China's Investment Rate: Implications and Data Reliability

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26 November 2015

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For the past nearly forty years, China has experienced average annual real GDP growth of close to ten percent, much of it driven by investment and capital accumulation. By 2014, gross capital formation had reached 46 percent of aggregate expenditures. This paper documents the role of investment in driving economic growth in China, questions how much longer China can sustain a relatively high investment rate, and examines the arguments that have been offered for an impending drastic reduction in investment. The quality of the investment statistics and of the gross fixed capital formation statistics (the latter as part of the national income and product accounts) is assessed; these data are potentially problematic with no easy way for researchers to improve the data. The paper finally makes the point that investment in China remains broad-based across all economic sectors, with little specialization in sight; the size of the Chinese economy would appear to allow comprehensive development across all economic sectors. At the same time, the relative size of foreign investment in China has become negligible and the China growth story thus has become a domestic one.

Journal of Economic Literature classification codes, all China:
E01 Measurement and Data on National Income and Product Accounts and Wealth, Environmental Accounts
E22 Investment, Capital, Intangible Capital, Capacity
E6 Macroeconomic Policy, Macroeconomic Aspects of Public Finance, and General Outlook
O11 Macroeconomic Analyses of Economic Development
O53 Economywide Country Studies — Asia including Middle East

Keywords (all: China): investment rate, capital-output ratio, ICOR, national investment strategy, economic growth

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26 November 2015

[1] A short version of this paper has been published as "Hohe Inlandsinvestitionen: Ein Problem fuer China?" (High Domestic Investment: A Problem for China?), *China Monitor 29*, 27 November 2015, MERICS (Mercator Institute for China Studies, Berlin), available at http://www.merics.org/de/merics-analysen/analysechina-monitor/merics-china-monitor-no-29.html.

[2] The author thanks Bjoern Conrad, Sebastian Heilmann, and seminar participants at MERICS (Mercator Institute for China Studies, Berlin, 27 July 2015) for feedback on an earlier, shorter draft.

Executive Summary

- Investment is a key driver of economic growth in China, both in the short and in the long run. Capital accumulation plays a much larger role for economic growth in China than it does in two selected Western comparison countries, Germany and the U.S.

- The volume of investment is in good part the outcome of government macroeconomic policies. I.e., investment is a key channel through which the Chinese government fosters and shapes economic growth in China.

- The trajectory of China's rate of investment fits well with those of other East Asian economies. China's recent annual rates of investment, at approximately half of gross domestic product, exceed the peak rates of other East Asian economies. But the current high rate of investment could in part be due to measurement problems, with several percentage points likely reflecting consumption.

- The East Asian experience suggests that China's high rate of investment is at or near its peak. The completion of a real estate and infrastructure construction cycle in China will lower the investment rate. Structural change across economic sectors away from heavy industry further indicates a decline in the investment rate.

- China invests much more than Germany or the U.S. and has a higher capital stock than Germany and the U.S. However, the available volume of capital per laborer currently still is only one-quarter that of Germany or the U.S. China has much further scope for physical capital upgrading and expansion. In order to persist in catching up with developed economies, China will need to continue to invest a large share of its output.

- Various concerns about investment in China are unfounded. (1) Rising capital-output ratio: the development of China's capital-output ratio (incremental or not) is no different from other East Asian economies or Germany (though different from the U.S.). (2) Debt-financed investment: today, four-fifths of investment in China is financed out of retained profits or via other sources outside the fiscal system and the state banking system. (3) Inefficient state investment: today, only one-quarter of economy-wide investment occurs in state-owned units.

- China's domestic market size allows broad-scale economic development with continued expansion of investment in many sectors of the economy. Recent investment growth in China was more about individual sectors catching up than about individual sectors becoming dominant.

- The importance of foreign-funded investment and of investment in foreign enterprises in China has declined drastically over time to the point where China has the capability to sustain significant forward momentum on its own.

1. Introduction

Between 1978 and 2014, the size of the Chinese economy grew by an average annual 9.7 percent in real terms. Much of this economic growth can be accounted for by investment. The ratio of investment to economy-wide output, measured as the share of gross fixed capital formation (GFCF) in aggregate expenditures or, equally, in gross domestic product (GDP), has been rising drastically in recent years (Figure 1).

Development economics has long stressed the crucial role of investment for a country to take off on a self-sustaining growth path, and then to realize structural change as part of a continued growth strategy. In that respect, China follows traditional economic development patterns.

Investment policies have always featured prominently in the economic policies of the People's Republic of China. Today, the Chinese government directly influences the amount of investment by directing fiscal funds into investment, for example into infrastructure projects, or by channeling credit to government-supported investment projects. It can also use indirect policy tools such as interest rate policy and tax policy. Macroeconomic theory predicts that changes in interest rates impact on investment decisions of at least private firms, as do investment-related tax policies (for example, tax reductions for investment, investment subsidies, or accelerated depreciation rules). The volume of investment in China, thus, is closely linked to the regime's macroeconomic policies. This means that further economic growth is in good part a policy choice.

Creating growth through state-driven 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 appears to be at its peak, or to have already peaked, it is unclear to what extent investment will drive continued economic growth in the future. Raising the investment rate yet further would be historically unprecedented, economically questionable, and probably politically impossible. What then is the role of investment in future economic growth in China?

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

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 production and thereby economic growth. Annual real growth in aggregate expenditures can be decomposed into growth of its three components consumption, investment, and net exports. Figure 2 shows a relatively stable contribution of consumption to economic growth in China, of an average 5.5 percentage points per year from 1979 through 2014. 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), comprising investment in fixed assets produced and acquired this year plus a typically very small volume of inventory investment, contributed 4.0 percentage points per year.

Although consumption's average annual contribution to growth is larger than that of GCF, since the early 2000s GCF is as important as consumption for generating annual economic growth in China. Given that annual investment fluctuates more than consumption, stable annual economic growth is conditioned on a continuously growing stream of investment.

This is quite different from Germany and from the U.S. In Germany, the average annual contribution of GCF to economic growth in the period 1992-2014—with 1992 being the first year for which the data are available—was exactly zero (Figure 3). The average annual real GDP growth rate of 1.3 percent was driven by consumption (0.9 percentage points) and net exports (0.3 percentage points, with a 0.1 percentage point discrepancy to annual real GDP growth due to rounding).

In the U.S., following a slightly different growth decomposition in the official statistics, private consumption was the main driver of economic growth: consumption contributed 1.9 percentage points to the average annual real GDP growth rate of 2.7 percent in the period 1978-2014 (Figure 4). Gross private domestic investment contributed 0.6 percentage points, net exports negative 0.1 percentage points, and government consumption 0.3 percentage points.

Two findings stand out. First, investment plays a much larger role for GDP growth in China than it does in the U.S., let alone in Germany. Second, on an annual or short-run basis, investment's contribution to economic growth is much more volatile than consumption's contribution, across all three economies. Because investment is volatile, China's economic growth, in good part driven by investment, is volatile. Periods of relatively low growth may alternate with periods of relatively high growth.

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 accumulated physical capital, labor, and a third factor that represents everything which is not captured by capital or labor inputs, typically labeled "total factor productivity" (TFP).

Figure 5 shows China's annual real GDP growth rates and their decomposition into growth in the services of capital and of labor, plus TFP growth. In the long-run analysis covering 1979-2013 (with 2013 being the most recent year of analysis due to technical requirements in the construction of capital stock data), labor growth contributed only 0.9 percentage points to the average annual 9.8 percent GDP growth, TFP growth 5.0 percentage points, and capital growth 4.0 percentage points.

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 2013. Growth in China's labor force is about to turn negative. I.e., all future growth will have to come from TFP growth and capital accumulation.

TFP growth made major contributions to GDP growth in the early years of reform and then again in the mid-2000s. TFP captures everything from institutional factors to the education level of the labor force, the rate of capacity utilization, and the level of technology in use (and not embedded in capital or labor). Policy makers do not have available a direct and unambiguous channel through which to influence TFP. While one might envisage a link

between market-enhancing economic reforms and TFP growth, the precise nature of the link is unclear (how big is the impact, how fast do reforms feed through into TFP growth?). Pursuing TFP growth through specific government policies in order to achieve GDP growth thus is not a viable option.

What remains is capital accumulation. From the supply side, investment appears of supreme importance—more physical capital of the same quality directly leads to higher levels of output. Replacing old physical capital by better new physical capital also immediately leads to higher output. Some types of investment may yet have positive externalities (such as network effects) which then lead to TFP growth.

3. China invests a lot for good reason

China re-invests close to half of GDP every year (Figure 1). At first sight, this appears to be an exorbitantly high share. However, in a cross-country comparison China's investment behavior comes as no surprise, though China is extending the frontier.

Figure 6 shows the share of GCF in GDP for China in comparison to selected other countries. For comparability, all data are taken from the Penn World Tables, which cover the years 1950 (or later) through 2011. The data in the Penn World Tables are in purchasing power parity (PPP) terms, i.e., adjusted for price differences between countries.

In China, the share of GCF in GDP rose from approximately 10 percent in the early 1950s to approximately 20 percent by the late 1970s. It hovered around 20 percent until the early 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 2011. 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 and 35 percent levels between the late 1970s and the mid-1990s, with virtually uninterrupted high ratios from the mid-1970s until today. In Taiwan, the ratio peaked at just above 30 percent in the 1970s and stayed around 25 percent until 2000.

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 can be prolonged (measured in decades).

Germany fits this pattern, too, at an earlier point in time. In Germany, the ratio of GCF to GDP rose to a high of just short of 40 percent in 1960 before gradually falling back over the next 50 years to approximately 20 percent; the ratio was near or above 35 percent for a total of 12 years from the mid-1950s through the mid-1960s. In the chart, only the U.S. does not match the pattern, likely because it experienced an investment boom during World War II, prior to the period covered by the Penn World Tables (and prior to the adoption of a complete system of national accounts).

China thus is no different from other economies in take-off, except that its investment boom may be more pronounced. If the patterns of the other East Asian economies are anything to go by, China's investment rate will remain at a relatively high level for two to three decades.

Viewed differently, countries undergoing a process of economic development tend to have a relatively high investment rate at low levels of economic development. Figure 7, for the same selection of countries as before, documents that a low level of GDP per laborer is accompanied by a high share of GCF in GDP. China fits the pattern well, albeit with a tendency for relatively high investment rates at an earlier stage of economic development

than the other countries, and then reaching unprecedented high levels in the most recent years.[3]

Yet the recent high investment rates may not be what they seem; the accuracy of the recent investment rates is being questioned in a section below. China may also be a particular case due to its political system with a history of central planning that strongly favored investment over consumption. Even as output planning was dismantled in the early reform period, investment planning remained intact well into the 1990s and was only gradually relaxed.

Figure 7 confirms the findings of Figure 6 regarding the duration of high investment rates. Figure 7 suggests that while the investment rate may come down from its immediate peak, it is likely to remain at a relatively high level until China's output per laborer has tripled if not quadrupled. At a seven percent real GDP growth rate, that will take twenty years.

Similarly, investment in residential housing—accompanying continued urbanization—is likely to support a high investment rate for another twenty years. Over the past twenty years (since when data on residential investment became available), China's urbanization rate (share of urban population) has climbed from 29.0 to 54.8 percent and this trend shows little sign of leveling off (Figure 8). If it continues as in the past, an 80 percent urbanization rate will be reached in twenty years' time.[4] 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 one-fifth of total investment (and a sub-category "real estate" residential investment that accounted for just above 10 percent of total investment since 2000). For the past ten years, both series exhibited near-consistently double-digit real growth rates.

Compared to Germany, China has an increasingly larger investment volume (in comparable prices), rising from approximate equivalence in 1978 to a ten-fold higher investment value by 2011 (Figure 9). In the same period, China's accumulated capital stock—using the Penn World Tables' definition of capital stock—rises from a value half that of Germany's to a value four times Germany's. However, the amount of capital *per laborer* in China is still far below that in Germany, rising from 4 percent of Germany's value in 1978 to 23 percent in 2011.

The same picture emerges in a comparison of China to the U.S. (Figure 10), except that U.S. investment and capital stock are four times higher than Germany's, in line with the difference in population and employment numbers. The capital per laborer comparison also matches that in the case of Germany, with the amount of capital *per laborer* in China rising from 3 percent of the U.S. value in 1978 to 20 percent in 2011.

Thus, even though investment and capital stock in China are large, China is lagging far behind in capital per laborer. With output per worker intricately linked to the capital stock available to each worker, China thus has much further to go in increasing output by increasing the capital stock. While China has narrowed the gap to Germany and the U.S. between 1978 and 2011, today it is still a four- to five-fold gap. China's capital stock per laborer is still less than a quarter that in Germany and the U.S.

[3] China's recent investment rates reported in Figure 7 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 the author in published research.)

[4] The urbanization rate of Germany is 73.9 percent (2011) and that of the U.S. 82.4 percent (2011). See https://en.wikipedia.org/wiki/Urbanization_by_country (accessed 19 Sept. 2015).

4. Potential issues with investment-driven growth

Across countries, a high investment rate is invariably linked to high economic growth. The higher the investment rate, the higher economic growth, whether that is growth this period (Figure 11) or growth two years later (Figure 12). A growth objective thus implies certain investment objectives.

China's investment-growth nexus appears to be 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 Chinese investment is debt-financed (and not sustainable due to the interest burden on debt), and investment is state driven (and therefore not efficient). But these concerns are largely unfounded.

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 as ICOR): to produce an additional unit of output requires more additional capital than the previous unit of output did. But this widely known truism is not as straightforward as it may appear.

Capital-output ratios may well exhibit an upward trend over time, but this trend is not uniform and can even reverse (Figure 13). The most striking changes, in accordance with standard expectations, occurred in Japan and in South Korea, with their capital-output ratios in 2011 double those of the early 1950s. In contrast, the capital-output ratio of the U.S. has remained rather stable over time. China's capital-output ratio shows some variation but ends the period little above the beginning level. Capital-output ratios also vary drastically across countries: in 2011, Japan's capital-output ratio was twice that of Taiwan, and about a third higher than those of China and the U.S.

Capital-output ratios appear to vary more systematically with development level (GDP per laborer), but even that association is weak (Figure 14). The Chinese data, all at relatively low levels of development, hint at a negative long-run correlation: the capital-output ratio declines with increasing GDP per laborer. The U.S. data, at higher development levels, tell the same story. Germany, Japan, South Korea, and Taiwan, however, suggest a strong positive relationship between development level and the capital-output ratio.

The cross-country data show that any given level of development can come with a wide range of capital-output ratios. For a given value of GDP per laborer, the highest capital-output ratio can be twice the lowest capital-output ratio.

The *incremental* capital-output ratio is yet more difficult to interpret. When annual changes in output are close to zero, the incremental capital-output ratio can assume values that go into the thousands. Thanks to such outliers, trend lines, whether linear or polynomials, can assume rather unusual patterns (Figure 15). 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.). China's trendline has the lowest slope (and values at the lower end of the spectrum). I.e., among the selected countries (except for the U.S.), China's incremental capital-output ratio increases least from year to year (Figure 16).

If one examines the relationship between the level of development and the incremental capital-output ratio, the results are similar to the case of the (non-incremental) capital-output ratio (Figure 17). The trendlines slope upward, except for the U.S. What is new is that China's incremental capital-output ratio is relatively high—compared to the other economies—at low levels of economic development. The data show that this has always been the case and is not a phenomenon of only the recent years. The bunching of all observations

at a relatively narrow range in the level of development implies that future observations, should growth continue, may yet rotate the trendline significantly.

In sum, what these data imply 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), and the same development level can come with very different capital-output ratios.

If attention focuses on the recent years, one will notice that China's capital-output ratio has been gradually trending upward since the mid-1990s. But seen in perspective, both Japan and Korea's capital-output ratios are higher than China's and have been rising faster. Is that a sign that growth in China will slow, as it did in Japan and in Korea? There is no easy answer. Over the fifteen years through 2010, China's gradually rising capital-output ratio came with invariably high growth rates; since 2010, it doesn't.

Capital-output measures suffer from several deficiencies. First, capital-output ratios do not consider structural change: as an economy moves from heavy industry into services, an additional unit of output in services is likely produced with less additional capital than the previous unit of output in heavy industry. The capital-output ratio may rise only within an industrial sector, or in the course of structural change towards capital-intensive sectors.

Second, 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 things as climate, tax regulations, and obsolescence. Variations in depreciation rates etc. affect capital but not output, softening any relationship between capital and output. If one were to use current-period GFCF instead of capital, some of these difficulties could be avoided, but it is far from clear if the effects of this year's GFCF should be seen in output changes this year, next year, or, say, the five years starting two years from now.

Further, 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, 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. I.e., equally efficient use of investment leads to vastly different capital-output ratios due to different depreciation rates.

Third, China's capital stock could 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. High capital-output ratios are also a hallmark of planned economies, and thus China's capital-output ratio can be expected to be unusually high particularly in the early reform years, but possibly up through the present.

As a result, while the capital-output ratio and its derivative, the (well-known) incremental capital-output ratio, ICOR, constitute standard vocabulary in development economics, their use in short-run analysis, or in anything beyond rule-of-thumb analysis, appears limited. As an outgrowth of neoclassical thinking at the margin, in simple one- or two-sector models, the ICOR plays a crucial theoretical role, but once one allows for significant structural change and for the intricacies of a real world setting with varying capacity utilization and government polices ranging from industrial policy to depreciation-based tax deductions, its usefulness for understanding economic growth becomes rather limited.

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. A comprehensive treatment of debt in China is beyond this paper. Suffice to report that the share of state budget appropriations in the financing of investment in fixed assets in China has fallen from 28 percent in 1981 (the first year for which the data are available) to 5 percent in 2014 (Figure 18). The share of investment financed through credit rose from 13 percent in 1981 to a high of 27 percent in 1992 before falling back to 12 percent in 2014, while the share of foreign funds rose from 4 percent in 1981 to a high of 12 percent in 1996 and then fell to 1 percent in 2014. The residual consists of "own" funds (largely retained earnings) and "other" (unspecified) funding. By 2014, 70 percent of investment was financed through own funds and a further 13 percent through "other" funds, which, in the aggregate, hardly makes for an overly debt-financed investment scenario.

What might give rise to a different concern is the low share of foreign funds in investment financing in China, at just one percent today, down from a peak of 12 percent in 1996. Even if the foreign investment were all in crucial industries, the volume of foreign-funded investment (compared to total investment) is still exceedingly small.

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 could be if it were in private hands. Again, the data tell a different story (Figure 19). Investment by state-owned units, while accounting for 82 percent of all investment in 1980 (the first year, for which these data are available), accounted for only 25 percent of all investment in 2013 (the last year for which these data are available). Investment by individual/privately owned units accounted for 30 percent of all investment in 2013, and investment by shareholding units for another 32 percent (with the remainder undertaken by units in collective, foreign, Hong Kong / Macau / Taiwan, "joint," and "other" ownership). I.e., three-quarters of investment today occurs outside the state sector.

One caveat ist that shareholding units may well include state-controlled listed stock companies. I.e., the state may have a hand in more than just the investment by outright "state units."

There is a temptation to equate state investment with inefficiency. But that is too simplistic. State-controlled listed stock companies may not differ much in their behavior from private companies. And private companies could well be quasi state-controlled/-influenced via Party cell or other mechanisms. While some state investment could indeed be wasteful, some seemingly inefficient state investment may have positive externalities (for example, supporting growth in other enterprises, including private enterprises), whereas private investment tends to internalize all benefits. I.e., from an economy-wide, social perspective, even seemingly inefficient state investment may contribute to economic growth.[5]

The data on investment by ownership form moderates the observation in the previous section of very little foreign funding of investment in China, though not by much. While investment in foreign-funded enterprises accounted for (a peak) eight percent of total investment in 1994-1997 and investment by Hong Kong / Macau / Taiwan enterprises for (a

[5] Journalism and much of the research literature easily jumps to a conclusion of "state ownership bad, private ownership good," but when subjected to careful examination such a conclusion is not tenable. At the very least, one will have 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."

peak) five percent in 1998, by 2013 each of these ownership forms accounted for only two percent of total investment, in contrast, for example, to the state's share of 25 percent, or the shareholding companies' share of 32 percent..

5. China's investment data raise questions

China's GCF data are based on investment in fixed assets statistics. Both the derivation of GCF data from investment in fixed assets statistics and the investment in fixed assets statistics themselves are problematic. Further examination leads to the paradoxical conclusion that China's GCF is both under- and over-estimated, a contradiction that cannot be resolved.

Gross capital formation (GCF) comprises gross fixed capital formation (GFCF) and inventory investment. Inventory investment typically accounts for only a small share of GCF, on the order of lower single-digit percentages. What is of most interest is GFCF. Following the United Nation's System of National Accounts, GFCF refers to the total value of fixed assets produced and acquired within a given period.

China's National Bureau of Statistics (NBS) derives GFCF by adding to and subtracting from the relevant investment in fixed assets data. Thus, GFCF equals investment in fixed assets, plus:

- value-added created in the sale of real estate;
- fixed assets created in the prospecting for mineral resources and in the improvement of land;
- small-scale investment that is not captured in the investment in fixed assets statistics;
- investment in intangible assets such as computer software;

less:

- the purchase of old structures, old equipment, and land.

Thus, while the national accounts measure GFCF is intended to capture all fixed assets produced and acquired within a given period, the coverage of the investment in fixed assets statistics is one of reporting convenience and does not distinguish between trading in existing fixed assets vs. the creation of new fixed assets. The NBS does not provide the data necessary to retrace its derivation of GFCF from the investment in fixed asset data. And while the NBS claims to distinguish between seven categories of GFCF—residential buildings, non-residential structures, machinery and equipment, expenditures on land improvement, mineral exploration, computer software, and "others"—it publishes data only on the economy-wide total.

A comparison of the official GFCF and the investment in fixed asset data reveals that the ratio of GFCF to investment in fixed assets changed drastically over time. Figure 20 shows the ratio to fall from a high of 1.4 in 1981 (the first year for which economy-wide investment values have been published) to a low of 0.6 by 2013. Only between 1985 and 2003 is the ratio relatively stable at a level close to unity.

One could rationalize the decline. A possible reason for the high ratios in the early 1980s could be that the investment statistics up through 1980 covered only state-owned units and the inclusion of investment by units in other ownership forms may not have been fully implemented immediately in 1981; non-state investment accounted for 18 percent of total investment in 1980, and for 34 percent in 1985. The decline in the ratio since 2003 could possibly be explained by an increase in land transactions (which contribute to investment, but

not GFCF). The coverage of the investment statistics also changed on a near-annual basis throughout this period, with often unclear effects on the ratio; for example, coverage was reduced in 1996 (which should lead to an increase in the ratio) and in 2003 the data compilation and classification system changed from one based on an ownership distinction to one based on a rural-urban distinction.

Alternatively, one could question the accuracy of this particular pattern of decline. ZHU Tian, ZHANG Jun, and LIU Fang (2014) follow the NBS's instructions on how it derives GFCF from investment in fixed asset data and construct their own GFCF values for 2004-2012 from the official investment in fixed asset data. Their constructed GFCF values differ little from the official investment in fixed asset values, contrary to the NBS statistics which show the official GFCF values to in this period be significantly lower than the official investment in fixed asset values (Figure 20). The researchers' derived GFCF value in 2012 is 64 percent higher than the official GFCF value (and similar in earlier years). Their derived GFCF value implies that 2012 aggregate expenditures—based on a 64 percent higher GFCF value—exceed production approach GDP by 32 percent. One could conclude that China's official GDP is severely under-estimated. The authors opt to *assume* that China's official GDP figure is correct and then conclude that, by implication, the NBS must derive GFCF not from the investment in fixed assets data but as a residual of production approach GDP. I.e., the authors assume that the NBS derives GFCF values by subtracting consumption, inventory investment, and net exports from production approach GDP. [6]

In separate work, two of the three authors, ZHANG Jun and ZHU Tian (2013, 2014a), argue that household consumption is underestimated by approximately ten percentage points of GDP. Consequently, ZHU Tian, ZHANG Jun, and LIU Fang (2014) suggest to reduce the official measure of GFCF downward by approximately ten percentage points of GDP, while accepting the official government consumption and net export values.

Overall, thus, if one accepts the official GDP values, the official GFCF values are under pressure from two sides: they are an under-estimate in that the investment in fixed asset statistics suggest significantly higher GFCF values (64 percent higher in 2012), and they are an over-estimate in that 10 percentage points are likely to be consumption rather than GFCF.

One now has several options. One is to simply accept the paradox.

Another option is to explain it away via some new factor, such as that investment expenditures in recent years are wasteful or syphoned off to non-investment destinations through, say, corruption, and the NBS in deriving GFCF from investment makes corresponding, undocumented downward corrections. There is no possibility to collect evidence to that effect.

Yet another option is to significantly raise China's GDP values. That would imply that China's complete set of national accounts is wrong. The problematic investment data would not seem to justify throwing out the complete set of national accounts data.

A fourth option is to revisit the provincial data because those at least show a relatively stable relationship between GFCF and investment in fixed assets (Figure 20). For summed provincial values, the ratio of GFCF to investment in fixed assets remains stable, at a value close to unity, through the late 2000s, when it starts to decline gradually. The immediate rationale for the different behavior of summed provincial values vs. official national values is that national investment values approximately equal summed provincial investment values, while national GFCF differs significantly from summed provincial GFCF values (Figure 21). This in turn reflects the fact that the NBS calculates national GFCF independently of

[6] It would also mean that the NBS somehow further manipulates its annual aggregate expenditure value since it differs from production approach GDP. (If GFCF were obtained as residual, then aggregate expenditures equal production approach GDP.)

provincial GFCF values, while investment statistics are compiled in a bottom-up approach which yields a nationwide figure as the sum of local values.

Provincial statistical authorities do not enjoy an option to derive GFCF as a residual of GDP: provincial data on net exports (including from one province to another) are impossible to compile. At the provincial level, therefore, net exports must constitute the residual. Provincial statistical authorities then have no other option than to derive GFCF values from investment values. However, what this means is an astoundingly high investment rate measured as share of GFCF in GDP (Figure 1).

The share of GFCF in aggregate expenditures has been rising over time, across provinces. In the case of a very few provinces, it has reached a value above unity (Figure 22), made possible only through negative net exports (i.e., more imports than exports).[7] The level of provincial GFCF relative to aggregate expenditures appears high across the board.

Thus, the relative steadiness of the ratio of GFCF to investment in fixed assets in the case of summed provincial values is simply the outcome of little flexibility in adjusting the investment in fixed asset statistics when deriving provincial GFCF. If the investment in fixed asset data are correct, then the summed provincial GFCF values are likely better than the national ones. On the other hand, if the national GFCF value were obtained in some reliable, albeit highly secretive way, then provincial GFCF values, derived from the provincial investment in fixed asset statistics, are problematic.

How sound are the investment in fixed asset statistics? Focusing on the most recent years, the head of the NBS Fixed Asset Investment division identified several shortcomings of the current data compilation procedures (NBS 2013, pp. 219f.). Thus, investment data are still collected based on the needs of the originally planned economy, with a focus on overall values, macroeconomic indicators, and degree of project completion. Statistics are lacking for such investment items as software development and purchase, large-scale database investment, and the creation of intangible assets such as through research and development expenditures. Data compilation still relies on complete enumeration (except for rural households). The calculation procedures are reported to be cumbersome, and statistics officials are said to face great time pressure.

Of key interest is the claim that the investment volume is determined by the degree of project completion combined with the project price. If this official NBS source were correct, then investment values are potentially severely flawed: the degree of project completion by its very nature is a highly imprecise measure, which is furthermore easily subject to manipulation.[8] Reading through the details on data compilation one is further led to suspect double-reporting by investment across localities, as well as a large amount of guesswork in the compilation of investment statistics. Local statistics offices are left to their own devices in guessing investment in large projects that are not under local jurisdiction. They are also under pressure from local government leaders whose job performance is evaluated using a list of criteria, one of which is the annual increase in investment in fixed assets. Improvement in the investment statistics is promised with a switch from measuring the degree of project completion to measuring financial expenditures, and with a switch from project-based reporting (a staple of the planned economy) to reporting by legal units, as part of the "one-report form" reform begun in 2012 (with each legal unit fulfilling all its reporting duties through the use of one form).

[7] Figure 22 also documents the phenomenon already noted above for countries, that the lower per capita (or per laborer) income (or aggregate expenditures), the higher the share of GFCF in aggregate expenditures: poor provinces invest relatively more than rich provinces.

[8] Project costs will likely change over time and it is unclear how that is then reflected in the investment in fixed asset statistics.

At this point, one may be tempted to despair and dismiss the Chinese investment and GFCF data altogether. However, one is then left with no possibility to examine Chinese investment patterns and their possible implications. The option chosen here was to accept the national GFCF figure. This figure comes with no breakdown nor any truthful explanations as to how it is derived. Its one advantage is that it is consistent with the national accounts, including GDP. For more detailed analysis, a breakdown at least by main economic sectors is desirable, and the only possibility then is to apply the structure of the investment data to the GFCF data. Even though the investment data are problematic in their relationship to GFCF, that does not rule out that their sectoral patterns (proportions) may somewhat reliably reflect actual investment patterns across sectors.

6. What does China invest in?

China offers a multitude of sectoral data that allow analysis of the distribution of investment across sectors, identification of the sectors in which investments grows fastest, and analysis of the distribution of investment per laborer across sectors.

6.1 Sectoral distribution of investment

Investment in China is heavily concentrated in one-third of the 19 first-digit economic sectors: six sectors together account for more than four-fifths of total investment (bars in Figure 23, for the year 2011). Manufacturing alone accounts for 33 percent of total investment, followed by real estate with 26 percent (keeping in mind that much of real estate investment may not be investment in new fixed assets but reflect trading in existing fixed assets). The next four sectors are transport, storage and post (9 percent), environment and public facilities (8 percent), utilities (5 percent), and mining (4 percent).

On average, sectoral (nominal) investment grew 5.6 fold between 2003 and 2011, with some variation across those sectors that receive only a small amount of investment (line in Figure 23). The growth rate of investment in IT (information transmission, computer services and software), as well as the share of investment in this sector in 2011, is astonishingly low and could indicate that some investment in IT might not be captured by the sector "IT."

Comparable investment in fixed asset data for Germany are not available. The Statistisches Bundesamt appears to not compile comprehensive economy-wide investment statistics (but collect investment data from enterprises in several sector-specific enterprise surveys). The data that are available are a breakdown of GFCF by economic sector—with GFCF constituting the more desirable data to begin with, as it excludes trading in existing fixed assets. Similar to China (with investment in fixed assets in the case of China), the two sectors manufacturing and real estate together account for half of all GFCF (Figure 24). Also similar to China, the top six sectors account for three-quarters of total GFCF in Germany. China and Germany share four of the six largest sectors (with the sectoral classifications being only approximately identical); other economic services and 'health and social work' make it into the top six sectors in Germany whereas utilities and mining do so in China, a difference that appears plausible given the different levels of economic development in the two countries.

The variation in growth rates of sectoral investment in Germany between 2003 and 2011 is similar to that in China (albeit at a much lower level of growth rates in Germany). As in China, growth in (nominal) investment in manufacturing and real estate in Germany is around the sectoral average value, of a 2011 multiple of 1.33 times the 2003 investment value in

Germany. Germany has only one sector with an outstanding growth rate, namely the hospitality sector. China has three, including, as in Germany, the hospitality sector, and then also trade and 'leasing and business services.'

For the U.S., neither the Bureau of Economic Analysis nor the Bureau of Labor Statistics offer data on investment (or GFCF) by industry. Industry data only come with a breakdown by income.

6.2 In which sectors does investment grow fastest?

For China, detailed sectoral investment data covering 1182 sectors (first- through fourth-digit sectors) are available for *urban* areas. These data allow identification of the detailed sectors in which investment grew fastest between 2003 and 2010.[9] Table 1 reports the 30 fastest-growing third- and fourth-digit sectors. Fast-growing sectors are found across the economy, with a relatively small number in manufacturing—manufacturing accounts for only 8 of the 30 fastest-growing sectors but comprises half of all sectors (though only 31 percent of investment)—and a relatively large number in retail trade. The list comprises a range of diverse sectors, from magnesium dressing to notary services. The 30 fastest-growing sectors together account for only 1.7 percent of total investment in 2010, where one would expect three percent (30 out of approximately 1000 third- and fourth-digit sectors). I.e., the fastest-growing sectors tend to be relatively small sectors to begin with, and to grow fast from a small base. This suggests that fast-growing investment in a particular sector primarily serves to develop previously undeveloped sectors.

For Germany, the detailed GFCF data only extend to 100 first- through third-digit sectors (with the second- and third-digit sectoral data apparently non-exhaustive). Of these 100 sectors, the following ten sectors experienced the fastest growth in investment between 2003 and 2011: fisheries, repair and installation of machines and equipment, wholesale trade, storage, hospitality, telecommunications, financial services, architectural services, mediation and provision of personnel, and social welfare. Compared to China, some of these top performing investment growth sectors appear to be sectors that serve rich(er) societies (such as social welfare). The ten fastest-growing second and third-digit sectors (out of approximately 80) account for 11.4 percent of GFCF in Germany in 2011, i.e., account for a share of all investment that is no different from that of the average sector.

Starting 2012, Chinese investment data follow a new sectoral classification scheme. So far, data have been released only for the approximately one hundred second-digit sectors, through 2014. Between 2012 and 2014, the fastest growing sector was leasing business, with a 2014 investment value that was 3.4 times the 2012 value, but leasing business in 2014 accounted for only 0.14 percent of total investment (where the average, given approximately one hundred second-digit sectors, is one percent).This was followed by "capital market services" (2.7-fold value in 2014, with 0.07 percent of total investment), radio, television, motion picture and videotape program production services (2.3-fold value; 0.11 percent), science and technology popularization and application services (1.9-fold value; 0.26 percent), and software and information technology (1.9-fold value; 0.32 percent). Investment grew slowest for a public management sector "people's political consultative conference and democratic parties" (0.7-fold value; 0.00 percent). This again suggests that investment grew

[9] 2003 and 2010 were chosen as beginning and final years due to statistical breaks in 2002/2003 and in 2010/2011. Detailed data on urban investment first became available in 2003. 2010 is chosen as final year because the definition of "urban" changes in 2011 to include rural non-household investment, raising the share of urban in total investment from the 2003-2010 range of 82-87 percent to 97 percent.

across the board with little distinction by sector. Investment continued to grow fastest in very small sectors that were likely catching up.

6.3 Sectoral distribution of investment per laborer

Investment and laborer data for China can be matched at the level of the approximately one hundred second-digit sectors. In many of these second-digit sectors, investment per laborer in 2010 was relatively small (Figure 25, focusing on the year 2010 for which the population census provides employment figures, with a maximum breakdown by second-digit sector). 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 laborer (Figure 26).

Using the investment in fixed asset and employment data available from surveys of mining and manufacturing firms in Germany, it turns out that the frequency distribution of the 28 mining and manufacturing sectors is similar to that in China (Figure 27, covering the year 2013, for which the data are richest). With the Euro categories in Figure 27 chosen to roughly match the RMB categories in Figure 26, the distribution of investment per laborer by investment size appears to be very similar in Germany to that of China, except that it has a more distinct peak. In sum, the broad sectoral distribution of investment in China appears perfectly plausible, as does the variation in investment per laborer across sectors.

7. 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 serving niche markets around the world. However, for China there are as yet no signs of significant specialization.

Across virtually all industries in China, the optimal firm size—the firm size with lowest per-unit production costs—is below market demand. I.e., there is sufficient market demand in every sector of the economy for several firms to co-exist and compete. The prospect of historically unprecedented domestic market size may yet lead to innovations in optimal firm size at lower per-unit production costs than hitherto experienced around the world.

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. In this case, world demand has driven specialization in production by China, except that in the Chinese economy the resulting degree of specialization is barely noticeable. As a result, one can expect to see ongoing investment across virtually every sector of the Chinese economy.

8. Conclusions

This paper has shown that investment has been an important driver of economic growth in China both in the short and in the long run, that a relatively large volume of further investment is needed to catch up with developed economies, and that China's high investment rate is quite in line with the experiences of other East Asian economies. Various concerns about the level of investment are unfounded. China is investing across all sectors of the economy leading to broad-based economic development rather than specialization.

Where does this all lead to? At the macro level, China is continuing the process of economic transition. Under the planned economy, investment and thereby growth were planned and dutifully implemented. In the reform period, state-driven investment became a policy tool and growth became less predictable. In the next step, investment will increasingly become dependent on market forces, with interest rates and industrial policy as main government economic policy tools.

Along with the gradual withdrawal of the state from direct participation in investment decisions will likely come structural change, in two respects. First, in terms of the structure of aggregate demand, following East Asian precedents, China's investment rate will fall. Given that it reached extraordinary high levels in recent years, it may yet fall significantly in a short period of time. But the Asian precedents also suggest that the investment rate will likely stabilize at a high level and then decline gradually over a period of decades. As driver of economic growth, consumption will likely return to be the mainstay. The government's wage policies, including the consistent increases in minimum wages over the past five years, are just one sign suggesting that the Chinese government is giving more weight to consumption while not underestimating the importance of investment for expanding production and implementing technological change.

Second, in terms of the structure of production, China's share of industry in GDP, at close to 40 percent, is still relatively large. Given typical development patterns, this share is likely to fall. Since industry has a relatively high ratio of capital to output, a reduction in the relative size of industry should lower the investment rate and put downward pressure on the capital-output ratio. Within industry, technological upgrading and technological progress are likely to lead to changes in the relative shares of different industrial sectors in industrial value-added. The Chinese government is furthering these developments through its industrial policies, including its promotion of specific industries through industrial policies and its promotion of job creation in services. What one can expect to see in the coming years then is not 'more of the same,' i.e., straight-out capital accumulation, distributed across sectors as before, but an adjustment of investment across sectors towards the use of capital in ways most conducive to economic growth.

The drastic drop in the share of foreign funds in total investment funding from 12 to one percent over the past twenty years is a striking testimony to the development of the Chinese economy, which simply no longer needs foreign funding. It is hard not to conclude that China's growth story today is a predominantly domestic one. China appears to have transitioned from a period when foreign firms played an important role in China's economic development to a period when China has the capability to sustain significant forward momentum on its own—perhaps the defining criterion of an economic superpower.

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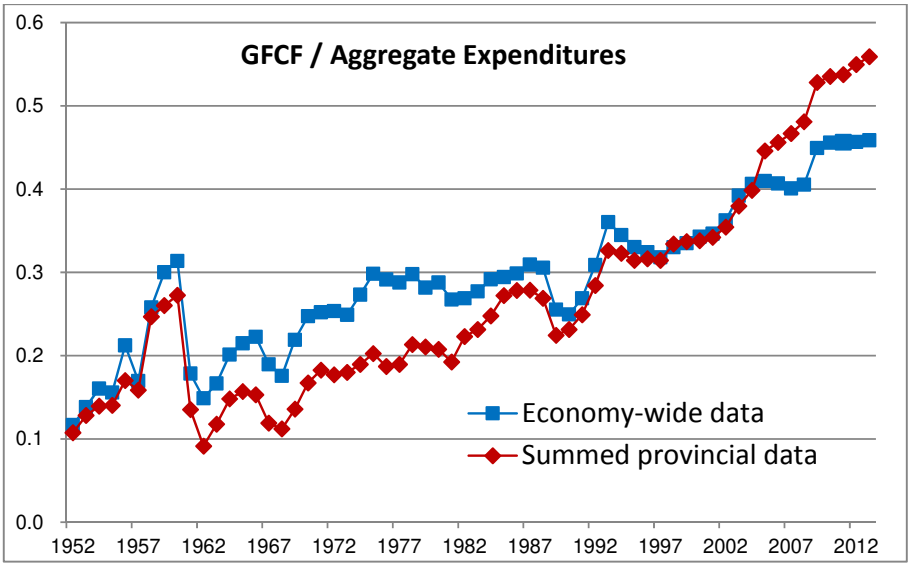
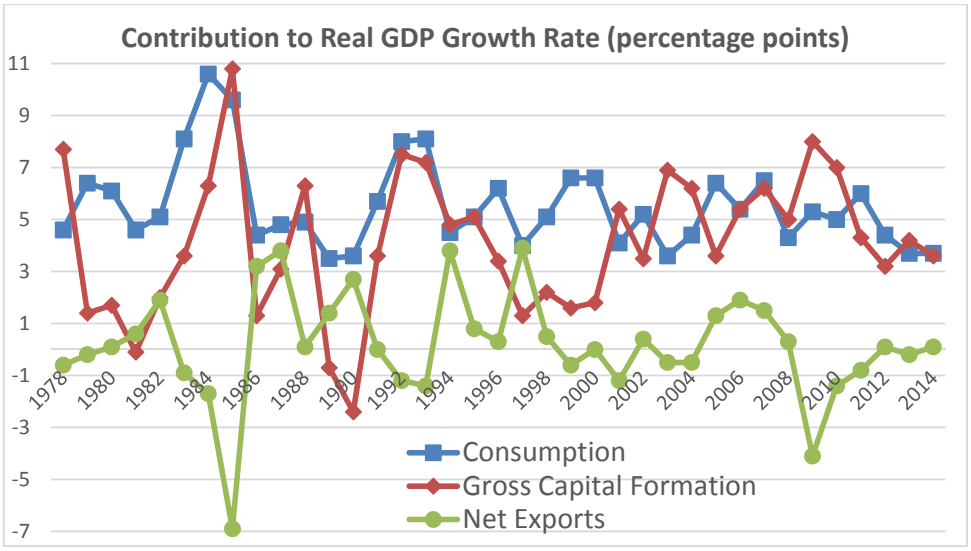


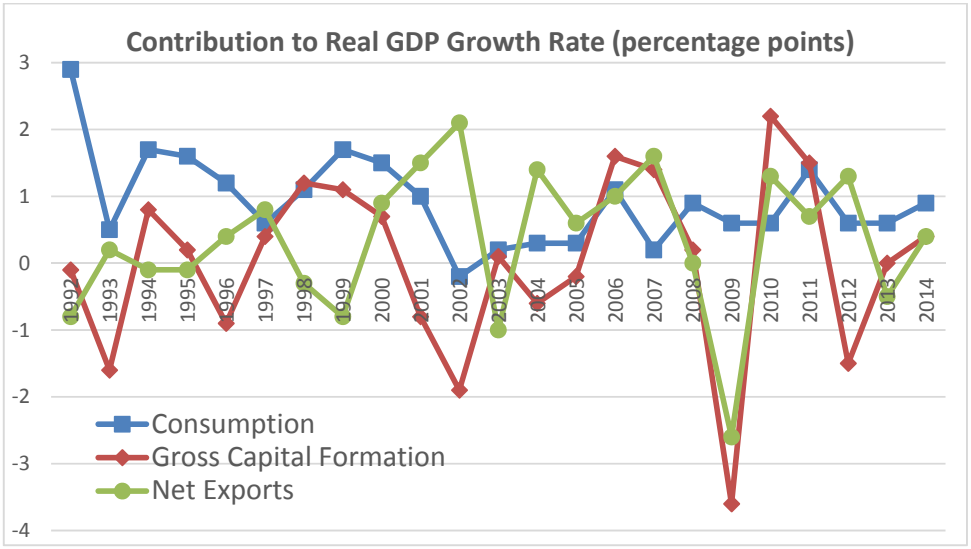
Sources: *Sixty Years*, *Statistical Yearbook*, *Investment Yearbook*.

Figure 1. Gross Fixed Capital Formation Relative to Aggregate Expenditures



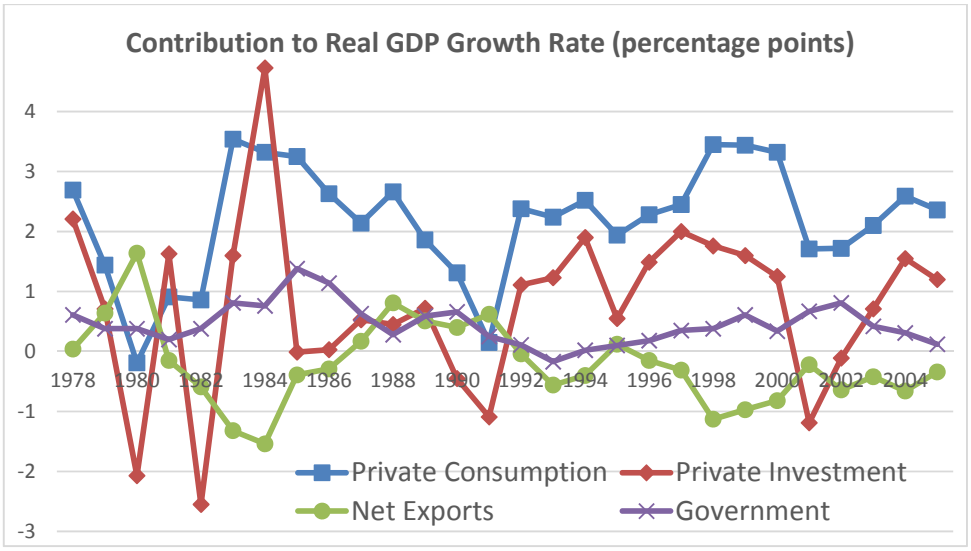
Source: NBS website.

Figure 2. Annual Contributions to the Real GDP Growth Rate, China



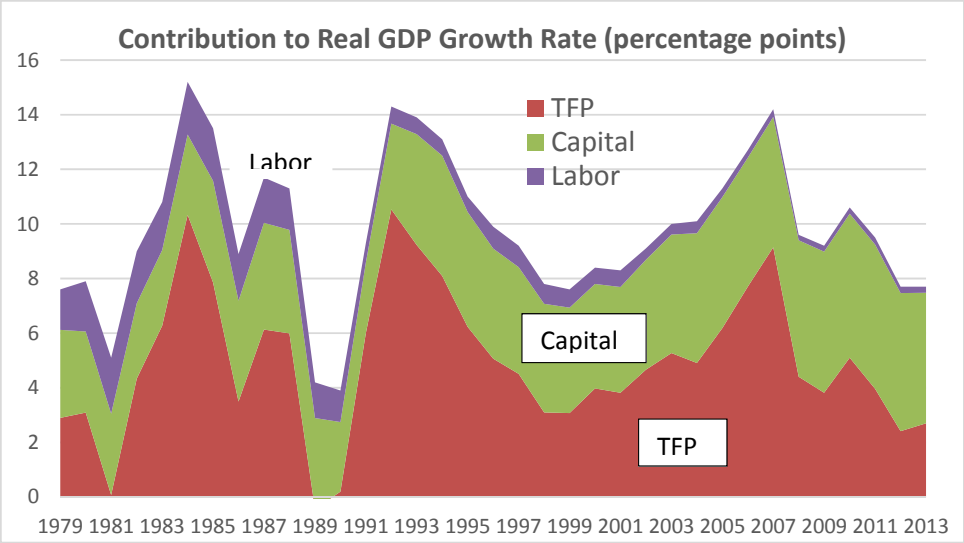
Source: Statistisches Bundesamt Deutschland, Table 81000-0029, https://www-genesis.destatis.de/genesis/online. Data for 2012-2014 are preliminary; first values available for 1992.

Figure 3. Annual Contributions to the Real GDP Growth Rate, Germany



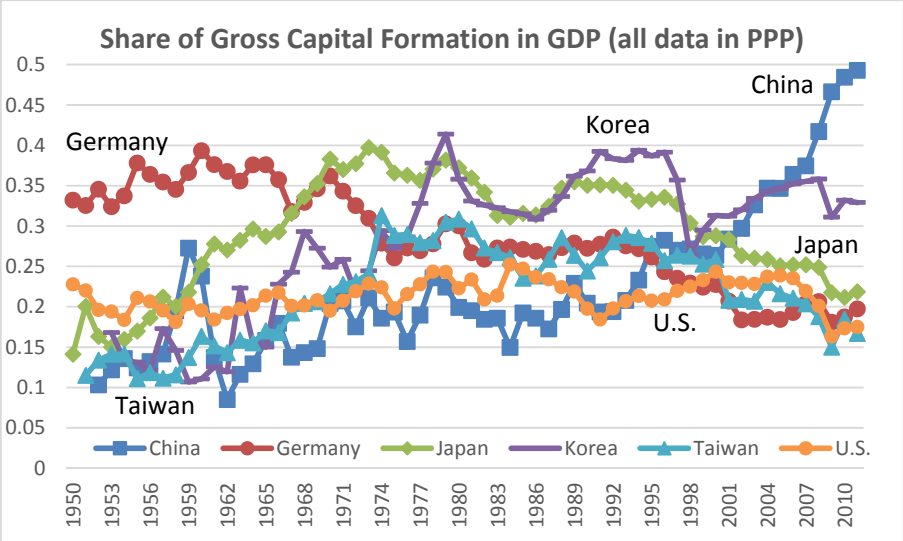
Source: BEA website, Table 1.1.2 Contributions to Percent Change in Real Gross Domestic Product.

Figure 4. Annual Contributions to the Real GDP Growth Rate, U.S.



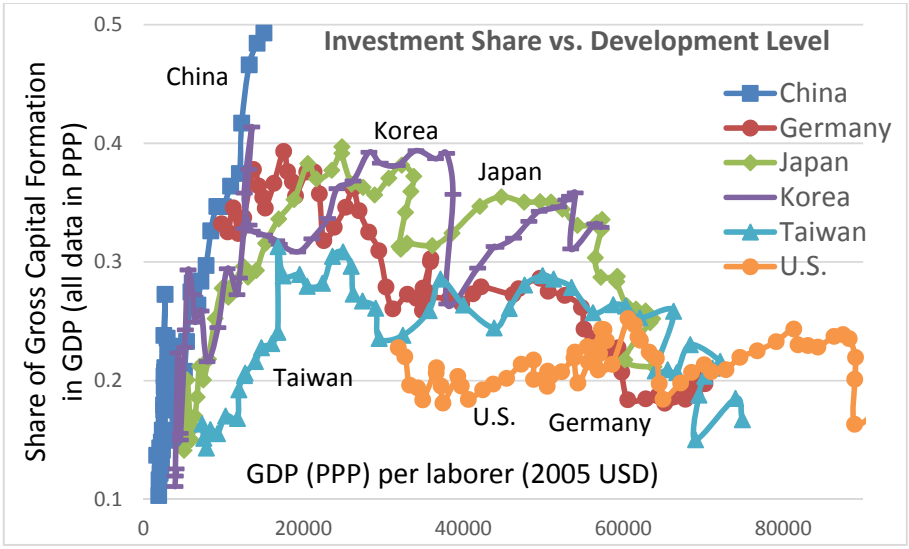
Source: NBS website, author's own calculations for capital stock. Average annual TFP growth and coefficients of capital and labor are first estimated in a Cobb-Douglas production function estimation with a constant-returns-to-scale constraint. In a second step, using the estimated coefficients of capital 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 5. Long-run Contributions to the Real GDP Growth Rate



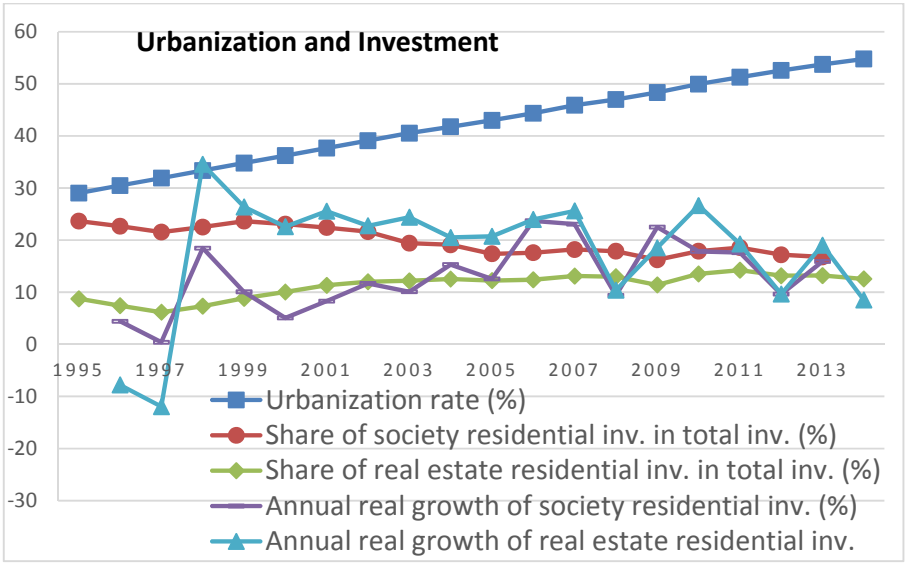
Source: PWT 8.1. Variable: share of gross capital formation at current PPPs in output-side real GDP at current PPPs (in 2005 USD).

Figure 6. Investment Share in GDP



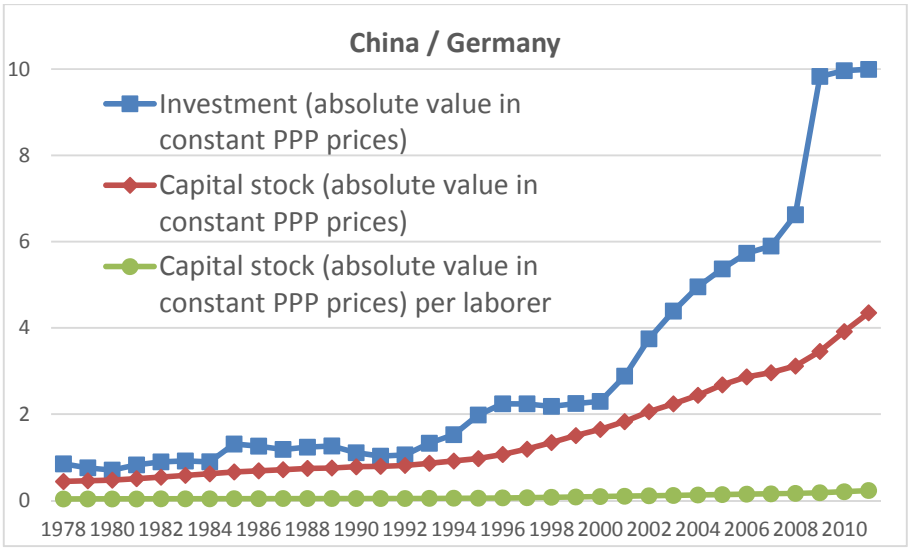
Source: PWT 8.1. Variables: share of gross capital formation at current PPPs in output-side real GDP at current PPPs (in 2005 USD); output-side real GDP at chained PPPs (in 2005 USD) per person engaged.

Figure 7. Investment Share in GDP by Level of Output Per Laborer



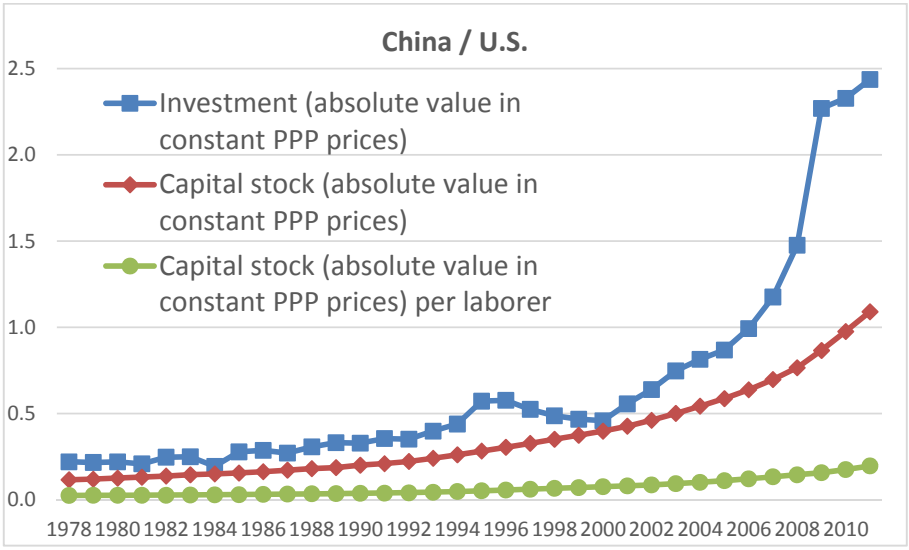
Source: NBS website (raw data). The definition of "urban" is revised repeatedly in the reform period, with the data series not accompanied by corresponding explanations. The coverage of investment changes on a near-annual basis, partly documented with the data series in the data source. Data on residential investment start in 1995. The deflator to obtain real growth rates is the Investment in fixed asset price index sub-index "Structures."

Figure 8. Urbanization and Investment



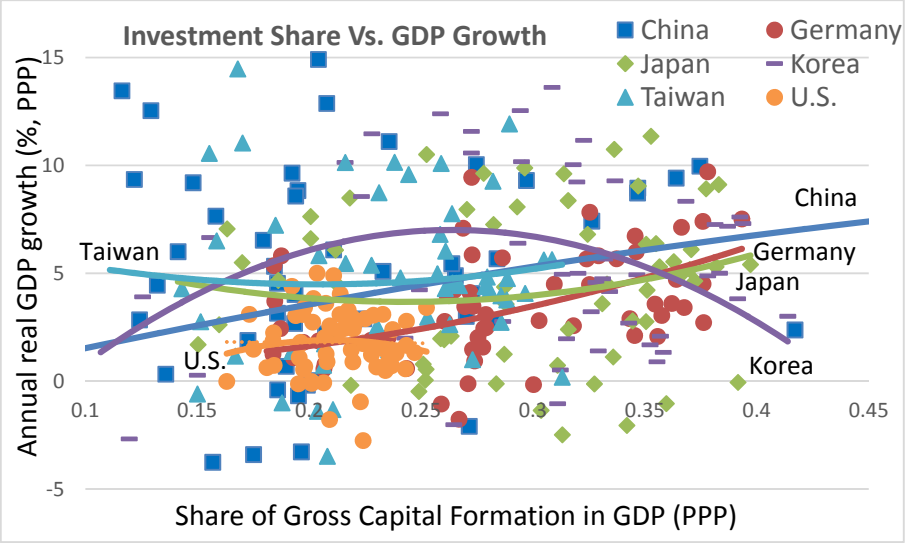
Source: PWT 8.1. Variables: share of gross capital formation at current PPPs in output-side real GDP at current PPPs (in 2005 USD) times output-side real GDP at current PPPs (in 2005 USD); capital stock at current PPPs (in 2005 USD); capital stock per number of persons engaged.

Figure 9. Investment and Capital Stock in China, China Relative to Germany



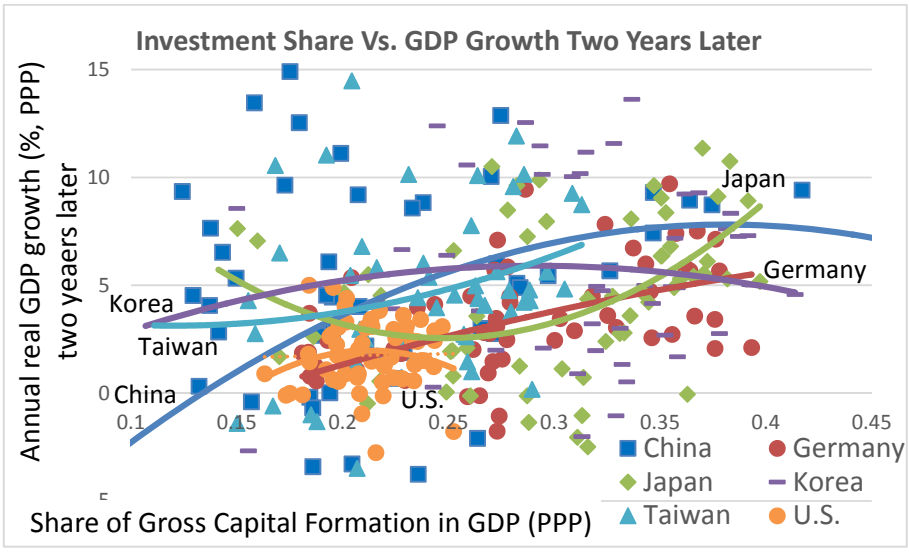
Source: PWT 8.1. Variables: share of gross capital formation at current PPPs in output-side real GDP at current PPPs (in 2005 USD) times output-side real GDP at current PPPs (in 2005 USD); capital stock at current PPPs (in 2005 USD); capital stock per number of persons engaged.

Figure 10. Investment and Capital Stock in China, China Relative to the U.S.



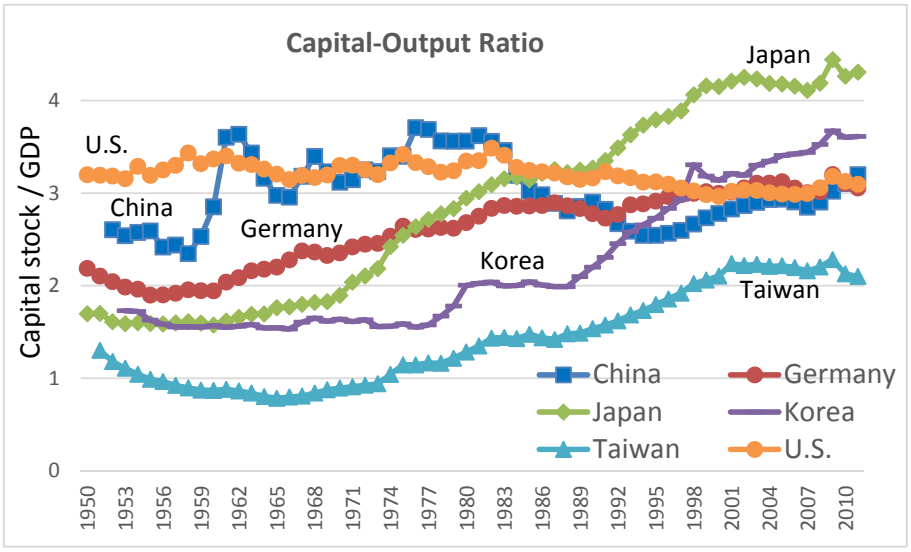
Source: PWT 8.1. Variables: share of gross capital formation at current PPPs; output-side real GDP at chained PPPs (in 2005 USD) per person engaged. Values are for 1950-2011 as available.

Figure 11. Investment Share Vs. GDP Growth



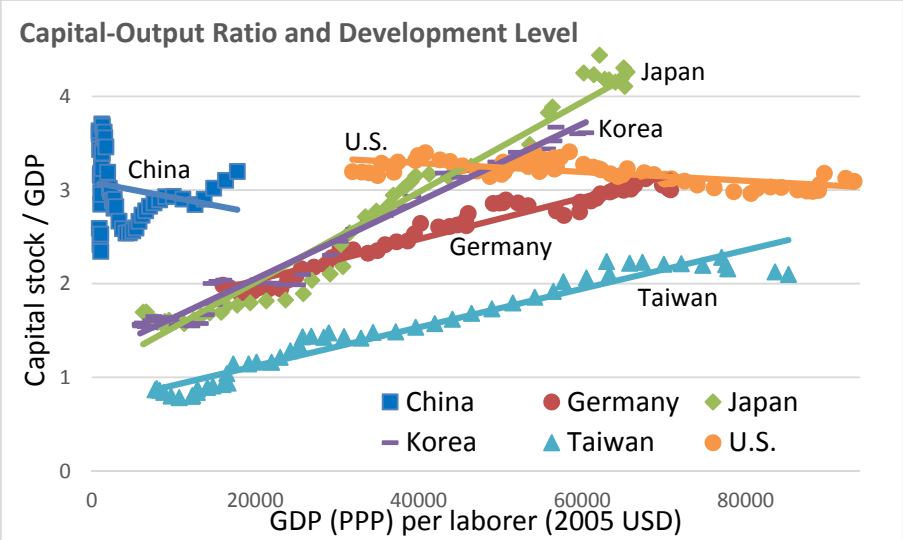
Source: PWT 8.1. Variables: share of gross capital formation at current PPPs; output-side real GDP at chained PPPs (in 2005 USD) per person engaged. Values are for 1950-2011 as available.

Figure 12. Investment Share Vs. GDP Growth Two Years Later



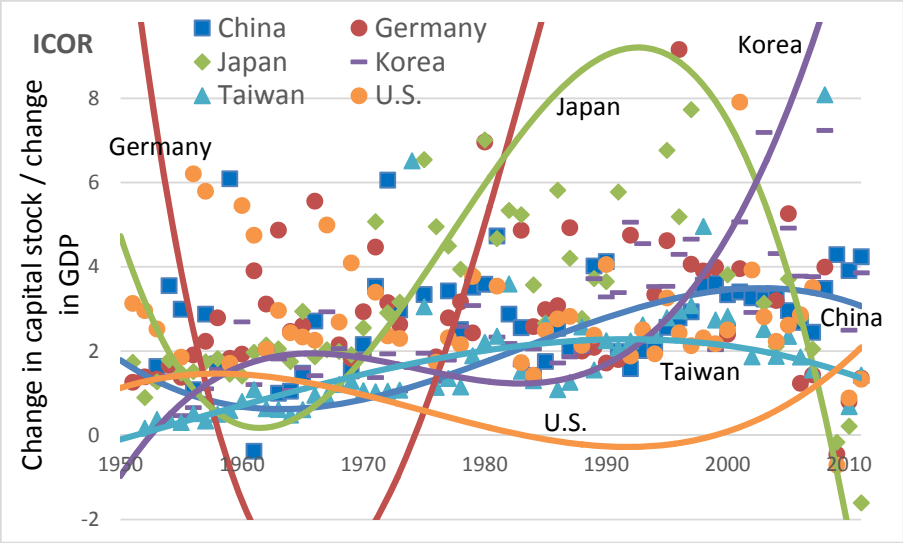
Source: PWT 8.1. Variable: capital stock at constant 2005 national prices (in 2005 USD) divided by real GDP at constant 2005 national prices (in 2005 USD). Values are for 1950-2011 as available.

Figure 13. Capital-Output Ratio



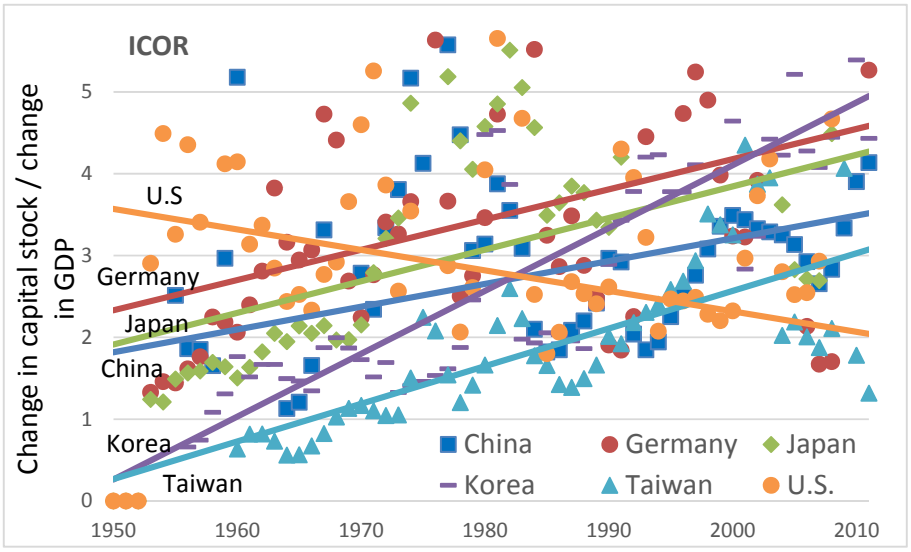
Source: PWT 8.1. Variables: capital stock at constant 2005 national prices (in 2005 USD) divided by real GDP at constant 2005 national prices (in 2005 USD); real GDP at constant 2005 national prices (in 2005 USD) per person engaged. Values are for 1950-2011 as available.

Figure 14. Capital-Output Ratio Vs. GDP Per Laborer



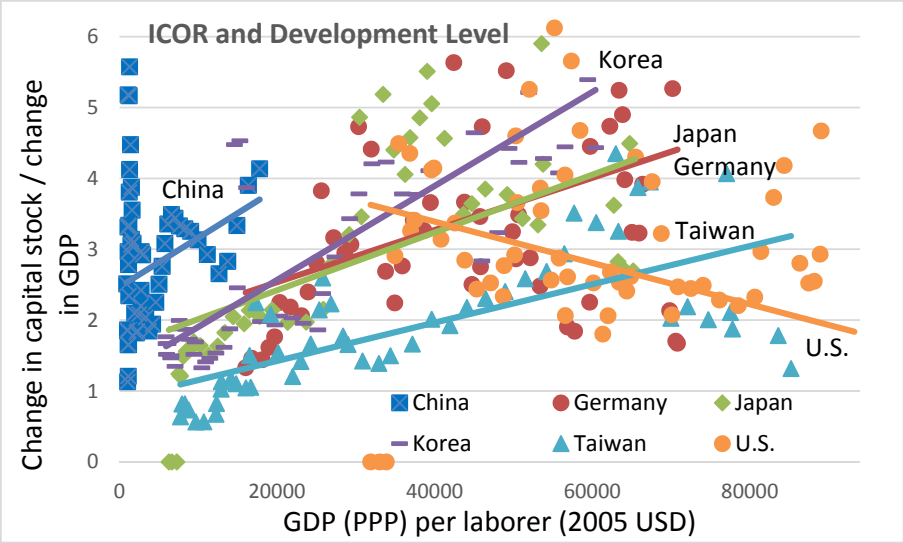
Source: PWT 8.1. Variables: capital stock at constant 2005 national prices (in 2005 USD); real GDP at constant 2005 national prices (in 2005 USD). Changes are annual absolute changes. Values are for 1950-2011 as available. A third-degree polynominal is imposed as trendline. The trendline is subject to severe outliers. If a linear trend is imposed, it is upward sloping for all countries except for the U.S.; the slope is implausibly high for Germany. Using three-year changes leads to some variation in a third-degree polynominal trendline, and to downward sloping linear trendlines for China, Germany, and the U.S.

Figure 15. Incremental Capital-Output Ratio



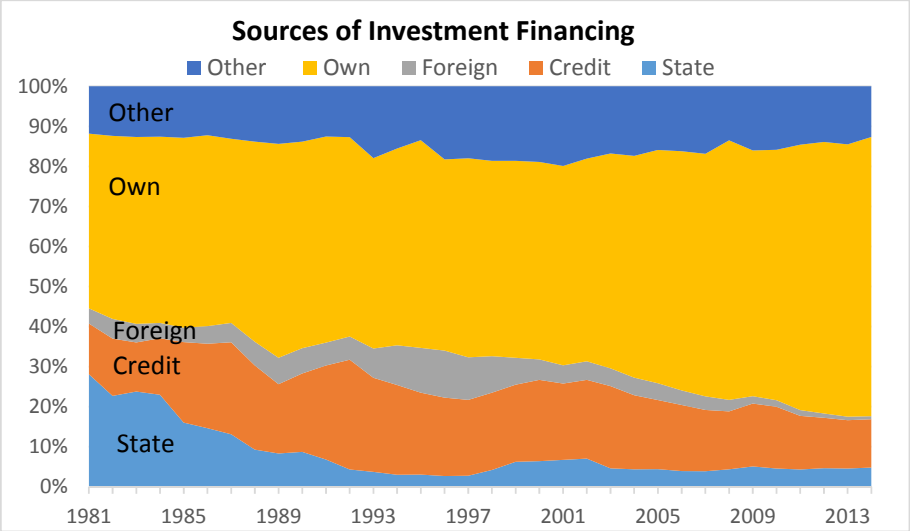
Source: PWT 8.1. Variables: capital stock at constant 2005 national prices (in 2005 USD); real GDP at constant 2005 national prices (in 2005 USD). Changes are three-year absolute changes. Values are for 1950-2011 as available. A linear trend is imposed. Across the six countries and close to sixty years, approximately one dozen observations with absolute values above 10 were removed.

Figure 16. Three-Year Incremental Capital-Output Ratio With Outliers Removed



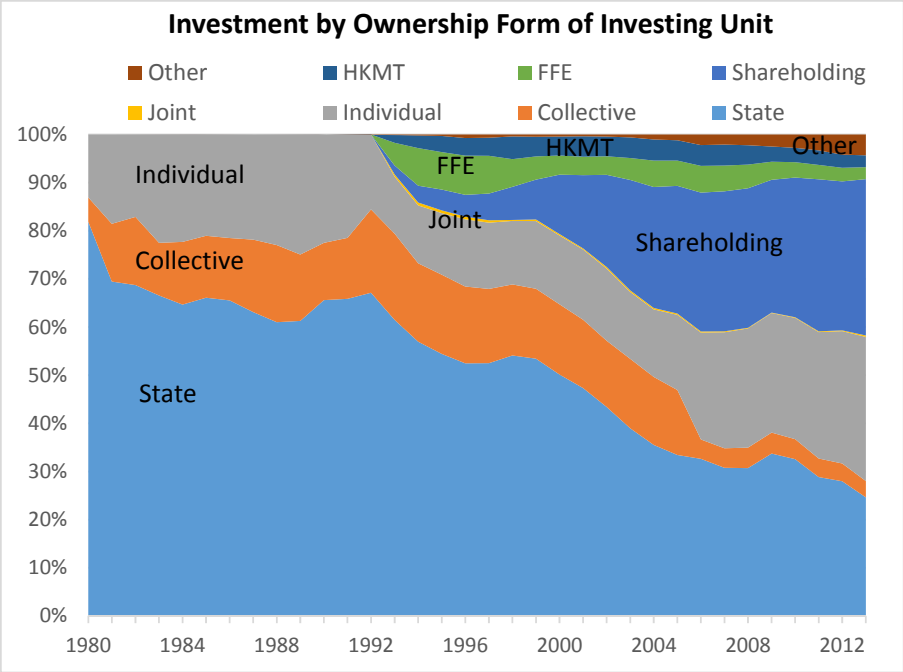
Source: PWT 8.1. Variables: capital stock at constant 2005 national prices (in 2005 USD); real GDP at constant 2005 national prices (in 2005 USD); real GDP at constant 2005 national prices (in 2005 USD) per person engaged. Changes are three-year absolute changes. Values are for 1950-2011 as available. A linear trend is imposed. Across the six countries and close to sixty years, approximately one dozen observations with absolute ICOR values above 10 were removed.

Figure 17. Three-Year Incremental Capital-Output Ratio (With Outliers Removed) Vs. GDP Per Laborer



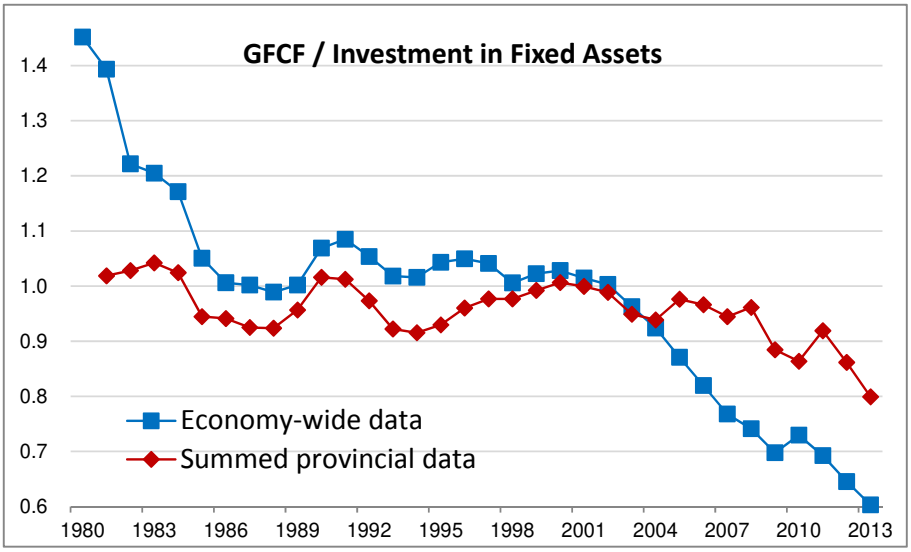
Source: NBS website. For 1981-1984 and 1994, the two financing sources "own" and "other" are only available as one joint value; in 1985 and 1998, the joint value equals the values for "other" with no values available for "own." 1981-1985 values are obtained by splitting the joint value using the average 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 in the data of 1986, 1987, and 1989-1993 was included in "other." Total investment *financing* equals total *reported* investment in fixed assets 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 18. Sources of Investment Financing



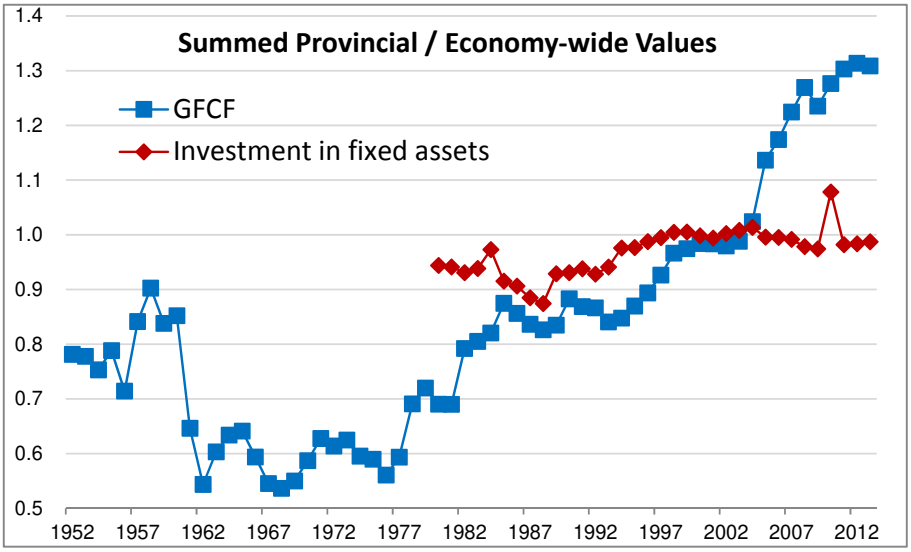
Sources: *Statistical Yearbook* and *Investment Yearbook*, various issues. Total investment in fixed assets by ownership form in the years 1986-1994, 1996, and 2010 differs slightly from the total investment in fixed asset values published on the NBS website (it is less by up to 6 percent, except for 2010, when it is 11 percent more, presumably due to the change in the coverage of the investment in fixed assets statistics).

Figure 19. Investment by Ownership Form of the Investing Unit



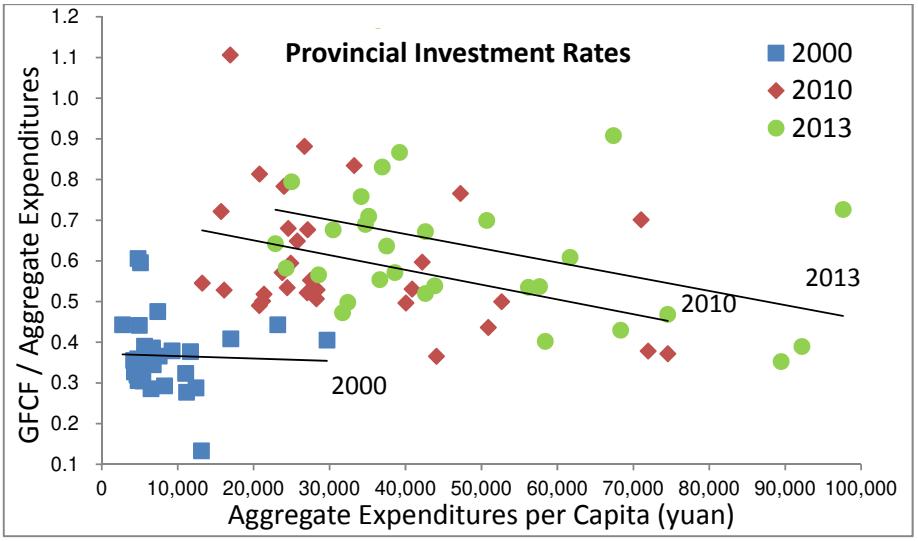
Sources: *Sixty Years*, *Statistical Yearbook*, *Investment Yearbook*.

Figure 20. Gross Fixed Capital Formation Relative to Total Investment in Fixed Assets



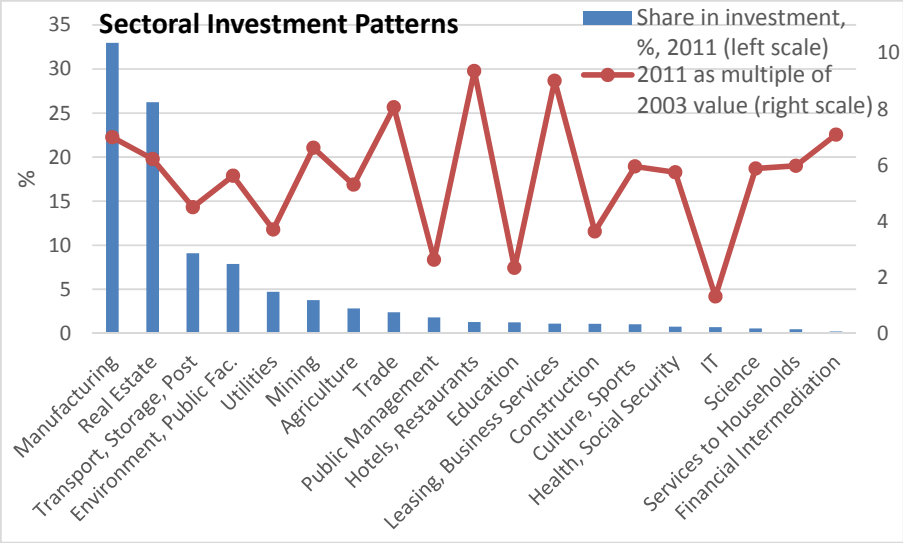
Sources: *Sixty Years*, *Statistical Yearbook*, *Investment Yearbook*.

Figure 21. Summed Provincial Relative to. National Values, GFCF and Investment in Fixed Assets



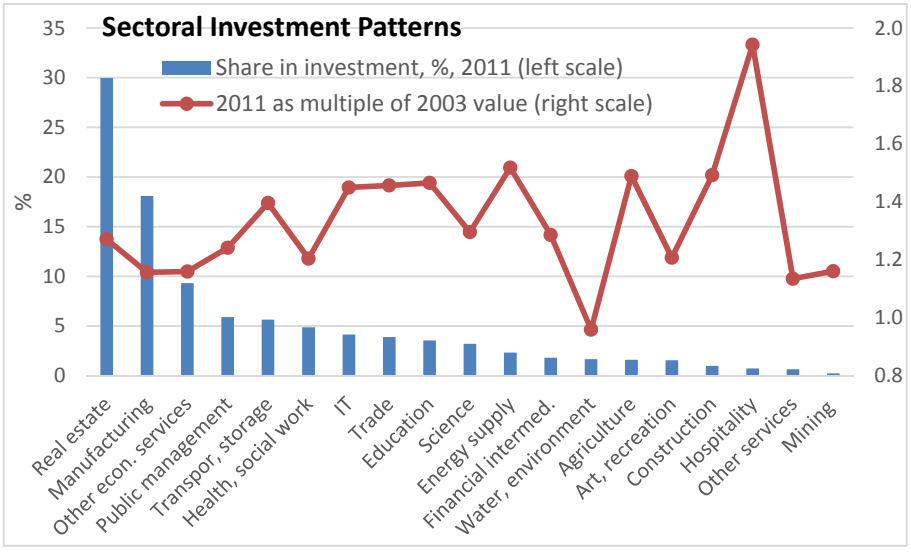
Sources: *Sixty Years*, *Statistical Yearbook*, *Investment Yearbook*. Population data are from the NBS website.

Figure 22. Cross-Provincial Gross Fixed Capital Formation Relative to Aggregate Expenditures



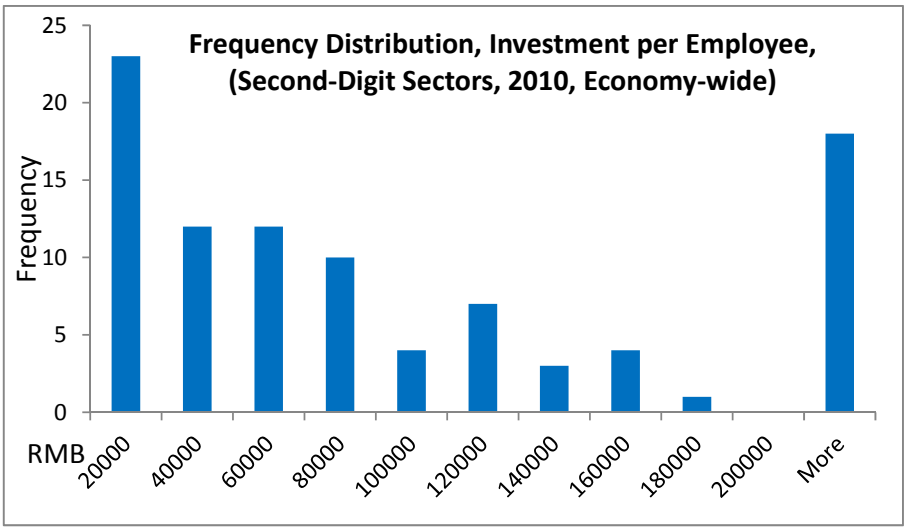
Sources: *Investment Yearbook*; own calculations to obtain an approximation of economy-wide values by sector (covering both urban and rural investment).

Figure 23. Sectoral Investment Patterns, China



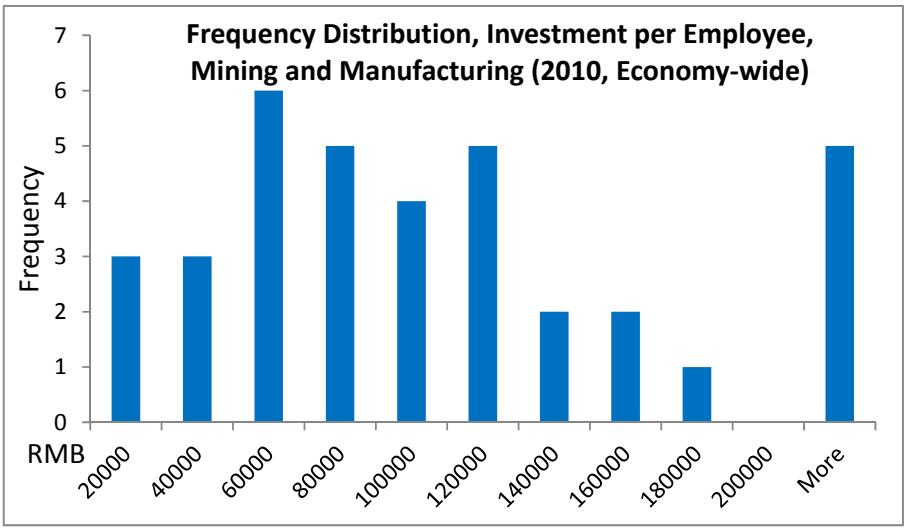
Sources: Statistisches Bundesamt, Destatis database, https://www-genesis.destatis.de/genesis/online, Table 81000-0015.

Figure 24. Sectoral Investment Patterns, Germany



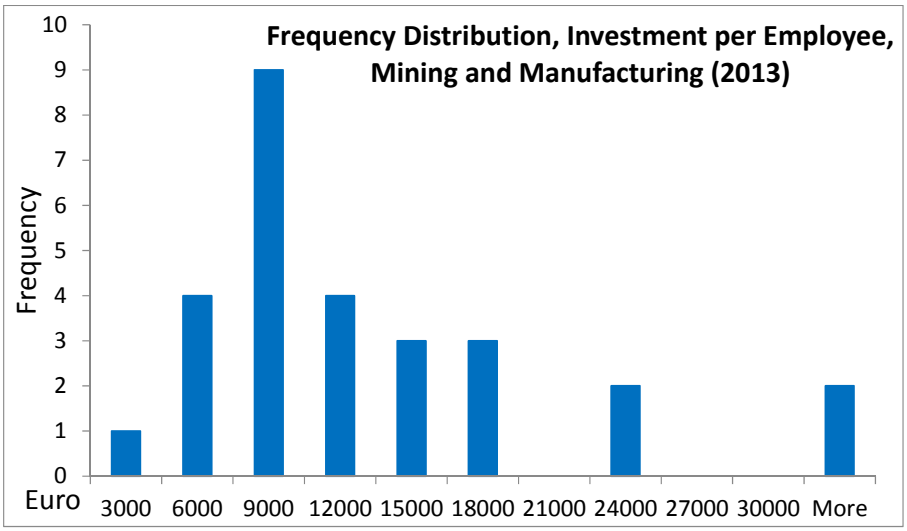
Sources: *Investment Yearbook*; own calculations to obtain an approximation of economy-wide values by sector (covering both urban and rural investment). 2010 Population Census data from NBS website, long-form employment values by sector approximated to whole population using ratio of total employment to long-form employment.

Figure 25. Frequency Distribution of Investment per Employee, All Second-Digit Sectors, 2010, China



Sources: *Investment Yearbook*; own calculations to obtain an approximation of economy-wide values by sector (covering both urban and rural investment). 2010 Population Census data from NBS website, long-form employment values by sector approximated to whole population using ratio of total employment to long-form employment.

Figure 26. Frequency Distribution of Investment per Employee, Second-Digit Sectors in Mining and Manufacturing, 2010, China



Sources: Statistisches Bundesamt, Destatis database, https://www-genesis.destatis.de/genesis/online, Table 42231-001.

Figure 27. Frequency Distribution of Investment per Employee, Mining and Manufacturing, 2010, Germany

Table 1. Thirty Fastest-Growing Third- or Fourth-Digit Sectors, 2010 vs. 2003

First digit sector (sometimes with second-digit sector) Third- or fourth-digit sector	% of invest-ment 2010	Mul-tiple 2010 / 2003
Agriculture, forestry, animal husbandry, fishery – cereals and other crops 谷物及其他作物的种植		
Tobacco cultivation 烟草的种植	0.009	126
Bamboo harvesting 竹材的采运	0.000	68
Inland fishery 内陆捕捞	0.001	156
Mining – non-ferrous metal industry 有色金属矿采选业		
Antimony ore mining 锑矿采选	0.005	65
Aluminum mining and dressing 铝矿采选	0.020	81
Magnesium dressing 镁矿采选	0.005	67
Other commonly used non-ferrous metals 其他常用有色金属矿采选	0.033	87
Other precious metals mining and dressing 其他贵金属矿采选	0.011	3681
Radioactive metal ore mining 放射性金属矿采选	0.002	160
Manufacturing – general equipment manufacturing 通用没备制造业		
Guns and similar appliances 喷枪及类似器具制造	0.005	113
Manufacturing – special equipment manufacturing 专用没备制造业		
Oil drilling equipment 石油钻采专用设备制造	0.113	66
Feed production equipment 饲料生产专用设备制造	0.008	61
Postal machinery and equipment 邮政专用机械及器材制造	0.000	90
Traffic safety and control equipment 交通安全及管制专用设备制造	0.007	69
Manufacturing – transportation equipment manufacturing 交通运输设备制造业		
Aids to navigation equipment and other floating devices 航标器材及其他浮动装置的制造	0.008	253
Manufacturing – electrical machinery and equipment manufacturing 电气机械及器材制造业		
Generators and generator sets 发电机及发电机组制造	0.189	65
Manufacturing – waste resources and materials recycling and processing 废弃资源和废旧材料回收加工业		
Metal waste and scrap processing 金属废料和碎屑的加工处理	0.083	74
Utilities – electricity and heat, production and supply 电力、热力的生产和供应业		
Other energy production 其他能源发电	1.015	66

Transportation, storage and postal services 交通运输、仓储和邮政业		
Freight trains 货运火车站	0.006	68
Trade – retail trade 零售业		
Audiovisual products and electronic publications 音像制品及电子出版物零售	0.003	58
Photographic equipment 照相器材零售	0.001	588
Medical supplies and equipment 医疗用品及器材零售	0.006	57
Other electronic products 其他电子产品零售	0.005	80
Paint 涂料零售	0.002	138
Financial intermediation 金融业		
Financial companies 财务公司	0.001	224
Leasing and business services 租赁和商务服务业		
Other machinery and equipment rental 其他机械与设备租赁	0.034	270
Notary services 公证服务	0.000	93
Other unlisted business services 其他未列明的商务服务	0.110	62
Resident services and other services 居民服务和其他服务业		
Office equipment maintenance 办公设备维修	0.002	209
Cultural, sports and entertainment 文化、体育和娱乐业		
Audiovisual production 音像制作	0.018	71
Sum shares	*1.706*	

Sources: *Investment Yearbook*. Total number of first- through fourth-digit sectors: 1182. (For some second-digit sectors, only third-digit sector values are available, for others, also fourth-digit sector values. Therefore, in the search for the fastest-growing sectors all levels of sectoral classification were retained.) About one dozen sectors saw no investment in 2003; these sectors are omitted from the search for the fastest-growing sectors.

[SectoralInvestmentValues -> wksht: 2ndDigit03-11 or -> Top Growing]