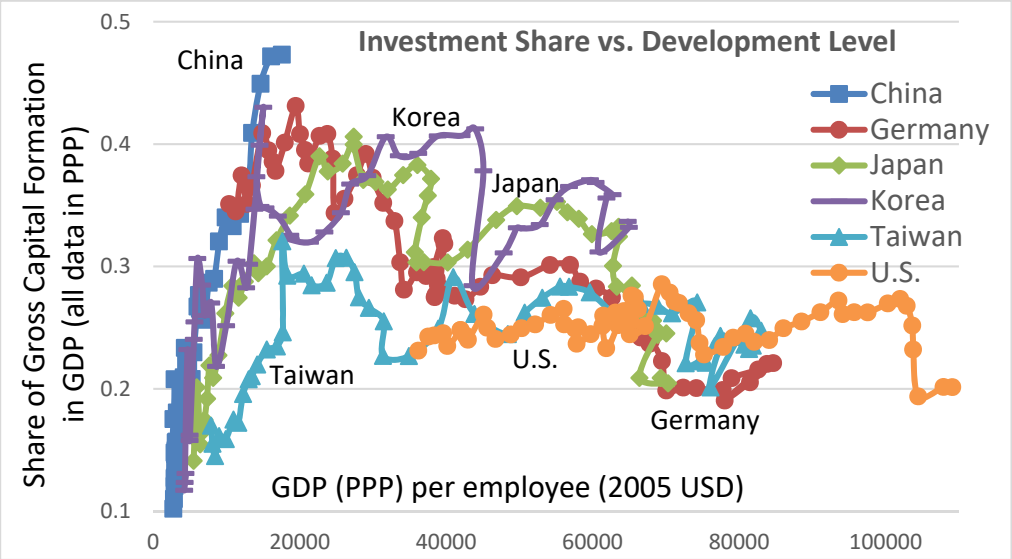
Sources: NBS database, Holz and SUN (2017). Average annual TFP growth and coefficients of capital and labor are first estimated in a Cobb-Douglas production function estimation with a constant-returns-to-scale constraint. In a second step, using the estimated coefficients of capital and labor as well as the known values of output, capital, and labor, year-specific TFP growth (reported in the figure) is obtained as residual.

Figure 3. Long-run Contributions to the Real GDP Growth Rate



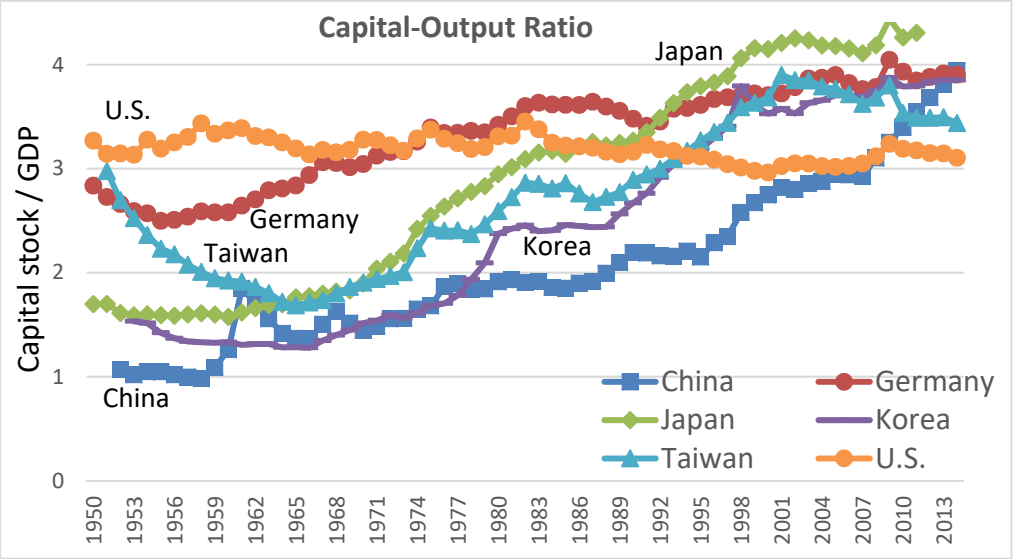
Source: PWT 9.0. Variable: share of gross capital formation at current PPPs in output-side real GDP at current PPPs (in 2005 USD).

Figure 4. Share of Gross Capital Formation in GDP



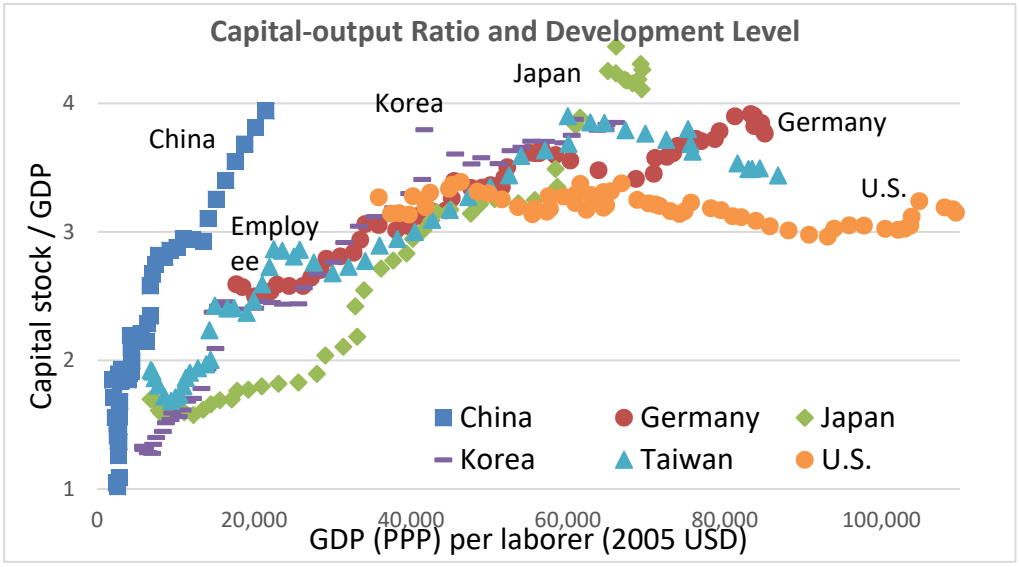
Source: PWT 9.0. Variables: share of gross capital formation at current PPPs in output-side real GDP at current PPPs (in 2005 USD); output-side real GDP at chained PPPs (in 2005 USD) per person engaged. Values are for 1950-2014 as available.

Figure 5. Investment Share in GDP by Development Level



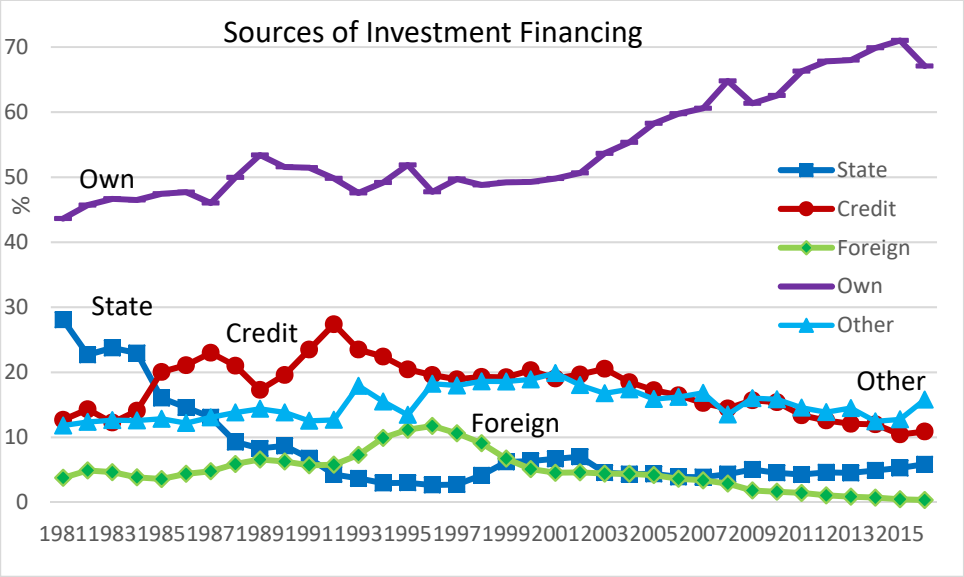
Source: PWT 9.0. Variable: capital stock at constant 2005 national prices (in 2005 USD) divided by real GDP at constant 2005 national prices (in 2005 USD). Japan values are from the PWT 8.1 due to errors in Japan's capital data in the PWT 9.0, and end in 2011.

Figure 6. Capital-Output Ratio



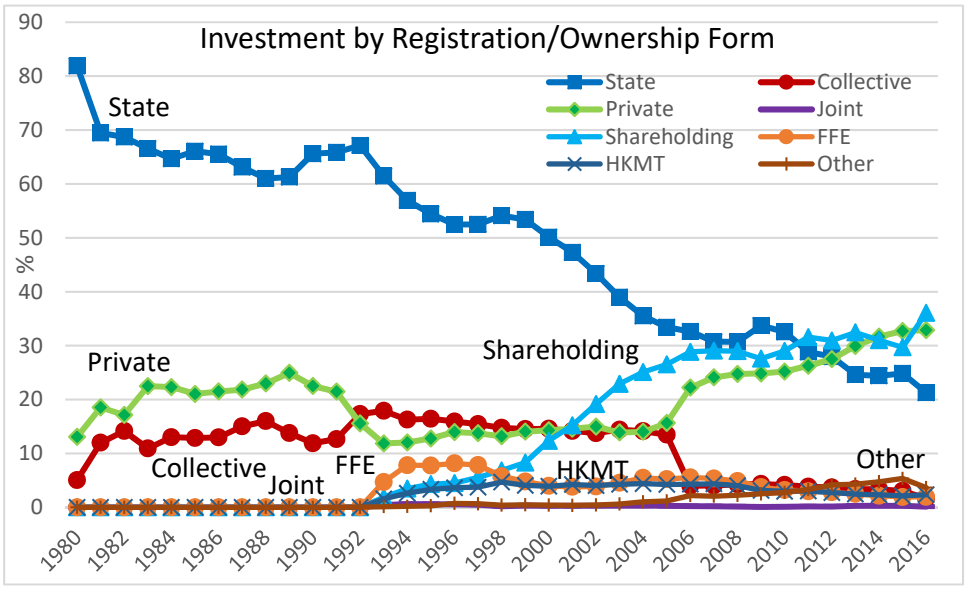
Source: PWT 9.0. Variables: capital stock at constant 2005 national prices (in 2005 USD) divided by real GDP at constant 2005 national prices (in 2005 USD); real GDP at constant 2005 national prices (in 2005 USD) per person engaged. Values are for 1950-2014 as available. Japan values are from the PWT 8.1 due to errors in Japan's capital data in the PWT 9.0, and end in 2011.

Figure 7. Capital-Output Ratio by Development Level



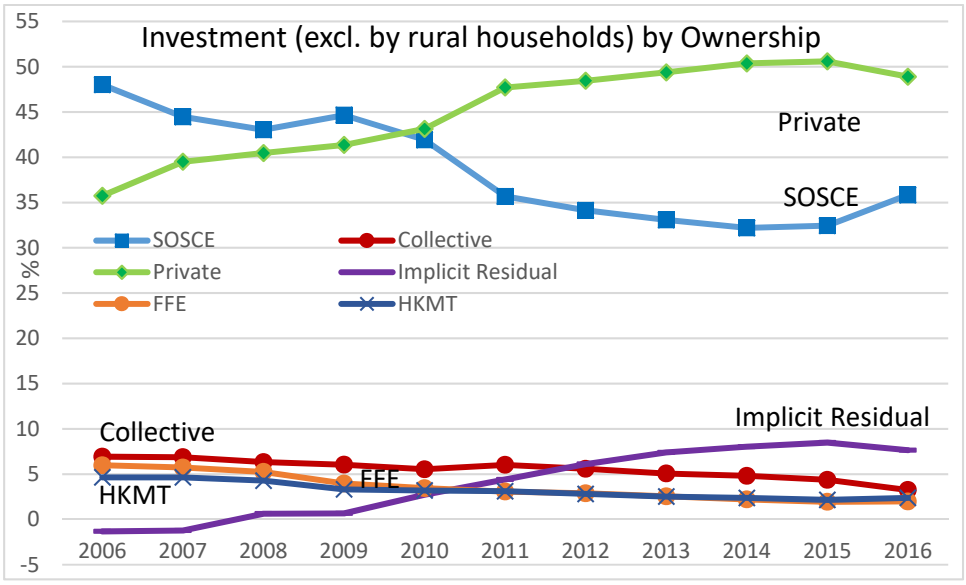
Source: NBS database. For 1981-1984 and 1994, the two financing sources "own" and "other" are only available as one joint value; in 1985 and 1988, the joint value equals the values for "other" with no values available for "own." 1981-1985 values are obtained by splitting the joint value using the average proportions of 1986-1990 (which range, for "own," from 0.78 to 0.80). 1988 and 1994 values of "own" and "other" are obtained by applying the average shares of "own" and "other" in the joint values of the previous and next year. An implicit residual (total less all individually listed sub-categories) in the data of 1986, 1987, and 1989-1993 was included in "other." Total investment *financing* (the data presented here) equals the separately reported total *reported* investment in fixed assets (next figure) in 1981 through 1993, and in the years since falls short by 1-12 percent, with a steady trend towards the biggest discrepancy in 2010, followed by a steady reduction in the gap since then.

Figure 8. Sources of Investment Financing



Note: HKMT: Hong Kong, Macau, and Taiwan (enterprises). FFE: foreign-funded enterprises.
Sources: *Statistical Yearbook* and *Investment Yearbook*, various issues; NBS database for 2014-2016 data. Total investment in fixed assets by ownership form in the years 1986-1994, 1996, and 2010 differs slightly from the total investment in fixed asset values published in the NBS database (it is less by up to 6 percent, except for 2010, when it is 11 percent more, presumably due to the change in the coverage of the investment in fixed assets statistics (Holz, 2019)).

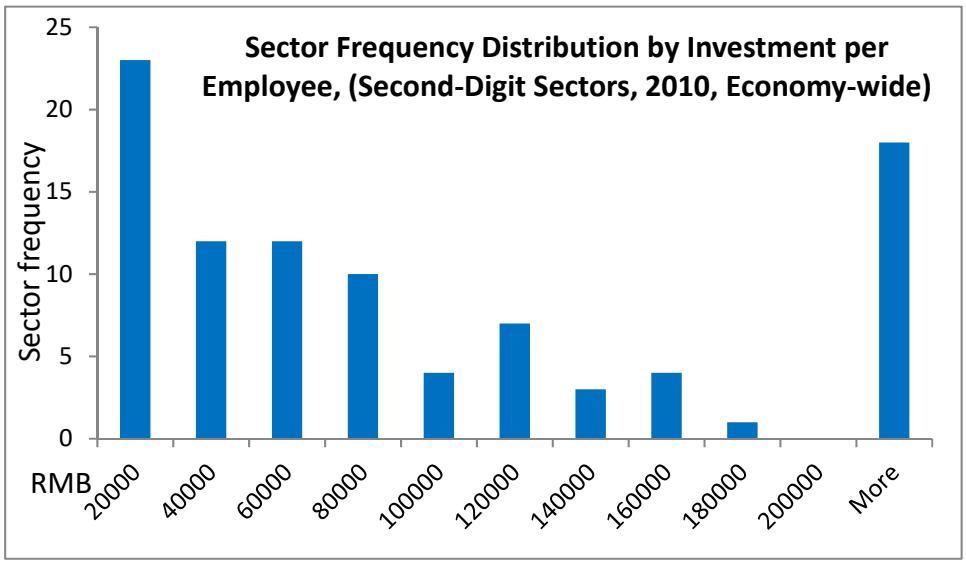
Figure 9. Investment by Registration/Ownership Form of the Investing Unit



Note: The source glosses over two statistical breaks. In 2010, the size criterion for inclusion in urban investment increased from CNY500,000 to CNY5 million, and in 2011 coverage switched from urban investment to "investment, except by rural households."

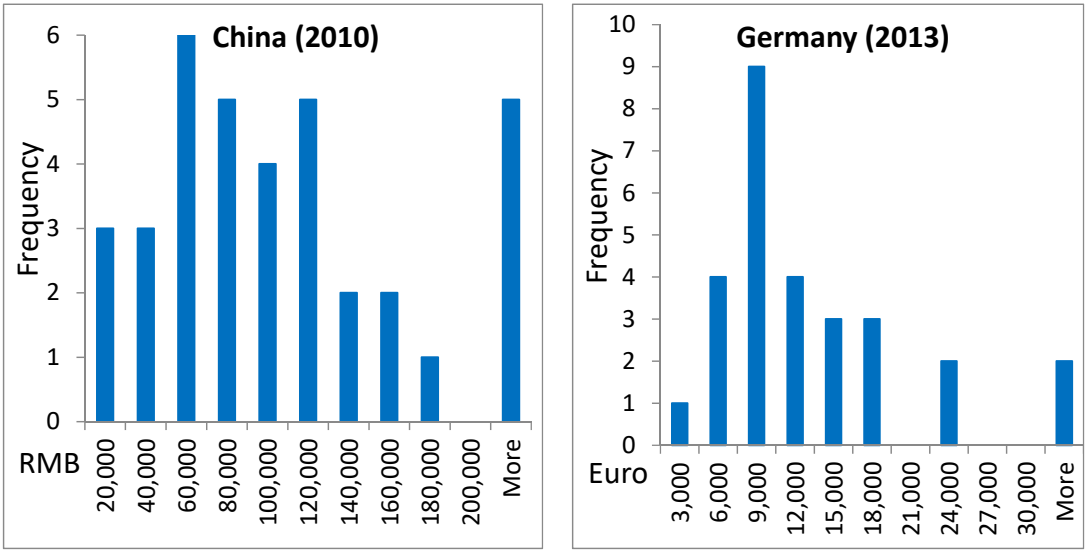
Source: CEIC (2004 and 2005 data would also have been available in the source, but the implicit residual (total less all individually listed sub-categories) in these two years was 16 and 21 percent, vs. -1 percent in 2006).

Figure 10. Investment (Excl. by Rural Households) by Ownership Form of the Investing Unit



Source: *Investment Yearbook*; own calculations to obtain an approximation of economy-wide values by sector (covering both urban and rural investment). 2010 Population Census data are from the NBS database; the approximately 10% subset on which employment values by sector are collected in a "long form" is approximated to the whole population using the ratio of total employment to long-form employment.

Figure 11. Sector Frequency Distribution by Investment per Employee, Second-Digit Sectors, 2010



Sources: China: See source of previous figure. Germany: Statistisches Bundesamt, Destatis database, https://www-genesis.destatis.de/genesis/online, Table 42231-001.

Figure 12. Frequency Distribution of Investment per Employee, Mining and Manufacturing