THE CHINESE ECONOMY: INTRODUCTION

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China at the crossroads

China's at the crossroads, again. With the decennial transfer of political power comes uncertainty about the future direction of the country. This is always the case. What is different this time is that the past decade has been a period of economic growth in China which is perhaps unparalleled in human history, anywhere. But there is anxiety among the political elite and the increasingly prosperous middle classes about how sustainable the current path is. Growth has been slowing, albeit from a remarkably high rate, fuelling unrest among those afraid of losing their new-found gains. Inequality has been rising at an alarming rate. The 'have-nots' have begun to make their voices heard, both through social media and on the ground with industrial unrest a major problem for the regime, particularly in the interior. Some question whether the Chinese model of 'socialist capitalism' is compatible with long-term growth, arguing that democracy is a prerequisite for sustainable growth. Others think the current arrangements are more robust and that China's road to a market economy has been laid by sound political decision-making, especially at provincial, regional and city level where many of the policy experiments behind China's success have been devised, piloted and implemented. Seen in this light, some of the recent difficulties China has been facing, such as wage inflation, can be seen as part of the typical difficulties countries face as they transit towards a market economy. So now seems like a good time to take stock of where China is 'at' by looking at some of the economic fundamentals. That is the purpose of this Special Issue on China.

The Issue begins with an article by Linda Yueh, Director of the China Growth Centre at the University of Oxford. She describes the difficulties analysts face in trying to account for China's phenomenal growth using standard growth models. The paper reviews the main modelling approaches to growth, reviews the existing literature on China's growth, and decomposes the factors behind China's growth into its various components. There are three issues that are salient. First, China is seemingly paradoxical in achieving such growth with what appear to be weak institutions. In fact, as the paper explains, China has engineered incentives for growth and productivity, albeit in an unorthodox fashion, which have delivered very substantial economic benefits. Second, China's impact on the global economy is so large that its development is hard to comprehend within the confines of models which have traditionally examined countries which are much smaller and, if larger, less open to the international economy. Analysts may do well to think in terms of what China is doing to the rest of the global economy, rather than begin with questions about the effect of the global economy on China. Third,

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questions are frequently raised about the sustainability of China's growth trajectory. The paper points to the importance of one-off hikes in productivity arising from various experiments China has undertaken with respect to capital restructuring and labour market reform. But these 'one-off' episodes appear to happen quite regularly, though China must achieve technological progress to make the productivity improvements needed to sustain its growth.

One crucial driver of China's economic growth has been the rise of its public listed corporations. Back in 2001 the public listed sector accounted for 14 per cent of China's GDP. However, over the decade to 2010 the total output of the public listed sector increased eleven-fold such that, by 2010, it accounted for 43 per cent of China's GDP (Bryson *et al*., 2012). Today China's stock market capitalisation as a percentage of GDP is on a par with the United States and greater than that in the Euro Area and Japan. One way to assess China's role in the global economy is to examine the degree to which China's stock markets (Shanghai and Shenzhen) are integrated with those elsewhere. As Jan Babecký and co-authors explain in their paper dealing with this issue, the existing literature is large but evidence on integration is mixed. The authors have a lot of data to play with because, as they point out, although the total number of listed firms in China is smaller than the United States, Japan and the Euro Area, the total value of stock traded in China has surpassed that in the Eurozone and Japan. The authors consider stock price movements in China, Russia, the Euro Area, Japan and the United States. Overall they find increasing stock market integration after the 1997 Asian financial crisis and the 1998 Russian financial crisis. Since then the speed with which differences in individual stock market returns are eliminated after shocks (beta-convergence) has been fairly constant. This is true for China, the Euro Area, Japan, the United States and Russia. There has been no clear convergence, however, with respect to cross-sectional dispersion in the returns on individual stock markets at a given moment in time.

A perennial danger to growing economies is the threat of inflation. This is particularly relevant for developing countries like China, where rapidly rising demand for goods and services has the potential to outstrip their supply, at least temporarily. This Special Issue contains two papers analysing inflationary pressures in China. The first, by Christian Dreger and Yanqun Zhang, is a very interesting investigation into the sources of pressure on consumer price inflation. The authors show that pre-crisis inflation in China was driven entirely by international factors such as food and energy prices. But this changed with the crisis; since then domestic factors such as nominal wages have become increasingly important. The paper points to important policy challenges ahead for China. Growth in domestic demand is a precondition for strong growth in the next Five Year Plan, and this in turn relies on growth in real wages. To avoid inflation, it is going to be necessary for productivity growth to match wage growth. Of course, as the authors note, tight trade linkages and the role of Chinese firms in international production chains mean that how this plays out is going to affect all of us, not just the Chinese.

The second paper on price inflation, by Xi Chen and Michael Funke, considers the potential for a house price bubble in China. The authors deploy a recently developed methodology for identifying potential speculative bubbles in real time, an approach that may assist in constructing early warning systems in future. Although there has been a phenomenal real estate boom in the 2000s, one which received a boost from China's 2009 fiscal stimulus package, it appears that house prices are not significantly disconnected from fundamentals. A bubble in the period 2009–10 appears to have disappeared, in part due to 'cooling down' policy measures. In general, then, there is little evidence of a speculative house price bubble, although the authors remain cautious about potential developments in coastal areas of China.

Our final paper, by Lili Kang and Fei Peng, examines trends in productivity growth and labour costs in China. These are fundamental to China's economic prospects. If you examine a league table of average labour productivity levels across countries, you will see that China is well behind leading economies such as the United States, Germany and some other highly developed western economies. If China is to be a top player globally, it needs to foster very substantial productivity growth. This entails fundamental transformation of the Chinese economy, away from exporting cheap goods and towards being a producer of high value-added goods, often for consumption by an increasingly sophisticated domestic market. The implication is that it may not be enough for China to be the place where the world's Apple products (and, more recently, Land Rovers) are assembled. Instead, China will be looking to shift towards the Silicon Valley end of the production chain, where ideas are spawned and innovation is key. What is often overlooked in such debates is the degree of heterogeneity there is in the cost competitiveness and productivity of China's regions. Kang and Peng examine trends in unit labour costs across China's regions over a 35-year period for nine single-digit industries. What they find is a remarkable improvement in the relative competitive position of the Interior as measured by declining relative unit labour costs, such that its level of unit labour costs is now on a par with the Coastal region, which is renowned as the most dynamic region in terms of productivity. There has been relative stability over the whole period in competitiveness of the West and Coastal regions, with the West having by far the highest levels of labour costs. When drilling down to a more disaggregated level, it is apparent that there is very substantial heterogeneity with respect to trends in both labour costs and labour productivity across industry and region. But, in general, the Interior, the West and the Northeastern regions improved their competitive position relative to the Coastal region, primarily through lower relative labour costs rather than through productivity growth, though the latter was apparent in a sub-set of industries. One might argue that convergence of this nature is good news for China, since it implies a more efficient economy beyond the Coastal region, one which should, in the long run, be better equipped to generate the goods and services that the burgeoning middle classes will demand.

Taken together these papers give a fascinating glimpse inside China's economy. The precise path that China's economic development will take may be uncertain, but there is no doubt that debate over that path, and its implications for the global economy, will attract an ever-increasing number of economists studying China.

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WHAT DRIVES CHINA'S GROWTH?

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This paper analyses the drivers and components of China's economic growth, showing that the structure of the economy is just as important as standard growth factors in determining its growth. The structural reforms that dismantled state-owned enterprises and shifted factors from agriculture to urban areas are key, as are technology transfers and know-how. Taking these factors into account, the paper shows that total factor productivity (TFP) not derived from those one-off reforms accounted for less than one-eighth of China's GDP growth during the first thirty years of the reform period. There are signs that efficiency is improving in the 2000s and productivity must continue to increase for the country to sustain its development.

Keywords: Economic growth; China; economic reform; productivity

JEL Classifications: O1; P2

1. Introduction

China has accomplished a remarkable feat in transforming itself from one of the poorest countries in the world into the second largest economy in just thirty years. Market-oriented reforms began in 1979, transforming the previously centrally planned economy. Since then it has grown at an impressive 9.6 per cent per annum, on average. China has not only doubled its GDP and income every 7–8 years, it has also lifted 660 million people (or one-tenth of the world's population) out of abject poverty. With its 1.3 billion people accounting for one-fifth of the global population, China's economic growth has begun to shape the world and yet the determinants of its successful development are far from established or well understood.

China, like other large countries, has unique aspects of its economy. It is a transition economy that has dismantled most, but not all, of its state-owned enterprises and banks. But it is also a developing country where half of its population is rural and in large parts agrarian. Although agriculture is declining as a share of GDP, it accounted for 40 per cent of rural employment in 2010. China is also an open economy whose trade-to-GDP ratio was about 70 per cent in the 2000s, making it substantially more globally integrated than other comparably-sized open economies such as the UK (37 per cent). It also does not fit well into the studies of institutions and growth, as China remains a Communist state dominated by the Chinese Communist Party. It is therefore unsurprising that the rule of law and other market-supporting institutions, such as private property protection, are weak, as there is no independent judiciary, giving rise to the so-called 'China paradox' where the country has grown well despite not having a well-developed set of institutions (Yao and Yueh, 2009). China's economic growth is therefore in many respects both impressive and puzzling. It is also, like any other fast growing economy, not assured of sustaining such economic growth.

The paper examines the drivers of China's impressive development. A key theme is that the structure of the economy is as important as the standard growth factors in understanding Chinese development and its sustainability. Thus, this article will review the main models and evidence of China's growth and identify the main drivers of Chinese growth within its particular context. The conclusion is that about half of China's growth has been generated by capital accumulation, about a quarter by labour and human capital, and a quarter by productivity gains. But, within each of these categories, the institutional context is important in order to determine the sustainability of such growth. An example is the productivity gains from one-off movements of labour from state-owned to private enterprises. Moving from a less efficient to a more efficient sector

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can inflate the contribution of total factor productivity (TFP) which captures that reallocation, as well as true innovation that increases efficiency permanently.

The next section sets out the standard models of economic growth. It is followed by a review that covers the four main growth theories and their application to China. It starts with a review of neoclassical growth theories before turning to new growth theories. Then, endogenous growth theories are reviewed in terms of the importance of human capital. Technology as a growth driver is analysed both as a result of innovation and from imitation of existing know-how. The final section will draw together the evidence and present the main components of China's GDP growth and how it breaks down among factor accumulation (capital, labour), TFP, human capital, and imitation versus innovation. The breakdown will not only help to increase the understanding of what has explained China's rapid economic growth thus far, but also why innovation and technological progress has become so important in order to sustain the country's growth rate.

2. Economic growth models

In neoclassical models of economic growth, technological change is exogenously determined. In this context, government and market policies cannot increase economic growth in the long run. In empirical models rooted in the neoclassical literature, TFP differences are often attributed to a number of factors, such as those related to institutional differences, and do not comprise technological change alone. Endogenous growth models represent a response to criticism of neoclassical models of economic growth. They are concerned that technological change is a response to economic incentives in the market and can be affected, and created, by government. Technological change can be increased through incentives to innovate and investment in human capital, such as through education and training. Endogenous growth theory also predicts that spillovers from investment in value-added products and knowledge are themselves a form of technological progress and lead to increased growth. In these models, policy and institutions can have an effect on long-term growth.

2.1 Neoclassical growth

Whether it has to do with reforming state-owned enterprises or dismantling the allocated labour market or promoting exports, structural change modifies the traditional drivers of economic growth. When considering the contribution of capital accumulation China should not be viewed as an 'industrialising' country. It was industrialised in the centrally planned period before 1979, and has continued to develop its industrial base since then. So it is the reindustrialisation process that explains much of the continuing capital accumulation in the economy that has accounted for about half of its economic growth. In other words, China's growth can be explained by the standard economic models, but with additional features that are specific to its rather unusual institutional context.

Neoclassical growth models emphasise factor accumulation of labour and capital as determining the steady state, whilst technology and productivity growth increase the rate of growth. In China's case, productivity is not only driven by technology but also by factor reallocation, e.g., the structural change in the economy of labour migrating from state-owned to private industries. The process of factor reallocation exists within the industrial sector, so it is not captured just by the urbanisation and industrialisation processes described by the Lewis model (Lewis, 1954) and others which explain how developing countries grow. It is but one feature of the complex background of China being both a transition and a developing economy. This is also why TFP growth is often difficult to interpret, because it covers both technological as well as one-off productivity improvements, such as those related to privatisation (that involves moving capital from state-owned to private ownership), which are all counted as part of the residual in growth estimations that is counted as TFP.

2.2 Endogenous growth

In terms of endogenous growth models that include human capital, the Chinese experience is more straightforward. The exception is the 'iron rice bowl' – a lifetime employment system that curtailed returns to investment in educational attainment and skills and impeded labour mobility, so that productive workers were not always matched to the most appropriate jobs. Thus, human capital models which consider only the standard measures of educational levels will miss the allocative improvements from other labour market reforms that better matched the human capital of workers to the skills required in jobs, which contributed to China's impressive economic growth.

2.3 'Openness' and growth

China also confounds straightforward interpretations of the theories that link openness to the global economy with growth. These explanations centre on the positive correlation between greater opening and faster development. The mechanisms include how the experience of exporting and accessing global markets can induce competitiveness improvements, as well as learning from foreign investors with more advanced technology and know-how. It would enable a developing country like China to catch up in its growth rate if it could imitate the existing technology embodied in foreign capital, the classical avenue through which countries achieve convergence in their growth rates according to the Solow model.

Again, the theories require adaptation to China, as they do for many other countries. China is an open economy but exercises elements of control that prevent direct competition in its domestic economy and utilise a policy towards foreign direct investment (FDI) that furthers its own active industrial policies to develop domestic companies. As such, the simple openness measure that underpins the models of openness and growth does not fully capture the nature of China's 'open door' policy, which first introduced market-oriented reforms in the external sector in 1978, accelerating them after 1992.

Restrictions on its exchange rate and capital account while seeking technology transfers from FDI mean that several metrics are needed to calibrate the influence of opening on growth. For instance, FDI supplemented domestic investment, accounting for as much as one-third of all investment at the start of the reform period when China was a poor country with a low rate of household saving at only 10 per cent of GDP. Foreign direct investment was also thought to be a source of productivity improvement, particularly via the Chinese–foreign joint venture policy that required transfers of technology to the Chinese partner as a condition of approval to produce in China. The joint ventures and other foreign-invested enterprises (FIEs) were also explicitly geared toward exports. They were initially located in Special Economic Zones (SEZs), which were created as export-processing zones similar to the export-oriented growth models of China's East Asian neighbours.

China thus became integrated with East Asia, as it joined regional and global production chains, and eventually became the world's largest exporter. The focus on exports, together with the fixed exchange rate and the restrictions on the other side of the balance of payments for a high saving economy, contributed to large current account surpluses by the 2000s at a time when the United States became a large deficit country. By the late 2000s, huge global macroeconomic imbalances had developed, such that China and other surplus countries (in Asia and the Middle East oil exporters) and the main deficit country (the United States) experienced growing and seemingly unsustainable imbalances. Therefore, analysing China using an export-led growth model would explain only part of its success and indeed misrepresent China by applying theories which are geared to small, open economies like those in East Asia. The global imbalances and other aspects of the 'China effect' (the impact on global prices) point to the need to examine China as a large, open economy that affects the global terms of trade, in order to understand the role of openness in its economic growth.

2.4 Innovation and growth

The other aspect of technological progress derives from innovation. Technology in endogenous growth models is generated by a knowledge production function and not treated as an exogenous shock, so that innovation is created by researchers within the model. This also applies to China, particularly since it has increased its focus on patents and investment in R&D since the mid-1990s. Endogenous growth theories, including some variants of the human capital models, attempt to explain why some countries innovate and develop technologies that underpin a sustained rate of economic growth that is not subject to the usual diminishing returns. In other words, knowledge builds upon knowledge (the 'standing on shoulders' effect), generating increasing returns, unlike factor accumulation which is subject to decreasing returns per unit of investment. These models have been applied to the United States in particular, which has been not only the world's largest economy but also the standard setter for the technological frontier. However, there is only limited empirical evidence. Jones (1995), for example, finds that a larger number of US researchers does not increase innovation or growth. Since researchers and scientific personnel are numerous in China, this strand of theories can potentially help explain its sustained rate of growth. Since China is farther from the technology frontier, it is plausible that this phenomenon is only just emerging, whereas the earlier reform period might be characterised as one of catching up by imitating existing know-how.

2.5 Institutions and growth

Applying institutional and growth theories to China is complex. The predominant view is that market-supporting institutions (those which protect property rights and provide contracting security), and an effective rule of law, support and can thus drive strong economic growth (see e.g., La Porta *et al.*, 1997, 1998; Acemoglu, Johnson, and Robinson, 2005). This genre of models was proposed to try and explain why some countries grow faster than others, since existing growth theories did not seem able to account fully for the differential growth of countries in the post-World War II period. China is generally not included in those studies – such as

Acemoglu, Johnson and Robinson (2005) – that argue for a causal relationship whereby good institutions lead to growth, as it does not have a colonial past with which to establish the exogeneity of its institutions. Within this methodology, specific instruments related to colonial history are relied upon to address the reverse causality relationship whereby countries that grow well could develop good institutions rather than *vice versa*. Nevertheless, China has been measured against the rule of law and legal origins studies (see e.g., Allen, Qian, and Qian, 2005) and found to be a paradox in having a weak legal system but strong economic growth.

China is therefore deserving of special attention if we are to understand how markets were enabled given the poor formal, legal system. Specifically, the informal institutional reforms of the various dual-track policies, which created a market alongside an administered track, were important when applied to agriculture and the state-owned enterprises (SOEs). These 'institutional innovations' were seemingly sufficient to instil incentives short of formal law-based reforms. But, even in terms of legal protection, China's adoption of laws in some key respects was not dissimilar to that of the United States at a similar stage of economic development. The institutional theories of growth therefore apply to China, but its precepts need modifying to account for the effective role played by incremental legal and institutional improvements. This is particularly important when examining the development of the crucial private sector, which had been stymied by preferential policies towards state-owned enterprises even after the mid-1990s reforms had significantly reduced state ownership.

The role of informal institutions, such as social capital, also cannot be overlooked. Entrepreneurship relied on social networks or *guanxi* to overcome the lack of well-developed legal and financial systems. It is also the case that the cultural proclivity towards interpersonal relationships meant that social capital played a key part in understanding the development of self-employment and the impressive rise of the private sector. Measuring and quantifying social capital requires detailed individual and household level surveys rather than aggregate-level studies.

3. Studies of China's economic growth

3.1 Neoclassical growth model: factor accumulation and TFP

China's rapid economic growth has stimulated a wide-ranging debate as to whether it is driven by productivity growth or by capital and labour factor accumulation. Some find evidence of a clear improvement in total factor productivity in the reform period. Specifically, the increase in TFP contributes about 40 per cent to GDP growth, roughly the same as that of fixed asset investment (Borensztein and Ostry, 1996; Hu and Khan, 1997; Jefferson, Rawski, and Zheng, 1992; Yusuf, 1994). Others conclude that economic growth in China is mostly driven by capital investment (Chow and Lin, 2002; Wu, 2003). For instance, Chow and Lin (2002) show that the increase in TFP contributed 29 per cent to GDP growth between 1978 and 1998, compared to a 62 per cent contribution by capital (see also Chow, 1993; Borensztein and Ostry, 1996; Young, 2003; Wang and Yao, 2003; Islam, Dai, and Sakamoto, 2006). Hu and Khan (1997) found that an average TFP growth of 3.9 per cent explained more than 40 per cent of China's growth during the early reform period. The studies, though, concur that capital accumulation contributes about half of GDP growth. The share of TFP is less clear.

There is one trend that most studies agree on, that is, the slowdown in TFP after the mid-1990s. For instance, the World Bank (1997) estimates that TFP growth accounted for 30 to 58 per cent of China's growth during 1978–95 but slowed after 1995 (see also Zheng, Bigsten, and Hu, 2009). The OECD (2002) considers that part of the reason was that human capital, land, and other resources were misallocated, under-employed, and inefficiently used. Growth thus increasingly relied on capital accumulation, since labour force growth declined from 2.34 per cent per annum from 1978–95 to 1.07 per cent in 1995–2005.

Zheng and Hu (2006) estimate that TFP growth fell dramatically during 1995–2001, accounting for as little as 7.8 per cent of GDP growth. Whereas TFP had risen by 3.2 to 4.5 per cent per year before 1995, it rose by only 0.6 to 2.8 per cent per year afterwards. The OECD (2005) estimated that annual TFP growth averaged 3.7 per cent per annum during 1978–2003, but slowed to 2.8 per cent by the end of that period. However, Young (2003) argues that, though on official figures it is 3 per cent, in reality it should be adjusted downwards to 1.4 per cent from 1978–98.

Explanations for changes in TFP growth are often controversial, but the slowdown during 1995–2005 coincided with sluggish rural income growth and widespread industrial inefficiency as well as the decline of one-off, reallocative effects. From the late 1970s to the early 1990s, China's growth depended more on productivity growth and less on increased capital than other East Asian countries at a comparable stage of their development. However, since then, growth in capital inputs has often substantially exceeded GDP growth. The issue is whether TFP has slowed down, or whether there were one-off productivity gains associated with reform. This measurement issue may help to explain why there is such wide disagreement as to whether China's growth is based on true productivity improvements. To investigate further, Zheng, Bigsten, and Hu (2009) examined reform measures and found that they often resulted in one-time level effects on TFP, e.g., movement of capital from state-owned to private enterprises.

A similar trend affected labour productivity. Jefferson, Hu, and Su (2006) explore the sources of China's growth covering the period 1995–2004. They conclude that there is evidence of improved allocative efficiency from labour moving out of agriculture and between industrial and ownership sectors resulting in productivity advances. Brandt and Zhu (2010) come to a similar conclusion, but find that the reallocation effect weakens in the 2000s. Yet, labour productivity accelerated in the 2000s. In my estimation, moving labour out of the state sector contributed 8.5 per cent of the total average labour productivity growth of 9.2 per cent in the 2000s (Yueh, 2010). The predominant factor (accounting for around 85–92 per cent) of labour productivity growth in the 2000s is due to improvements in technical efficiency, which are promising as a basis for sustained growth. It does, though, again suggest that the early measures of TFP include the one-off gains from sectoral reform. As that declined, TFP appeared to be slowing down but was mismeasured in the earlier period since prior growth data included allocative gains from reform and not true productivity growth due to increased efficiency and technological progress.

3.2 Endogenous growth: human capital

Although it has long been believed that human capital plays a fundamental role in economic growth, studies based on cross-country data have produced surprisingly mixed results (Barro, 1991; Mankiw, Romer, and Weil, 1992; Benhabib and Spiegel, 1994; Islam, 1995; Pritchett, 2001; Temple, 2001). For instance, Barro (1991, 2001), Benhabib and Spiegel (1994) and Bils and Klenow (2000) find that the initial stock of human capital has a larger impact on the growth rate than the improvement in human capital. The exception is Gemmell (1996), who finds that both the stock and accumulation of human capital were significant determinants of growth. In addition, human capital had both a direct effect on growth and an indirect effect through physical capital investment. One reason for the mixed findings is that the impact of education has varied widely across countries because of very different institutions, labour markets and education quality making it hard to identify an average effect (see Temple, 1999; Pritchett, 2001).

It is widely hypothesised that human capital has a direct role in production through the generation of workers' skills and also an indirect role through the facilitation of technology spillovers. Most studies use different measures of human capital, such as secondary school enrolment, student–teacher ratio, spending on education and science, and the number of science and technology workers. Thus, the incorporation of a measure of human capital 'inside' the production function is based on micro-level evidence that better educated workers are more productive.

In general, labour supply is found to be a less important growth factor for China than capital investment and TFP. The one-child policy slowed down population growth and the high degree of labour force participation limited labour as a source of factor accumulation driving growth. Perhaps also as a result, there are fewer studies of the contribution of human capital to China's growth rate. This set of models internalises human capital as the source of productivity and technology advancement, implying that endogenous growth occurs when there are improvements in human capital. Technological progress is thus explained by the accumulation of education, skills, training, etc. and not left as the unexplained portion of growth as in the neoclassical models.

China's economic growth is largely labour-intensive with high levels of fixed capital investment (Arayama and Miyoshi, 2004; Chow, 1993; Yusuf, 1994). Differentiating the portion from human capital is essential, as growth driven by education and skills improvements has the potential to be sustainable due to the associated increase in productivity, technological innovation and diffusion (Aghion and Howitt, 1998; Lucas, 1988; Romer, 1990). During China's reform period, 10 to 20 per cent of GDP growth may be attributable to the growth of the labour force, a less important source of factor accumulation than capital, which accounts for about half (Chow and Lin, 2002; Hu and Khan, 1997; Wu, 2003).

In terms of separating out human capital, Wang and Yao (2003) find that capital, labour, human capital, and TFP each accounted for 48, 16, 11, and 25 per cent, respectively, of GDP growth in China during the period 1978–1999. Human capital is measured as the average years of schooling per capita for the working age population. In about the same period (1978–98), using provincial data, Arayama and Miyoshi (2004) similarly find that human capital contributes about 15 per cent to China's growth. This is again confirmed by Qian and Smyth (2006) using provincial data for 1990–2000. They find that the contribution of human capital to GDP growth was 13 per cent, while physical capital contributed 55 per cent and TFP growth accounted for 22 per cent. Comparing across 28 provinces for 1978–2005, Li and Huang (2009) concur that education (quality measured as teacher–pupil ratio and educational attainment) and health both positively contribute to provincial growth rates. Démurger (2001) also finds evidence that education at the secondary or college level helps to explain differences in provincial growth rates. These provincial studies support the national findings, a common research methodology for China.

However, these studies have not differentiated between the stock and accumulation of human capital (Krueger and Lindahl, 2001). Fleisher and Chen (1997) specifically do so, separating out the effect of the stock of human capital on TFP. They measure human capital as the percentage of university graduates in the population, and find that it had a significant effect on total factor productivity. Chen and Feng (2000) use a similar measure and find that human capital is a significant determinant of differential provincial growth rates. Fleisher, Li, and Zhao (2010) also show how regional growth patterns in China depend on regional differences in physical, human, and infrastructure capital as well as on differences in foreign direct investment flows. They find that human capital positively affects output and productivity growth across provinces. Moreover, they find both direct and indirect effects of human capital on TFP growth. The direct effect is hypothesised to come from domestic innovation activities, while the indirect impact is the spillover effect of human capital on TFP growth (Liu, 2009a,b finds an impact of human capital on productivity in both rural and urban China).

Using a less technical approach but one that is highly informative and suggestive, Sonobe, Hu, and Otsuka (2004) show that subtle and important changes in quality control, efficient production organisation and marketing of manufactured goods among emerging private enterprises have been more likely to occur in firms where managers have acquired relatively high levels of education. Fleisher and Wang (2001, 2004) likewise find evidence that highly educated workers have significantly higher marginal product than workers with lower levels of schooling incorporating these qualitative factors.

3.3 Catch-up growth: technology

There have been a large number of studies on the role of technology on innovation in China, particularly in terms of spillovers of knowledge from foreign investment. The government during the latter part of the reform period recognised the importance of innovation and enacted a patent law in 1985 and a slew of associated copyright and trademark legislation subsequently. Since the imposition of tougher intellectual property rights' (IPR) requirements with accession to the World Trade Organisation (WTO) in 2001, Chinese firms have gradually devoted more resources to innovative activities and acted aggressively on patent applications (Hu and Jefferson, 2009). But in the early part of the reform period China's policies were geared towards attracting FDI and promoting trade in order to benefit from the positive spillovers of technology and know-how that characterise the catch-up phase of development, whereby a country learns and imitates rather than reinvents or innovates when it is far from the technology frontier.

There are several arguments as to the mechanism through which FDI and trade boost economic growth (Gylfason, 1999). One of the widely recognised views is that FDI and trade are technology spillover channels for absorbing advanced knowledge. One of the benefits from FDI is that new technology is brought in by foreign firms. Technology transfer occurs through two channels – new technologies sold directly through licensing agreements or the transfer of new technology to exporters from their foreign purchasers. Alternatively, international trade also generates technology externalities through learning-by-exporting or imitating technologies embodied in the imported intermediate goods. There is also a productivity effect from facing greater competition at a global level. The argument that FDI and international trade served as major driving forces contributing positively to China's faster growth since the late-1980s through the 2000s is well recognised (Chen, Chang, and Zhang, 1995; Harrold, 1995; Liu, Burridge, and Sinclair, 2002; Pomfret, 1997; Shan 2002).

For China, FDI has facilitated the transformation of the state-owned and the collective sectors (Liu, 2009c). The location of FDI is also encouraged by exogenous geographical and political factors such as proximity to major ports, policy decisions to create special economic zones and free trade areas, local institutional characteristics such as laws and regulations, contract enforcement, local expenditure on infrastructure and labour market conditions. Using city-level data, Wei (1993) arrives at the conclusion that FDI contributes to economic growth through technological and managerial spillovers between firms as opposed to simply providing new capital. This is supported by studies such as Dees (1998), Sun and Parikh (2001), and Wei (1993) who conclude that inward FDI affects China's economic growth in ways beyond simple capital formation.

Indeed, FDI has played an important role in both China's TFP and its fast growth. The classic catch-up mechanism in neoclassical growth models is for capital to flow from developed to developing countries bringing with it technology and know-how. China has certainly been the recipient of a large amount of FDI since its 'open door' policy took off in the early 1990s. And FDI appears to have had positive effects on its growth. Using econometric methods to regress GDP (or GDP growth) on FDI and other variables, a large number of studies find a positive and significant coefficient on FDI, concluding that foreign investment has played a notable part in China's GDP growth (Tseng and Zebregs, 2002; Lemoine, 2000; Berthelemy and Démurger, 2000; Graham and Wada, 2001; Chen, Chang, and Zhang, 1995; Liu, Burridge and Sinclair, 2002; Wei, 1993; Dees, 1998; Sun and Parikh, 2001; Wei *et al*., 1999; Borensztein, De Gregorio, and Lee, 1998). Whalley and Xin (2010) further examine the role of foreign invested enterprises (FIEs). FIEs are often joint ventures between foreign companies and Chinese enterprises, and account for over 50 per cent of China's exports and 60 per cent of China's imports. Without FDI inflows in 2004, they estimate China's overall GDP growth rate would be lower by around 3.4 percentage points. Excluding FIEs whose FDI are from Hong Kong, Macao and Taiwan, FIEs still account for around 30 per cent of China's GDP growth.

Fleisher, Li, and Zhao (2010) find that FDI had a much larger effect on TFP growth before 1994 than after, and they attribute this to the encouragement of and increasing success of private firms. After 1994, they find a much smaller, even insignificant, economic impact of FDI. They conjecture that the drop in the impact of FDI after 1994 can be attributed in part to the encouragement of the non-state sector. Since then, private and 'red cap' enterprises (nominally rural collectives, but in fact privately owned) and the evolution of township and village enterprises (TVEs) from collectives to *de facto* private firms have become relatively more important sources of growth, while the relative importance of FDI-led growth has declined. Consistent with this conjecture, Wen (2007) reports that, at least since the mid-1990s, FDI has tended to crowd out domestic investment, more so in the non-coastal regions. A similar finding is reported for the early 2000s by Ran, Voon, and Li (2007).

But there is likely to be a degree of endogeneity in these relationships between FDI and TFP growth if TFP growth encourages FDI (Li and Liu, 2005). A number of studies conclude that technology transfers and the spillover effects are limited, and much if not most of the correlation between FDI and superior economic performance reflects reverse causality (Young and Lan, 1997; Woo, 1995; Lemoine, 2000). Woo (1995) argues that the role of FDI in spillover effects is overstated because foreign investment is located in liberalised regions. Rodrik (1999) also expresses doubts over spillover effects, arguing that greater productivity in domestic firms in producing for exports does not necessarily suggest efficiency spillovers from foreign firms, since more productive firms, domestic or foreign, tend to locate in export sectors.

Turning to R&D, studies of the roles of research and development, spillovers and absorptive capacity on growth are limited in China. Using provincial data covering the period 1996–2002, Lai, Peng, and Bao (2006) find that domestic R&D has a positive and statistically significant impact on economic growth, though that study does not include the external effects of technology imports. Their estimates also indicate that international technology spillovers depend on the host province's absorptive ability as measured by human capital investment and degree of openness. Brun, Combes, and Renard (2002) attempt to test for the existence of provincial spillover effects, though their concept of regional spillover is of 'regional growth spillover effects' rather than 'regional technology spillovers'. Utilising a panel dataset of 28 provinces covering the period 1981–98, they find that spillover effects have not been sufficient to reduce disparities across Chinese provinces in the short run. Kuo and Yang (2008) also assess how and to what extent knowledge capital and technology spillover contribute to regional economic growth in China. Moreover, a region's absorptive ability is considered as they measure the critical capability to absorb external knowledge sources embodied in FDI and imports, which then contribute to regional economic growth, e.g., the absorptive capacity of human capital on using acquired advanced foreign technologies. They find that knowledge capital, both in terms of R&D capital and technology imports, contributes significantly, with similar magnitude, to regional economic growth. There are also suggestions of the existence of R&D spillovers as well as international knowledge spillovers. R&D has a positive impact on regional growth with an estimated magnitude of R&D elasticity of 0.043, indicating that a 1 per cent increase in R&D capital would raise regional GDP about 0.043 per cent, controlling for other variables.

Along these lines, Dobson and Safarian (2008), using the evolutionary approach to growth in which institutions support technical advance and enterprises develop capabilities to learn and innovate, examine China's transition from an economy in which growth is based on labour-intensive production and imported ideas and technology to one in which growth is driven by domestic innovation. They find the increasing competitive pressure on firms encourages learning. Their survey of privately owned small and medium enterprises in five high-tech industries in Zhejiang province found a market-based innovation system and evidence of much process and some product innovations. These enterprises respond to growing product competition and demanding customers with intensive internal learning, investment in R&D and a variety of international and research linkages. Zheng, Liu, and Bigsten (2003) find that TFP growth in China has been achieved more through technical progress than through efficiency improvement.

Without question, the role of international knowledge spillovers in generating endogenous economic growth has been long emphasised in theory, e.g., Grossman and Helpman (1991). And a growing trend in empirical studies finds that international technology spillover is one of the major sources of productivity growth (see Coe and Helpman, 1995; Eaton and Kortum, 1996; Keller, 2000). This crucial and still under-explored issue could provide evidence for the possibility of more sustainable growth for China in the coming decades. In Van Reenen and Yueh (2012), we investigated the impact using a specially designed data set with measures of technology spillovers at the Chinese firm-level. Working on the premise that capital accumulation has accounted for about half of China's real GDP growth of 9.6 per cent per annum since 1979, we find that the contributions of Chinese–foreign joint ventures (JVs) of 9 per cent and FDI as a whole, accounting for 15 per cent of investment, translate into between 0.42 to 0.71 percentage point additions to growth. In other words, without having attracted FDI, China's growth rate would have been up to three-quarters of a per cent slower, bringing the average growth rate down to 8.9–9.2 per cent. Adding in the productivity boost of JVs, they are 23 per cent more productive as compared with other firms and JVs with technology transfer agreements hold a 73 per cent productivity advantage. As JVs are 15 per cent of all firms in the 2000s, China's GDP has been increased by between 3.45 per cent and 10.95 per cent, respectively. Translating this into growth terms (and assuming a cumulative process starting in 1979 for the increase in GDP by 2009) means that average growth would have been lower by 0.43 per cent per annum by 2009 without JVs.

Putting all this together, we calculate that had China not attracted FDI and JVs in particular, with their potential to allow for catching up via technology transfers and other indirect avenues of learning, then China's annual GDP growth could have been between one-half to over a percentage point lower (i.e. as low as 8.5 per cent) over the past 30 years. As JVs were more important as a share of investment during the 1990s, accounting for around one-quarter of total investment, this is a conservative estimate. The contribution of joint ventures is therefore sizeable, as 1 percentage point in compound growth terms translates into large differences in income levels, as countries like India, which has grown at 7–8 per cent instead of China's 9–10 per cent over the past few decades, can attest. China surpassed its Asian neighbour even though it was poorer in 1980.

3.4 New growth theories: institutions

The link between institutional development and economic growth has risen in prominence as a factor explaining the unexplained portions of growth (Acemoglu, Johnson, and Robinson, 2005), though economists have long been interested in the role of institutions in explaining economic transition and growth (North, 1990). The inability to explain long-run differences in growth has motivated a return to this subject, which was also revived by the instability of transition economies in the former Soviet Union when it underwent market-oriented reforms. China's underdeveloped institutions but relatively stable transition and remarkable growth rate make it an outlier in much of this literature, suggesting that analysis of China's growth has much to add to the understanding of how institutions interact with economic growth.

The late twentieth century witnessed the transformation of numerous centrally planned economies around the world into market-based systems. Many of these transitions were characterised by a 'Big Bang' (Hoff and Stiglitz, 2004) that combined economic liberalisation with rapid privatisation and democratisation. The theory is that growth will accelerate with the removal of the inefficient and distortionary state and the introduction of market forces (Persson and Tabellini, 2006). The result was a transformational recession whereby these nations underwent a decade-long period of contraction and stagnation in the immediate aftermath of shedding central planning.

By contrast, China followed a rather different path, where economic reform and transition towards a market economy occurred without democratisation. Liberalisation proceeded only incrementally and privatisation was delayed by almost two decades after the initiation of market-oriented reforms. Without clearly defined property rights, such as those vested in private firms, China managed to grow by fostering a different sort of competition – among provinces. Regional decentralisation helped to introduce market-oriented reforms into the economy through experimentation at the provincial level, where policies that worked could propel growth locally and serve as a template for others, such as Special Economic Zones which were first established on the coast (see e.g., Xu, 2011).

Indeed, China's gradual approach to reform has resulted in high and relatively stable growth rates for over three decades (Prasad and Rajan, 2006). This remarkable growth performance was accompanied by a relatively undeveloped legal and financial system, which makes China a puzzle or paradox given the focus of economists on the importance of well-defined legal and formal institutions. La Porta *et al*. (1997, 1998, 2000) study the relationship between law and finance, and consequently economic development, and highlight the importance of legal institutions. According to Allen, Qian, and Qian (2005), China seems like "a counterexample to the findings in law, institutions, finance and economic growth literature". They document the poor legal protection of minority shareholder interests and outside investors as well as the dominant role of the state public sectors and yet China managed to outperform other economies which score well on those measures.

Hasan, Wachtel, and Zhou (2009) examine the roles of legal institutions, financial deepening and political pluralism on growth rates. The most important institutional developments for a transition economy are the emergence and legalisation of the market economy, the establishment of secure property rights, the growth of a private sector, the development of financial sector institutions and markets, and the liberalisation of political institutions. They develop measures of these phenomena, which are used as explanatory variables in regression models to explain provincial GDP growth rates. Their evidence suggests that the development of financial markets, legal environment, awareness of property rights and political pluralism are associated with stronger growth. Based on a sample of 31 Chinese provinces for the period 1986–2003, their results indicate that those regions with a better rule of law, more property rights awareness and more political pluralism also have stronger growth. After controlling for the province-specific effects, endogeneity and potential problems associated with weak instruments, the data suggest a strong, positive link between institutional development and economic growth in China, and that a one standard deviation increase in relative pluralism is associated with a 0.6 percentage point increase in the growth rate.

There are a large number of other studies that examine the disparities among provinces as a way of identifying the determinants of growth in China (see e.g., Liu and Li, 2001), but few include the role of institutions. However, there are a few studies that look at province-level data on financial sector development and the private sector. Chen and Feng (2000) find that growth of private and semi-private enterprises leads to an increase in economic growth, while the presence of SOEs reduces growth rates among the provinces based on their sample 29 Chinese provinces from 1978 to 1989. Aziz and Duenwald (2002) and Boyreau-Debray (2003) find little influence of financial sector depth (development of capital markets in addition to the banking system) at the provincial level on growth primarily because little credit growth in the 1990s went to the private sector. In the latter part of the reform period, Liang (2005) and Hao (2006) find evidence that financial depth and the reduced role of government both positively influence provincial growth rates. In addition, Biggeri (2003), using provincial-level data for the period 1986 to 2001, finds that the level of aggregate output in each province is negatively influenced by the presence of state-owned enterprises, a proxy for the extent of marketisation of the economy. These studies of inter-provincial differences in growth indicate that the effort to measure institutional development is warranted. Allen, Qian, and Qian (2005) compare growth in the formal (state-owned and publicly traded firms) and the informal sector and find that the latter is the source of most economic growth even though it is associated with much poorer legal and financial mechanisms. They argue that there exist effective informal financing channels and governance mechanisms, such as those based on reputation and relationships (social networks), to support this growth.

An additional channel of financial sector influence on growth is through the capital markets which also rely on institutions such as corporate governance and regulatory structures. Stock markets accelerate growth by facilitating the ability to trade ownership and by allowing owners to diversify portfolios easily. Rajan and Zingales (1998) argue that financial development facilitates economic growth by reducing the costs of external finance to firms; their empirical evidence from a cross-country study supports this rationale. Further, in terms of private sector development, Guiso, Sapienza, and Zingales (2004) find that differences in local financial development can explain the spread of entrepreneurship and economic growth. Zhang, Wan, and Jin (2007) provide evidence of financial depth effects on productivity growth at the provincial level in China. Rousseau and Xiao (2007) find that stock market liquidity and banking development are positively associated with growth for China (see also Rousseau and Wachtel, 2000).

4. China's growth determinants

Summarising these findings, capital accumulation accounted for 3.2 percentage points of the 7.3 per cent growth in output per worker from 1979–2004, with TFP accounting for 3.6 percentage points. From 1993–2004, since the take-off of the open door policy, capital accumulation has accounted for 4.2 percentage points of the higher 8.5 per cent growth in China, and interestingly outweighs the contribution of TFP (3.9 percentage points). These estimates suggest that capital accumulation has contributed around half of China's economic growth, which is in line with other estimates that find that most of China's growth is accounted for by capital accumulation rather than TFP growth during the reform period thus far.

From the evidence, labour accumulation accounts for much less; 10–20 per cent of GDP growth may be attributable to the growth of the labour force. Human capital accounts for a slightly lower proportion of between 11 and 15 per cent of China's growth. Factor accumulation (capital and labour) thus accounts for about 60–70 per cent of GDP growth. Once human capital is accounted for in the residual, the contribution of TFP to economic growth declines.

Within TFP, there is a further need to separate the one-off productivity gains due to factor reallocation from efficiency-driven improvements. By the 2000s, labour reallocation accounted for 8–15 per cent of TFP gains but with higher contributions in the previous decades. It is similar for capital and could explain the decline in TFP after the mid-1990s. These calculations imply that around 8 per cent of China's GDP growth is driven by factor reallocation, leaving about 7–21 per cent that is explained by efficiency gains driven by sustained productivity improvements and not one-off structural change.

Of those efficiency improvements, Van Reenen and Yueh (2012) show that GDP growth would be lower by between 0.43 to 1 per cent per annum if not for joint ventures that allowed for transfers of knowledge and technology, the catch-up mechanism as opposed to domestic innovation. Positive spillovers and imitation of existing know-how thus could account for between one-third to two-thirds of TFP. It implies that TFP driven by innovation and technological progress not directly traced to FDI accounts for about 5–14 per cent of GDP growth. Given the poverty of China when market-oriented reforms began in 1978, and the apparent catch-up potential, this is not surprising.

To achieve its ambition of sustaining growth for another 30 years China will require not only technological and human capital improvements, but also reform of its rule of law, the role of the state, and the rebalancing of its economy. Rebalancing the economy will involve boosting domestic demand (consumption, investment, government spending) to grow more quickly than exports, shifting toward services (including non-tradable areas) and away from agriculture, increasing urbanisation to increase incomes, and permit greater external sector liberalisation, including the internationalisation of the RMB. To achieve these aims will also require examining the role of the state in China and the legal system. The retention of large SOEs and the increasingly perceived un-level playing field for both foreign and domestic private firms raises doubts as to the efficiency of China's markets and thus its ability to overcome the middle income country trap, whereby countries start to slow after reaching upper middle income levels. For China to realise its potential as an economic superpower requires reforms of both the microeconomic drivers of productivity as well as significant transformation of the structure of its economy.

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CONVERGENCE OF RETURNS ON CHINESE AND RUSSIAN STOCK MARKETS WITH WORLD MARKETS: NATIONAL AND SECTORAL PERSPECTIVES

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Interest in examining the financial linkages of economies has increased in the wake of the 2008/9 global financial crisis. Applying the concepts of beta- and sigma-convergence of stock market returns, we assess changes over time in the degree of stock market integration of Russia and China with each other, as well as with respect to the United States, the Euro Area, and Japan. Our analysis is based on national and sectoral data spanning the period September 1995 to October 2010. Overall, we find evidence for gradually increasing convergence of stock market returns after the 1997 Asian financial crisis and the 1998 Russian financial crisis. Following a major disruption caused by the 2008/9 global financial crisis, the process of stock market return convergence resumes between Russia and China, as well as with world markets. Notably, the episode of sigma-divergence from the 2008/9 crisis is stronger for China than for Russia. We also find that the process of stock market return convergence and the impact of the recent crisis have not been uniform at the sectoral level, suggesting the potential for diversification of risk across sectors.

Keywords: Stock market integration; beta-convergence; sigma-convergence; China; Russia; sectoral and national analysis

JEL Classifications: C23; G15; G12

1. Introduction

The economic and financial crisis of 2008/9 brought wider awareness that financial integration bundles considerable non-negligible costs with the much-touted benefits. Assessment of the costs and benefits of financial integration dates back to the work of Agénor (2003), who proposes that the benefits of financial integration outweigh the costs when mechanisms for maintaining financial stability are in place.[1] (Examples of these mechanisms are discussed in Agénor *et al*., 2011). When these mechanisms are overlooked, however, the costs of financial integration generated by a crisis can be considerable. Therefore, monitoring the degree of financial integration is useful both in good times, when the long-run benefits of economic growth are realised, and in bad times, when the costs of financial integration (e.g. through contagion) are manifest. Even leading policymakers now note the importance of assessing financial integration in both normal and crisis times (e.g. Trichet, 2010, 2008, 2007; Papademos, 2010, 2008a, 2008b; and Yam, 2006).

While this topic is vast, the objectives of our study are to help resolve mixed findings on the integration of Chinese and Russian stock markets with key world markets. In fact, there is no consensus in the literature on the extent of stock market integration of China and Russia with world markets. In the view of some scholars (e.g. Groenewold *et al*., 2004; Li, 2007; and Koźluk, 2008), Chinese stock markets move largely independently of global movements, while Russian stock markets show evidence of rising integration with global (particularly EU) stock markets (Koźluk, 2008). Other studies reach an opposite conclusion, i.e. Chinese stock markets continue to integrate with the global financial system,

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while the Russian stock market remains isolated. Chow *et al*. (2011) argue that China's stock market has become "more and more integrated" into the world market. Rizavi *et al*. (2011) report stock market integration has deepened between China and its Asian neighbours. The claim of Verchenko (2000) that the Russian stock market is not integrated with the stock markets of neighbouring countries is backed by the assessment of Tirkkonen (2008) on a set of benchmark countries made up of the US, China, Japan, and several EU countries.

To help fill in the gap in the existing literature, we focus on China and Russia to examine stock market integration between these two countries, as well as their integration with global benchmarks including the US, the Euro Area, and Japan. Deepening of trade, economic and financial Chinese-Russian ties[2] raises questions as to the extent to which the two countries' stock markets are interrelated, as well as how these links have evolved over time both in absolute terms and relative to world stock markets.

As we discuss in the literature review, there is substantial empirical evidence on Chinese and Russian stock markets, but few studies that compare links between them, and even fewer works that present disaggregated evidence from sectoral or regional perspectives. Indeed, to our knowledge, there is no study on Chinese and Russian stock market links based on sectoral data. This study also is novel in its examination of stock market integration in China and Russia over time at both national and sectoral levels, and in quantifying the impact of the 2008/9 crisis.

Acknowledging the importance of assessing the cost–benefit aspects of financial integration and the effects expressed in various crises, we focus on quantifying the degree of stock market integration for China, Russia, and key world markets, as well as the time dynamics of this integration over the period 1995–2010. Stock markets continue to grow in size, yet these linkages represent an increasingly important, but mostly ignored, aspect of the financial system. According to Baele *et al*. (2004), financial integration, particularly stock market integration, can be assessed using three types of measures: (1) price-based, (2) news-based, and (3) quantity-based measures. The first class of measures could be viewed as a direct check of the law of one price on the condition that the compared assets have similar characteristics. The second class of measures makes possible identification of existing market imperfections such as frictions and barriers; in the integrated area, new information of a local character should have less impact on particular assets than global news. The third class of measures quantifies the effects of legal and other non-price frictions and barriers from both the supply and demand sides of the investment decision-taking process. We focus on the first dimension, the price-based indicators of stock market integration. They can be operationalised and the required stock market data are available, allowing cross-country comparison. Price-based measures can also be quantified by means of beta- and sigma-convergence. As applied to stock markets, beta-convergence characterises the speed at which differences in stock market returns between individual markets are eliminated, while sigma-convergence captures the dispersion of return differentials and its change over time.

Our study contributes to the literature in addressing the following three questions that have received little attention to date:

1. Is there convergence of stock market returns on the national and sectoral level between China and Russia, or conversely, with the US, the Euro Area and Japan? And if there is convergence, how fast is it?

2. How does the degree of stock market return convergence change over time? In particular, are Chinese and Russian stock markets becoming more integrated with each other or are they integrating with the major global markets such as the US, Japanese or Euro Area stock markets?

3. What are the effects of the current financial crises on analysed stock market integration?

The structure of the paper is as follows. Section 2 discusses the relevant literature focusing on the integration of stock markets generally and on studies that deal mainly with Chinese and Russian stock markets. Section 3 provides stylised facts on the development of Chinese and Russian stock markets at the national and sectoral levels. The fourth section provides a discussion of the theoretical approaches to estimating stock market integration. Section 5 gives an empirical evaluation of stock market integration and compares our findings with previous results in the literature. The last section concludes.

2. Literature review

This section provides an overview of the general studies on stock market integration and some specific works on China and Russia. A price-based concept is explored in these studies and a variety of alternative techniques is used, ranging from beta- and sigma-convergence of stock market returns to cointegration analysis of stock prices, variance decomposition, and conditional correlations of returns. With regard to Western Europe, an overview of studies on capital market integration at national levels is presented in Hartmann *et al.* (2003); examples of decomposition of stock returns into country- and industry-specific effects are given in studies by Heston and Rouwenhorst (1995) covering the time period from 1978 to 1992 and Baca *et al.* (2000) focusing on 1979–99. Portes and Rey (2005) employ the gravity equation framework to describe the determinants of cross-border equity flows amongst the main world markets in 1989–96.

A new feature – change of integration over time – is introduced by Bekaert and Harvey (1995), who construct a time-varying measure of financial integration. Their results show that world capital markets overall became increasingly integrated in 1975–92, but that delinkage also occurred for some individual countries. Applying an alternative time-varying approach, Ayuso and Blanco (2000) find that financial market integration between the stock markets of the Euro Area countries increased during the period 1990–9. Bekaert *et al.* (2000) also find that the degree of integration amongst emerging equity markets in 1980–96 is higher than previously thought when endogenous structural breaks in the series are taken into account. Applying the time-varying framework along the lines of Bekaert and Harvey (1995), Hardouvelis *et al.* (2006) examine whether steps towards the creation of the Euro Area in 1992–8 were accompanied by stock market integration. The degree of integration is found to have increased with the formation of the European Monetary Union (EMU), particularly since 1995. In contrast, Ekinci *et al.* (2007) propose a new metrics of *de facto* integration and report evidence of a low degree of capital market integration amongst the mature EU members in 1995–2003 relative both to their theoretical prediction and judged against the US. Berger and Pozzi (2011) revisit time-varying integration of stock markets amongst the US, Japan and selected European countries in 1970–2010, deriving the country-specific risk premia upon a capital asset pricing model and a GARCH-type estimation technique. They find evidence of rising stock market integration among all countries, except Japan.

A number of studies evaluate the extent of stock market integration in non-OECD countries. Applying the cointegration approach, Azman-Saini *et al.* (2002) find limited evidence of long-run relationships among five Asian equity markets between 1988 and 1999. Yang *et al.* (2003) present further evidence on co-movements among ten Asian emerging stock markets and in relation to the US and Japan in 1995–2001. They distinguish long- and short-run linkages, and explicitly control for the Asian financial crisis of 1997–8. The degree of integration amongst the Asian countries is found to increase for the post-Asian-crisis period. Employing the vector autoregression (VAR) framework, Phylaktis and Ravazzolo (2002) simultaneously examine financial and economic linkages for the Pacific Basin countries in 1980–98. Financial integration was found to occur along with economic integration. This observation has particular relevance for China and Russia as they strengthen economic ties between themselves and with the rest of the world.

Application to China

The research applied to China's stock market integration can be divided into four categories:

1. Integration within mainland China (mainly between Shanghai and Shenzen market),

2. Integration within greater China (mainland China, Hong Kong and Taiwan),

3. Integration of mainland or greater China compared to other countries, and

4. Sectoral analysis of the Chinese stock markets.

Studies in the first two categories commonly find evidence of stock market integration. There is no consensus as to whether Chinese stock markets are integrated with world stock markets or not, and the evidence from sectoral analysis is quite limited. Our paper, therefore, concentrates on empirical analysis of the third and fourth categories. However, a brief overview of all four categories may be useful before proceeding to our analysis.

Mainland China: Huang *et al.* (2000) report cointegration linkages between Shanghai and Shenzen stock exchange market and their significant feedback relationships from 1992 to 1997. Los and Yu (2008) apply advance signal processing aimed at detecting the degree of persistence, stationarity, and independence of Chinese A- and B-share Shanghai and Shenzen mainland markets in 1990–2005. The gradual improvement found in these characteristics is in line with the process of deregulation. Mainland Chinese stock markets are shown to behave efficiently and are integrated into a single Chinese stock market.

Greater China: Huang *et al*. (2000) also analyse causality and cointegration amongst the US, Japan and greater China. It is shown that the dynamics of returns on the US market has stronger influence on greater China than on the Japanese market in 1992–7. US stock market returns are found to be useful predictors for Hong Kong and Taiwan returns. Groenewold *et al*. (2004) focus on integration among greater China's stock exchange markets, i.e. mainland China, Hong Kong and Taiwan, using a VAR approach and Granger-causality tests for the period 1992–2001. Their results reveal that mainland China's markets are strongly interconnected, while the Hong Kong and Taiwan stock markets are relatively isolated. Evidence of rising links between the mainland markets and Hong Kong, however, is noted after the 1997 Asian crisis. Hatemi and Roca (2004) study integration between greater China and Singapore in 1993–2001 using the causality test based on the bootstrap method. The authors find a gradually rising interdependency between mainland China, Hong Kong, and Taiwan after the 1997 Asian crisis.

Cross-country comparisons: There is a broad group of studies that investigate integration of the stock markets of mainland China or greater China vis-à-vis other stock markets. Employing the same methodology and time framework as in the above analysis of stock markets within mainland China, Groenewold *et al*. (2004) find mainland China's markets to be relatively isolated from the Hong Kong and Taiwan stock markets. However, following the Asian crisis, there is weak evidence of spillovers from Hong Kong to greater China's stock markets. Using VAR models, Bahng and Shin (2003) test for the existence of asymmetric responses among national stock exchange indices of China, Japan, and South Korea over 1991–2000, finding pattern asymmetry amongst all three indices. The variance decomposition of the forecast errors reveals that the Chinese index is least explained by variations of the other two markets. When the US index is incorporated into this analysis, however, the US stock market appears to have a significant effect on the Chinese market. Hsiao *et al*. (2003) use pair-wise and VAR analyses to identify financial linkages in daily variations in stock prices indices between the US and Asia-Pacific region for 2001–2, and then test for the Granger-causality of these linkages. The authors report that a drop in the US stock market does not Granger-cause similar behaviour in the Chinese mainland stock market, but does cause a drop in stock markets in Japan, Korea and Taiwan, suggesting a certain degree of isolation of the Chinese mainland stock market.

These early conclusions are supported by the more recent literature. Girardin and Liu (2007), for example, investigate whether China's A-share market is integrated at the national level with the European, US, and Hong Kong markets. Application of the cointegration method to daily, mid-week, and average week data for 1992–2005 yields different results. There is no cointegration for daily and mid-week data, but evidence of co-integration between the Chinese Shanghai A-share market and the European S&P500. Using a multivariate GARCH framework, Li (2007) points out the relative isolation of Chinese stock markets from world markets in 2000–5. A large cross-country study by Koźluk (2008), which will be further discussed below in relation to Russian stock markets, concludes that Chinese stock markets are "almost completely separated from global affairs", but "strongly inter-related" themselves. More recently, Chow *et al*. (2011) find evidence of rising integration of the Chinese and world stock markets in 1992–2010, measured in terms of co-movements of Shanghai and New York Stock exchange prices. Rizavi *et al*. (2011) also report beta- and sigma-convergence of stock market returns between the Shanghai stock exchange and nine Asian markets with respect to a global benchmark (proxied by the Merrill Lynch Major 11 International Index) over the period 1999–2009.

Sectoral analysis: The sectoral analysis of Chinese stock markets is much less elaborated in comparison with analysis of national stock exchange indices. To our knowledge, the study of Demirer and Lien (2005) is the only one that examines firm-level returns across 18 sectors. The authors employ a Granger-causality test and correlation analysis to detect stock market correlations during the periods of rising and declining returns in 1999–2002. When a majority of investors were buying stocks, the correlation was markedly higher compared to the case of selling stocks.

Application to Russia

Evidence on integration of Russian stock markets with other countries' stock markets is mixed. Studies of Russian stock markets can be broken into three groups:

1. Russian stock markets extensively interconnected with global (particularly European) stock markets,
2. Russian stock markets are isolated, and
3. There are one-way spillovers from or into Russian stock markets.

Koźluk (2008) provides one of the rare studies that includes the stock markets of both Russia and China as part of a much broader analysis (135 indices for 75 countries in total from the early 1990s to 2007). The results of the approximate factor model (which allows the identification of global versus regional factors) show that while Russian stock markets behave like a 'typical' emerging market, i.e. characterised by rising integration with world markets, China's A-share and B-share markets move largely independently from global markets. Employing a VAR-GARCH-type model, Caporale and Spagnolo (2011) identify stock market volatility spillovers running in one direction from Russia to three Central and Eastern European countries in 1996–2008.

Using correlation and cointegration analysis, Verchenko (2000), in contrast, finds no interconnection between stock market returns in Russia and nine neighbouring transition economies from 1997 to 2000. Similarly, employing VAR and cointegration methods, Tirkkonen (2008) argues that Russian stock markets over the period 2003 to 2007 are relatively isolated from global markets such as the US, China, Japan, UK, Germany, as well as nearby Poland and the Czech Republic.

One-way stock market spillovers, from Russia to the Central and Eastern European countries in 1995–8, are found by Jochum *et al.* (1999) by means of variance decomposition. However, this result is obtained in relation to the effects of the Russian crisis of 1998, which is not surprising. Employing a rolling regression analysis, Anatolyev (2008) finds evidence for rising spillovers from the US stock markets in 1995–2004, and also from European stock markets when considering a larger set of countries (Anatolyev, 2005) to the Russian stock market, over the same time period. There is no robust indication for rising bilateral stock market integration, however, at either regional or sectoral levels.

3. Development of Chinese and Russian stock markets: stylised facts

National stock market indices

Table 1 provides information on the national stock market indices used in our study. Daily stock market indices for the period September 1995 to October 2010 were downloaded from Thomson Reuters and converted to weekly averages. The weekly indices were then expressed in USD equivalents to account for nominal exchange rate changes and rescaled using the first observation of 2007 as the 100 value. Figure 1 illustrates the resulting stock exchange indices for China and Russia compared with our three benchmark territories: the United States, the Euro Area, and Japan.

Table 1. National stock market indices (September 1995 to October 2010)

Code	Territory	Stock market price index	Thomson Reuters code
CH	China	SHANGHAI SE A SHARE	CHSASHR
EA	Euro Area	DJ EURO STOXX $	DJEURS$
JAP	Japan	NIKKEI 225 STOCK AVERAGE	JAPDOWA
RU	Russia	RUSSIA RTS INDEX	RSRTSIN
US	USA	S&P 500 COMPOSITE	S&PCOMP

Source: Thomson Reuters.

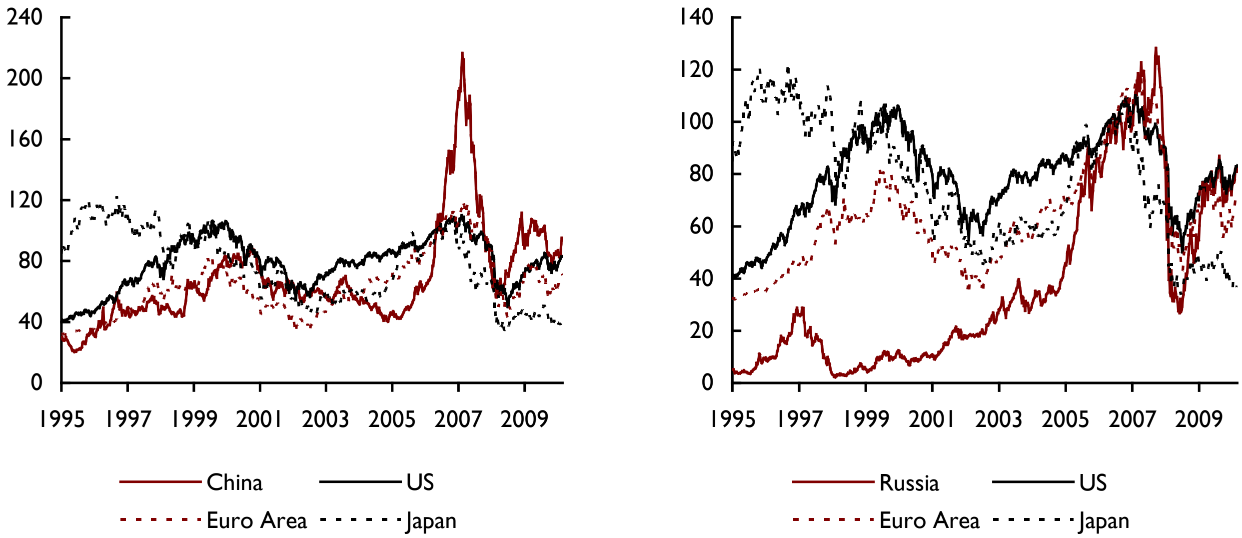
Figure 1(a) shows that the Chinese stock exchange index grows ahead of the Asian crisis of 1997, revives in 1999–2001, and then enjoys robust growth in 2006–7. A massive drop takes place between September 2007 and November 2008, with gradual recovery thereafter. The Russian stock exchange index in figure 1(b) rises until 1997. Growth returns after the Russian crisis of 1998 and continues until the global crisis in 2008. After a sharp drop in 2008, growth resumes in 2009. A comparison of national stock market indices amongst the five territories under review highlights the role of the recent crisis, which clearly affected all stock markets. However, the magnitude of impact and the timing differ from country to country. The Chinese stock market shows particularly high growth prior to 2007, so its plunge is proportional. The Russian stock market index is the last to fall after the arrival of the global crisis.

A complementary indicator that characterises the importance of stock markets to the economy is stock market capitalisation. Figure 2 shows that the highest market capitalisations (as a percentage of GDP) are observed for the United States, Japan and the Euro Area.[3] Since 2004–5, the market capitalisation for both China and Russia has increased sharply. By the end of 2008, the levels of market capitalisation were to the US level (and exceeding the Euro Area and Japanese benchmarks).

Other characteristics of stock markets studied here are summarised in figures A1–A3 in the Appendix (total number of listed domestic companies, total value of traded stocks as a percentage of GDP, and turnover ratio of stocks traded in per cent). These indicators cover the period 1996–2009 at yearly frequency. One can see that the capital market in China plays a greater role in comparison with Russia, as demonstrated by

Figure 1. National stock market indices (September 1995 to October 2010, weekly)

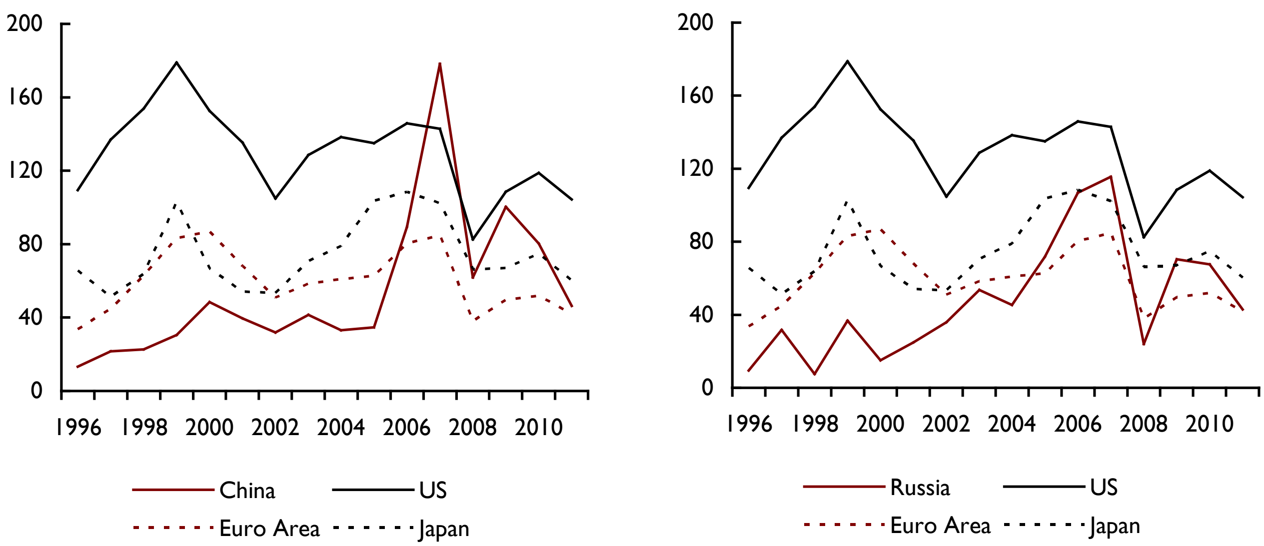
(a) China with benchmark territories (b) Russia with benchmark territories



Source: Thomson Reuters.
Note: The stock market indices are first expressed in USD equivalents to account for nominal exchange rate changes, then rescaled with the first observation of 2007 as the 100 value.

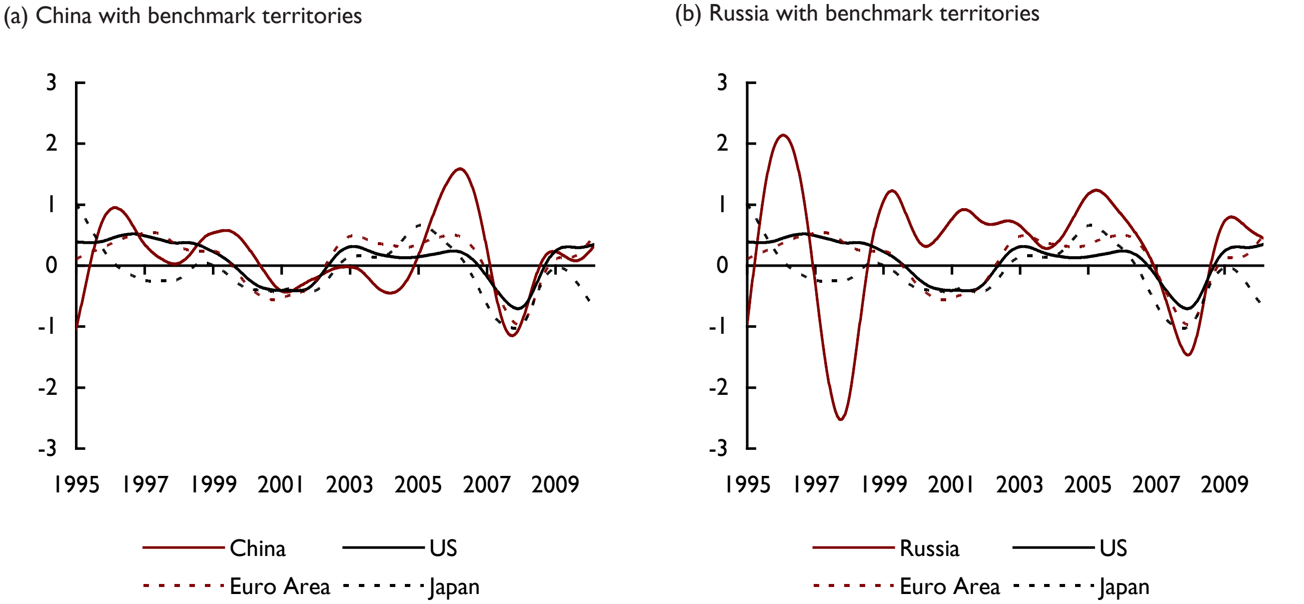
Figure 2. Stock market capitalisation (as a percentage of GDP, 1996–2011)

(a) China with benchmark territories (b) Russia with benchmark territories



Source: The World Bank.

Figure 3. National stock market returns (September 1995 to October 2010, weekly)



Source: Authors' calculation based on Thomson Reuters data.
Note: Trend values obtained by means of the H-P filter with the smoothing parameter λ=270400. The H-P filter is used only for charts and not in the subsequent calculation of sigma convergence.

each of the three indicators shown in figures A1–A3. Not only are the corresponding numbers of listed domestic companies, total value of stock traded and the turnover ratio significantly higher in China compared with Russia, the dynamics of these indicators is richer in China as well. This reflects the fact that China has recently become the second-largest economy in terms of GDP, surpassing Japan. Nevertheless, the number of listed domestic companies in China is still lower as compared to the United States, the Euro Area and Japan (figure A1), while in terms of the total value of stock traded and the turnover ratio China surpassed the Euro Area and Japan by the end of the sample period (figures A2 and A3).

Figure 3 shows the trends in the returns of the national stock market indices. Returns Y_t are calculated as weekly growth rates of stock market indices according to the expression: $Y_t=100^*[\ln SE_t-\ln SE_{t-1}]$, where SE_t denotes the stock exchange index at time t, taken in USD equivalent to account for nominal exchange rate changes.[4] For graphical illustration, trend values are obtained by means of the Hodrick-Prescott filter with the smoothing parameter λ = 270 400, which corresponds to the weekly data. While original stock market indices are found to be integrated of order one, the returns of these indices appear to be stationary according to standard unit root tests (ADF and PP) and non-stationarity test (KPSS).

Figure 3 reveals that the global financial crisis of 2008 resulted in a somewhat lower drop in Russian stock market returns than in the Russian 1998 financial crisis. In contrast, the recent global crisis has had much stronger effects for China and other monitored territories than the earlier turbulent episodes during the examined period, including the 1997 Asian crisis. This will be formally tested in our analysis. Moreover, the dynamics of returns (and indices) amongst the United States, Euro Area and Japan are more similar than with respect to either China or Russia, which implicitly gives an indication of higher stock market integration amongst our three benchmark territories.

Sectoral stock market indices

Table 2 describes data sources of the sectoral stock market indices used in our analysis. Multiple graphs showing the index trends relative to the US, Euro Area and Japan during 1995–2010 are presented in our discussion paper (Babecký *et al.*, 2012) for China and Russia. An immediate impression is the large variation

Table 2. Sectoral stock market indices (September 1995 to October 2010)

Sector Code	Sector	Thomson Reuters Code China	Euro Area	Japan	Russia	USA
AIR	Airlines	AIRLNCH*	AIRLNEM	AIRLNJP	AIRLNRS*	AIRLNUS
AUTO	Automobiles	AUTOSCA*	AUTOSEM	AUTOSJP	AUTOSRS*	AUTOSUS
BANK	Banks	BANKSCA	BANKSEM	BANKSJP	BANKSRS*	BANKSUS
BEV	Beverages	BEVESCH	BEVESEM	BEVESJP	BEVESRS*	BEVESUS
BREW	Brewers	BREWSCH	BREWSEM	BREWSJP	BREWSRS*	BREWSUS
CHEM	Chemicals	CHMCLCH	CHMCLEM	CHMCLJP	CHMCLRS*	CHMCLUS
ELEC	Electricity	ELECTCH	ELECTEM	ELECTJP	ELECTRS*	ELECTUS
FIN	Financials	FINANCH	FINANEM	FINANJP	FINANRS*	FINANUS
INDU	Industrials	INDUSCH	INDUSEM	INDUSJP	n.a.	INDUSUS
MIN	Mining	MNINGCH*	MNINGEM	MNINGJP	MNINGRS*	MNINGUS
OG	Oil & Gas	OILGSCH	OILGEM	OILGSJP	OILGSRS*	OILGSUS
PHAR	Pharmacy	PHRMCCA*	PHRMCEM	PHRMCJP	PHRMCRS*	PHRMCUS
RE	Real Estate	RLESTCH	RLESTEM	RLESTJP	n.a.	RLESTUS
SOFT	Software	SOFTWCA*	SOFTWEM	SFTCSJP	n.a.	SOFTWUS
TELE	Telecom	TELCMCA	TELCMEM	TELCMJP	TELCMRS*	TELCMUS
UTIL	Utilities	UTILSCH	UTILSEM	UTILSJP	UTILSRS*	UTILSUS

Source: Thomson Reuters (all sectors except pharmacy in China) and Bloomberg LP (pharmacy, China).
Note: The acronyms stand for the Thomson Reuters codes of the series (Bloomberg LP code for the pharmacy sector in the case of China). * Periods shortened due to data unavailability.

of indices across sectors, even if the 2008 crisis impacts all sectoral stock market indices without exception. In several sectors, the stock market indices fully recover by the end of 2010, reaching or even exceeding their pre-crisis levels. These include Beverages, Brewers, Pharmacy and Software for China, and Banks, Mining, Pharmacy and Telecom for Russia.

The development of sectoral returns for both the Chinese stock market and the Russian stock market against our benchmark territories is illustrated in full in Babecký *et al*. (2012). Similar to the dynamics of national returns, sectoral stock market returns are stationary in levels in the unit root tests (ADF, PP) and the stationarity test (KPSS). Several notable features are in evidence: (1) an opposite cyclical behaviour of Chinese and Russian stock market returns in some periods and sectors (e.g. Airlines, Automobile and Brewers) compared to the sectoral returns of the three benchmark territories; (2) a lower alignment of some sectors, not only between Chinese and Russian markets, but also among sectors of the Euro Area, US and Japanese stock markets (e.g. Real estate and Mining); and (3) a clear impact of past crises (the 1997 Asian crisis, the 1998 Russian crisis, and the global financial crisis of 2008/9) and bubbles (the 2000 dot-com bubble and the run-up to the 2008/9 crisis) on sectoral returns.

4. Approaches to measuring stock market integration

As outlined in Section 2, there are a number of alternative ways to operationalise the price-based concept of stock market integration. Cointegration analysis, vector autoregression (VAR), conditional correlations (GARCH-type framework), beta and sigma convergence are some of the most common approaches. Each of these methods is best suited to answer particular aspects of stock market integration given the data available. For example, cointegration analysis serves to determine whether there is a stable long-term relationship between stock prices or returns. Due to structural breaks or distinct differences between the markets analysed, such a long-term relationship might not always exist. The short-run dynamics can then be analysed using VAR models. These models are also well suited to test for the direction of causality (in the Granger sense) amongst fluctuations in stock market indices. However, the underlying assumption of linearity limits the applicability of VAR and cointegration techniques. General autoregressive conditional heteroscedastic (GARCH) models explicitly take account of non-linearity in stock market volatility. However, as there are many forms of non-linearity, which are also specific to the particular stock market data used, finding an optimal GARCH specification is not a trivial task.

Beta- and sigma-convergence measures of stock markets returns abstract from the direction of causality and allow the assessment of an overall degree of stock market integration in a relatively heterogeneous sample, as is the case in our study.[5] In particular, we face several types of heterogeneity, namely at the country level, at the sectoral level, and across time (since our sample contains several crisis episodes including the 2008/9 global financial turmoil). Thus, we explore a price-based approach to measuring financial integration that involves estimating beta- and sigma-convergence.

As discussed in Adam *et al.* (2002), any proper measure of financial integration of stock markets should account for asset pricing, which is empirically difficult to operationalise. We follow a common practice (Ayuso and Blanco, 2000; Hartmann *et al.*, 2003) of examining links between stock market returns that leave asset pricing aside. Strictly speaking, our results for the stock market should be interpreted as evidence of beta- and sigma-convergence of returns rather than integration, as we are unable to distinguish whether there is an underlying process of financial integration, whether financial shocks become stronger, or whether risk premia change. Even with this caveat, assessment of stock market convergence in returns (synchronisation) provides valuable new evidence on the interdependencies amongst the economies discussed. We explore a price-based approach to measuring financial integration that involves estimating beta- and sigma-convergence as advocated by Adam *et al.* (2002) and elaborated in Babecký *et al.* (2010).

The concept of beta-convergence

Beta-convergence enables identification of the speed at which differences in returns are eliminated on individual stock markets (selected against a benchmark). A negative beta coefficient indicates the existence of convergence. The closer the value of the beta coefficient is to –1, the higher the speed of convergence. To quantify beta-convergence, the following regression is estimated:

$$\Delta R_t = \alpha + \beta_t R_{t-1} + \sum_{l=1}^{L} \gamma_l \Delta R_{t-1} + \varepsilon_t \qquad (1)$$

where $R_t = Y_t - Y_t^B$ represents the difference between the stock market return of country (or sector) i and the selected reference territory (a benchmark, B) at time t, Δ is the difference operator, α is the constant term, l is the lag length and ε_t is the white-noise disturbance. The stock market return Y_t is calculated as the period-to-period growth rate of the underlying stock market index: Y_t=100*[ln(SE_t)–ln(SE_{t-1})] , where SE_t denotes the stock exchange index at week t taken in USD equivalent to account for nominal exchange rate changes. The lag length l is based upon the Schwarz information criterion; the maximum lag length L is taken as four, as we are using weekly data and the memory of stock markets is short.

The size of coefficient β is a direct measure of the speed of convergence. A negative beta coefficient indicates the occurrence of convergence. The β coefficient can take values ranging from –2 to 0. The closer the β coefficient to –1, the faster the rate of convergence. If β = 0 or β = –2, no convergence is observed. β values from –1 to 0 indicate monotonous convergence, while oscillating convergence occurs for β values from –2 to –1.

The concept of sigma-convergence

Sigma-convergence focuses on the cross-sectional dispersion of returns on individual stock markets at a given moment of time. It thus identifies the degree of integration vis-à-vis the benchmark country achieved at that moment amongst the selected national (or sectoral) markets. Sigma-convergence increases as the sigma parameter falls to zero. If the cross-sectional dispersion converges to zero, full integration is achieved. To quantify sigma-convergence, a calculation is used of the (cross-section) standard deviation (σ), according to the formula:

$$\sigma_t = \sqrt{\left(\tfrac{1}{N}\right) \sum_{i=1}^{N} [\log(Y_{it}) - \log(\bar{Y}_t)]^2} \qquad (2)$$

where Y_{it} is the stock market return i at time t, and $\overline{Y}_t$ is the cross-section mean value of the return at time t, and i stands for the individual countries or sectors (i = 1, 2, …, N). For the purposes of this analysis, we use N = 2; i.e. we examine, at the national level or by sector, the evolution of sigma-convergence over time between our benchmark territories (the US, Euro Area, and Japan) and China or Russia.[6] By definition, σ takes only positive values. The lower the σ value, the higher the level of convergence. In theory, full integration is achieved when the standard deviation falls to zero, while high (several digit) σ values reflect very low degrees of integration. For graphical illustration, the results are normalised over the full time period and filtered using a Hodrick-Prescott (H-P) filter with the recommended weekly time series coefficient λ = 270 400.

Note that the two convergence indicators contain different information: beta-convergence does not imply sigma-convergence. There *could* be cases of beta-convergence along with sigma-divergence, of course.[7] However, the essential idea here is that both aspects of convergence need to be assessed to make an inference about stock market integration. Beta- and sigma-convergence are estimated for China and Russia at the national and sectoral level, in comparison with the three benchmark territories.

5. Empirical results

In this section, we examine whether, and how quickly, the national (and sectoral) stock markets of China and Russia are integrated with each other and with our three global benchmarks (the US, Euro Area, and Japan). To analyse stock market integration over time, our estimation period is divided into three sub-periods for beta-convergence, while in the case of sigma-convergence the estimations are by definition available at each moment of time. For beta-convergence, the sub-periods are September 1995 to December 1998, January 1999 to December 2008, and January 2007 to October 2010. The first sub-period includes the 1997 Asian crisis and the 1998 Russian crisis. The second sub-period could be described as a relatively tranquil episode. The last sub-period includes the 2008/9 global financial crisis.

Beta-convergence

Table 3 shows the beta-convergence analysis results for the national stock markets. Equation (1) was estimated by OLS with robust standard errors. All beta-coefficients are negative and significant; hence there is convergence of stock market returns between China, Russia and the corresponding benchmarks. The values of the β coefficient are close to minus one, which means that the levelling of newly arising differences in stock market returns between the relevant national economy and the reference country can be labelled as fast. Indeed, the shock half-life, defined as the period during which the magnitude of a shock to the return differential between two countries becomes half of the initial shock, is between about one to two days, as indicated in the shaded areas in table 3.[8] Notice, however, that the use of weekly data for calculation of beta-convergence gives us the advantage of minimising noise (holiday effects and time zone differences playing a greater role on daily frequency) and at the same time we can still discriminate between countries; in other words the beta coefficients do not equal unity in all cases. Should such an outcome occur, the use of higher frequency data (e.g. daily indices) would be more appropriate. A comparison of the sub-periods 1995–8, 1999–2006 and 2007–10 suggests no clear systematic pattern in the rate at which shocks to return differentials dissipate.

Similarly, at the sectoral level (table A1 in the Appendix), the beta coefficients are close to minus one for most sectors; the corresponding shock half-lives vary between one and three days, and there are cases of both rising and declining half-lives over time that lack any clear systematic pattern. However, the sectoral dimension brings more variety into the results. In the case of China, the slowest speed of convergence in the return differential is observed for the sectors Electricity and Utilities (both with respect to the US) during the 2007–10 period. The corresponding half-life of shocks is six days. For Russia, there are two sectors characterised by the slowest convergence (both in the 1995–8 period): Automobiles (15.9 days, vis-à-vis Japan) and Telecom (15.4 days vis-à-vis the United States and 11.6 days vis-à-vis the Euro Area).

A finding of beta-convergence at national and sectoral levels suggests that Chinese and Russian stock markets

Table 3. Beta-convergence of national returns: coefficients and half-lives of shocks

Territory i	China vis-à-vis territory i						Russia vis-à-vis territory i					
	1995–1998		1999–2006		2007–2010		1995–1998		1999–2006		2007–2010	
China	–		–		–		–0.90	2.1	–1.06	1.7	–1.11	2.2
Euro Area	–0.99	1.0	–1.10	2.1	–1.01	1.1	–0.87	2.4	–0.93	1.8	–0.98	1.3
Japan	–1.00	0.6	–1.00	0.9	–0.98	1.3	–0.88	2.2	–1.10	2.1	–1.07	1.8
Russia	–0.90	2.1	–1.06	1.7	–1.11	2.2	–	–	–	–	–	–
United States	–1.01	1.1	–1.02	1.3	–0.98	1.2	–0.90	2.1	–1.09	2.0	–0.95	1.7
Mean	–0.98	1.2	–1.05	1.5	–1.02	1.5	–0.89	2.2	–1.05	1.9	–1.03	1.8

Source: Authors' calculations based on Thomson Reuters data.

Note: Estimations of equation (1) on weekly data. Half-lives of shocks (number of days) in shaded areas. All beta coefficients are statistically significant at the 5% level. Beta coefficient equalling –1 corresponds to full convergence. The half-life (H-L) of a shock to the return differential between two territories is a period during which the shock declines to one half of its initial value. Lower H-L values correspond to faster beta-convergence.

can hardly be labelled as ‘isolated’. Indeed, the shock half-life, typically much less than a week, means that there could not be persistent differences in returns amongst the stock markets of these two countries or with respect to the three global benchmarks. This finding is broadly in line with evidence on beta-convergence of stock markets at the national level for China and other Asian economies (Rizavi *et al.*, 2011) and amongst European countries (Babecký *et al.*, 2010, 2011). Studies of beta-convergence on the sectoral level also find higher heterogeneity of outcomes, amongst e.g. West European countries (Erdogan, 2009) and New EU Member States (Babetskii *et al.*, 2007). Notice that a finding of beta-convergence is generally not granted for any type of financial markets. For example, regarding real estate markets, Srivatsa and Lee (2010) report cases of beta-divergence in rents and yields amongst the office markets in seven European capitals during 1982–2009.

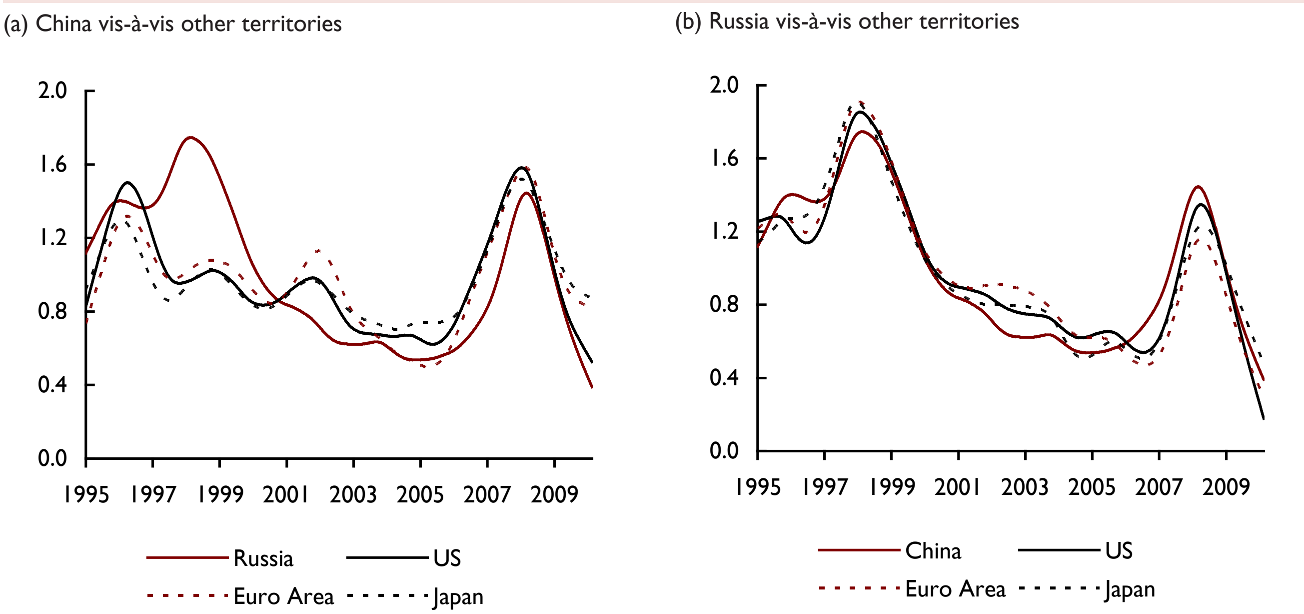
Sigma-convergence

For each period of the sample, cross-section standard deviation (σ) was calculated according to formula (2) Sigma-convergence occurs if the cross-section deviation declines over time. We make four observations about figure 4, which presents the sigma-convergence analysis for the Chinese and Russian national stock markets.

First, the Chinese and Russian stock markets share common dynamics; there is an increase in return dispersion ahead of the 1997 Asian crisis and the 1998 Russian crisis, followed by a trend convergence that lasts through the mid-2000s. We then see a sharp increase in dispersion after 2006/7 that corrects back toward convergence in 2009.

Second, the Chinese stock market had much lower dispersion with respect to the stock markets of the US, Euro Area, and Japan prior to 2001 than Russia (see figure 4a). This situation reverses around 2002. For most of 2002–10, the dispersion of Chinese-Russian stock market returns is lower than in benchmark territories. The development of stock market indices and returns displayed in figures 1 and 3 helps to interpret this result. In the early sample years, the 1997 Asian crisis and the 1998 Russian crisis were the main reasons for an increase in dispersion between the Chinese and Russian stock market returns. After 2002, the dynamics of Chinese and Russian stock market

Figure 4. Sigma-convergence at the national level (September 1995 to October 2010)



Source: Authors’ calculation based on Thomson Reuters data.
Note: Trend values obtained by means of the H-P filter with the smoothing parameter λ=270400. The H-P filter is used only for charts and not in the calculation of cross-section standard deviation.

indices are characterised by substantial co-movement. We see a common rise in indices through 2003, moderation (and decline) in 2004, robust growth in 2006–7, and a massive fall during the global crisis.

Third, a comparison of the left and right charts in figure 4 shows the relative importance of the global crisis of 2008/9 against the earlier Asian and Russian crises of 1997–98. For China vis-à-vis the US, Euro Area, and Japan (figure 4a), the dispersion of returns was somewhat higher in 2008 (1.50–1.60) compared to the 1997 Asian crisis (1.30–1.50). For Russia (figure 4b), the 2008 global crisis is accompanied by much lower dispersion (1.15–1.33) than during the 1998 Russian crisis (1.85–1.90).

Fourth, the Chinese stock market is characterised at the end of our sample (October 2010) by the lowest dispersion with respect to the stock markets of Russia (0.39) and the US (0.53), followed by the Euro Area (0.82) and Japan (0.88). The Russian stock market has an overall lower dispersion (i.e. higher sigma-convergence) with all reference territories, in particular the US (0.18) and Euro Area (0.30), followed by China (0.39) and Japan (0.48).

Babecký *et al.* (2012, figures 9 and 10) show the sigma-convergence analysis of Chinese and Russian stock markets respectively at the sectoral level, in 1995–2010. The results are illustrated for sixteen sectors in the case of China and the three reference territories (the United States, Euro Area and Japan), while thirteen sectors are available for the Russian stock market (the data are unavailable for Industrials, Real Estate and Software), and the periods for which Russian sectoral data are available are shorter. We offer four observations on the development of sectoral σ.

First, all sectors have been affected by the financial crisis of 2008/9. There is also clear evidence of substantial impacts of the previous (Asian and Russian) crises and the burst of bubbles (for example, the dot-com bubble) preceding the unfolding of crisis events in 2008. However, the relative importance of the previous and recent crisis differs across sectors. At the national level, the Russian stock market experienced higher dispersion in 1998 compared to 2008. At the sectoral level, however, one can identify industries that were affected to a comparable degree by both crises (e.g. Airlines and Automobiles). The impact of the 2008 crisis on dispersion was also much milder compared to the 1998 crisis for several sectors in Russia (e.g. Banks, Financials, and Telecom).

Second, the magnitude of the dispersion varies substantially across sectors. Overall, the most integrated sectors (i.e. lowest dispersion) appear to be Software for China, and Oil & Gas and Telecom for both China and Russia). An interesting sector-specific example is for Automobiles in the case of Russia. During the 2008 crisis, the lowest dispersion of sectoral returns was observed between Russian and Chinese markets (1.15), followed by the pairs Russia-US (1.29), Russia-Euro Area (1.37) and Russia-Japan (1.54). Arguably a strong decline in stock markets indices in the automobile industry in both China and Russia contributed to the observed synchronicity in stock market returns between these two countries.

Babecký *et al.* (2012, figures 9 and 10) present evidence of sigma convergence at the sectoral level; cross-sectional dispersions of returns exhibit a downward-sloped trend over time; the effects of the 2008/9 crisis fade out by the end of 2010. Heterogeneity of the results at the sectoral level indicates potential for diversification of risk.

Our finding of sigma-convergence between Russian and Chinese stock markets, as well as with respect to the stock markets of the US, Euro Area, and Japan in 1995–2010, corroborates the similar conclusion of sigma-convergence amongst the stock markets of selected EU member states with respect to the US and Euro Area over the comparable period (Babecký *et al.*, 2010, 2011). There is recent evidence for China of sigma-convergence between China and other Asian stock markets in 1999–2009 (Rizavi *et al.*, 2011). This result, however, is sensitive to sample length. In fact, the Asian stock markets are characterised by sigma-divergence during 2004–9. The assessment of sigma-convergence thus substantially depends on the time horizon considered. The results of our study illustrate that the sub-sample of 2004–9 is characterised by sigma-divergence amongst China, Russia, and the three global benchmarks. This was a period of rising dispersion of returns amongst the analysed territories; rising asset prices initially drive dispersion, then a fall in stock market indices during the global crisis. However, extending the sample to 1995–2010 leads to an overall finding of sigma-convergence as the effects of the 2008/9 crisis fade and the downward-sloped trend in return dispersion re-emerges. A declining trend in return dispersion (i.e. sigma-convergence) is particularly clearcut when considering an even longer period, such as the 1973–2008 observation period, at both national and industry levels for the stock markets of seven Western European countries reported in Erdogan (2009).

Why do we observe sigma-convergence in stock market returns worldwide? Apparently globalisation (and related deepening of economic and financial links) is a key factor for sigma-convergence of such distinct stock markets as those of China, Russia, the Euro Area, EU countries outside the Euro Area, the US, and Japan. Quantification of the determinants of global convergence of stock market returns could be a prospective avenue for future research.

The evidence of sigma-convergence, on the one hand, means decreasing opportunities for risk diversification. On the other hand, as our results suggest, there is still room for risk sharing over the short- to medium-term horizon, when sigma-divergence could happen. This was evident in particular in the period from 2004 to 2009, characterised by substantial sigma-divergence. A non-negligible potential for risk-sharing also exists at the level of industries as sectoral stock markets do not necessarily follow the dynamics of national indices.

6. Conclusions

In this paper, we have investigated the convergence of returns on Chinese and Russian stock markets in comparison with the United States, the Euro Area, and Japan at both national and sectoral levels from September 1995 to October 2010 using weekly averages of daily indices. We tested for its existence and analysed the dynamics of stock market integration based on a price-based approach. Our measures of stock market integration were built upon the two complementary concepts: beta-convergence (measuring the rate at which differences in returns are eliminated between the selected stock markets) and sigma-convergence (measuring cross-sectional dispersion of return differentials at a given moment).

We find evidence of beta-convergence of stock market return differentials between China and Russia, as well as with respect to the US, Euro Area, and Japan. Convergence is observed at both national and sectoral levels. Beta-convergence means that return differentials are not persistent; that is, stock market returns in China or Russia cannot permanently deviate from the returns in other analysed territories. The results of beta-convergence could be alternatively formulated in more intuitive terms of shock half-lives. Our results imply that stock market shocks, which are represented by deviations of returns vis-à-vis benchmark territories, dissipate with a half-life of about one to three days.

We do not find a systematic effect of the 2008/9 crisis on beta-convergence nor clear sectoral patterns. The rate at which shocks dissipate can be labelled as fast, both between China and Russia and with respect to our global benchmarks. This suggests that stock markets offer limited arbitrage possibilities, contrary to, for example, real estate markets where beta-divergence of rents and yields is not uncommon (Srivatsa and Lee, 2010).

Contrary to beta-convergence, sigma-convergence clearly changes over time and the effects of the recent (and past) financial crises are well tracked. We find overall evidence of sigma-convergence in 1995–2010 at both national and sectoral levels. However, the assessment of sigma-convergence critically depends on the period analysed. For example, our results indicate sigma-convergence of the Chinese and Russian stock markets with respect to the world markets after the 1997 Asian crisis and the 1998 Russian crisis until about 2005/6, when we see sharp sigma-divergence and a return to convergence after the 2008/9 crisis.

Sigma-convergence exhibits strong sector-specific patterns. At the sectoral level in particular, the difference in sigma-convergence becomes pronounced during crisis episodes, suggesting the potential for diversification of risk across sectors.

The answer to the question of whether Chinese and Russian stock markets become more interrelated amongst themselves or with respect to the global benchmarks ultimately depends on the assessment of sigma-convergence and, thus, the period considered. This is because, in terms of beta-convergence, we do not find any systematic differences over the time period analysed. Shocks to return differentials dissipate rapidly, with half-lives less than a week. A high degree of beta-convergence has already been achieved during the 1990s. The assessment of overall convergence of stock market returns is therefore driven by the sigma-convergence results.

In terms of sigma-convergence, we find that the Chinese stock market is more interrelated with the US, Euro Area, and Japanese stock markets than with the Russian stock market during 1998–2000. The situation reverses from the second half of 2001 until the end of our sample in October 2010. During that period, return dispersion between the Chinese and Russian stock markets was lower than between the Chinese-US, Chinese-Euro Area, and Chinese-Japanese stock markets. The reasons for this finding require examination of stock market indices and their returns. In 1998–2000, when Russia was largely affected by the 1998 crisis, its stock markets experienced substantially different dynamics compared to stock markets in China and the three benchmarks. On the other hand, China's entry into the WTO in December 2001 enhanced similarity in stock market dynamics between China and Russia (that is lower return dispersion) than with respect to the US, Euro Area, and Japan. In the aftermath of the 2008/9 crisis, there is also an indication of rising sigma-convergence between the Chinese and US stock market returns, although these are only just marginally lower than for the Chinese-Russian duo.

From the viewpoint of Russia, its stock market interrelation was higher with the US, Western Europe and Japan during 1996–7 than with China, as Chinese stock markets were affected by the Asian crisis. Since about 1998 to 2006 the Russian-Chinese stock market return dispersion was somewhat lower compared to the cases of Russia versus the three global benchmarks. Starting from the second half of 2006 and to mid-2010, the lowest dispersion emerged between the Russian and Euro Area stock markets, reflecting strong bilateral exchanges. Sectoral patterns of sigma-convergence of returns bring more diversity. For some sectors, (e.g. Automobiles after 2008), the highest degree of sigma-convergence is observed between the Russian and Chinese stock markets, followed by such pairs as Russia-Japan, Russia-Euro Area and Russia-US, which stresses the role of sector-specific factors. It can also be the case that in Russia trading in most sectors is very thin, with low volumes and a large share of the free float in the hands of foreign investors. This may result in spurious correlations for some sectors.[9]

Returning to the comparison of our results with findings from the literature discussed at the end of the previous section, one salient fact emerges: a *global* convergence in stock market returns over the past decades measured in terms of beta- and sigma-convergence. A finding of convergence of returns amongst stock markets of the Asian economies, EU countries, the US, China and Russia suggests the presence of common global factors. International trade and cross-border portfolio investment could be examples of such factors (Lee *et al*., 2012). In addition, there are also complex nonlinearities involved in international stock market spillovers (Amira *et al*., 2011). Identifying the determinants of international stock market return convergence would be a fruitful direction for future research.

One should also keep in mind the limitations of the considered price-based measures of stock market interlinkages. Such price-based measures present the results in terms of stock market return convergence (or synchronicity) which only characterise an upper bound of the underlying stock market integration. It remains a challenge for future research to understand whether the finding of stock market return convergence is driven by (1) effects of global shocks (whose incidence for the national economies becomes stronger in the globalised world), (2) changes in asset pricing (which is empirically difficult to operationalise), or (3) changes in country (sector) risk premia.

NOTES

1 The most frequently mentioned benefits of financial market integration include: (i) consumption smoothing due to international diversification of risks (reduction of the large country-specific shocks), (ii) the positive effect of capital flows on domestic investment and economic growth, (iii) improving efficiency of the financial system, and (iv) increasing prudence of financial market agents and the attainment of a high level of financial stability. The major costs include: (i) insufficient access to funding at times of financial instability, including capital concentration and procyclicality, (ii) inappropriate allocation of capital flows, (iii) loss of macroeconomic stability, and (iv) herd behaviour amongst investors, financial contagion and high volatility of cross-border capital flows.

2 Some examples of growing cooperation between Russia and China are: (i) establishing a joint private-equity fund in June 2012; (ii) setting a goal in 2012 of more than doubling bilateral trade between both countries (from $83.5bn in 2011 to $200bn in 2020), (iii) cooperating in the transfer of raw materials (the first pipeline from Russia to China was finished in 2011).

3 Historically, the financial structure in the USA is more capital market-oriented and less bank-oriented than that of the Euro Area and Japan, where banks play the dominant role in financial intermediation.

4 Notice that payments of dividends have an influence on the price of individual shares and the returns are not fully measured when dividend yields are excluded, although the omission of dividend yields is typical of literature in general. Bekaert and Harvey (1995) argue that a decreasing trend in dividend yields could be one of the manifestations of capital market integration. Nevertheless the importance of dividends is arguably higher in the advanced country markets than Russia or China, where a larger proportion of firms are in 'growth mode'.

5 The terms beta-convergence and sigma-convergence originate from the literature on dynamics of economic growth (e.g. Barro and Sala-i-Martin, 1992, 1995).

6 For country pairs, the calculated sigma values in each period are essentially equal to half the square of the return differential.

7 See Quah (1993) for details.

8 The half-life is calculated as $H\text{-}L = \ln(0.5)/\ln(|\beta + 1|)$ and expressed in number of days.

9 Low liquidity in some sectoral stock markets represents another caveat. Accounting for the size of sectoral stock markets and their liquidity represents one possible extension for future research.

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Appendix A

Table A1. Beta-convergence of sectoral returns: coefficients and half-lives of shocks

Sector	Territory i	China vis-à-vis territory i						Russia vis-à-vis territory i					
		1995–1998		1999–2006		2007–2010		1995–1998		1999–2006		2007–2010	
Airlines	US	–1.12	2.3	–1.12	2.3	–1.04	1.5	n.a.	n.a.	–1.03	1.4	–1.08	1.9
	EA	–1.09	2.0	–1.15	2.6	–1.14	2.5	n.a.	n.a.	–1.04	1.4	–1.01	0.9
	Japan	–1.15	2.5	–1.13	2.3	–0.96	1.6	n.a.	n.a.	–1.04	1.5	–1.07	1.9
Autos	US	–1.09	2.0	–1.00	0.9	–0.96	1.5	–1.50	7.0	–0.97	1.4	–1.00	0.7
	EA	–0.98	1.3	–1.03	1.4	–1.20	3.0	–1.52	7.5	–0.96	1.6	–1.22	3.2
	Japan	–1.05	1.6	–1.10	2.1	–1.02	1.2	–1.74	15.9	–0.99	1.0	–1.02	1.3
Bank	US	–0.81	2.9	–1.05	1.7	–1.10	2.1	–1.14	2.5	–0.88	2.3	–1.09	2.0
	EA	–0.82	2.9	–1.01	1.0	–1.08	1.9	–1.10	2.1	–0.85	2.6	–1.05	1.6
	Japan	–0.83	2.8	–0.98	1.3	–1.03	1.4	–1.11	2.2	–0.96	1.5	–1.11	2.2
Beverages	US	–1.14	2.5	–1.04	1.6	–1.02	1.2	n.a.	n.a.	–0.97	1.3	–0.97	1.4
	EA	–1.13	2.4	–1.00	0.8	–1.01	1.0	n.a.	n.a.	–0.89	2.2	–0.99	1.1
	Japan	–1.14	2.4	–0.99	1.1	–0.96	1.5	n.a.	n.a.	–0.93	1.8	–1.02	1.3
Brewers	US	–1.17	2.7	–1.04	1.5	–1.04	1.5	n.a.	n.a.	–0.95	1.6	–0.89	2.2
	EA	–1.14	2.4	–0.99	1.1	–0.97	1.3	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
	Japan	–1.13	2.4	–0.96	1.5	–0.97	1.4	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Chemicals	US	–1.09	2.0	–0.91	2.0	–1.07	1.8	n.a.	n.a.	n.a.	n.a.	–1.07	1.9
	EA	–1.06	1.8	–0.88	2.3	–1.10	2.1	n.a.	n.a.	n.a.	n.a.	–0.93	1.8
	Japan	–1.03	1.3	–0.92	1.9	–1.10	2.1	n.a.	n.a.	n.a.	n.a.	–1.09	2.0
Electricity	US	–1.22	3.2	–1.05	1.6	–1.44	6.0	–1.22	3.2	–1.10	2.1	–1.06	1.8
	EA	–1.25	3.5	–1.00	0.9	–1.11	2.2	–1.23	3.3	–1.08	1.9	–1.09	2.0
	Japan	–1.28	3.8	–0.99	0.9	–0.98	1.2	–1.19	2.9	–1.06	1.7	–1.00	0.9
Financials	US	–1.07	1.8	–1.08	2.0	–1.23	3.3	–1.13	2.4	–0.88	2.3	–1.14	2.5
	EA	–1.06	1.7	–1.07	1.9	–1.24	3.4	–1.11	2.2	–0.84	2.7	–1.06	1.7
	Japan	–1.02	1.3	–1.05	1.6	–1.11	2.2	–1.10	2.1	–0.98	1.2	–1.12	2.3
Industrials	US	–1.14	2.5	–0.92	1.9	–1.11	2.2	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
	EA	–1.17	2.7	–0.93	1.8	–1.16	2.7	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
	Japan	–1.13	2.3	–0.98	1.2	–0.92	1.9	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Mining	US	–1.13	2.3	–1.11	2.2	–1.13	2.3	n.a.	n.a.	–1.18	2.8	–1.21	3.1
	EA	–1.17	2.7	–1.08	2.0	–1.09	2.0	n.a.	n.a.	–0.85	2.5	–1.04	1.5
	Japan	n.a.	n.a.	–1.24	3.4	–0.90	2.1	n.a.	n.a.	–1.05	1.6	–1.02	1.3
Oil & Gas	US	–1.20	3.0	–1.18	2.9	–1.08	1.9	–1.40	5.3	–1.11	2.2	–1.22	3.2
	EA	–1.19	2.9	–1.18	2.8	–1.08	1.9	–1.37	4.9	–1.11	2.2	–1.12	2.3
	Japan	–0.76	3.4	–1.12	2.3	–1.00	0.9	–1.36	4.8	–1.00	0.8	–1.38	5.0
Pharmacy	US	n.a.	n.a.	–1.10	2.1	–1.03	1.4	n.a.	n.a.	n.a.	n.a.	–0.97	1.4
	EA	n.a.	n.a.	–1.16	2.6	–1.07	1.8	n.a.	n.a.	n.a.	n.a.	–1.05	1.6
	Japan	n.a.	n.a.	–1.06	1.7	–1.09	2.0	n.a.	n.a.	n.a.	n.a.	–1.19	2.9
Real Est.	US	–1.06	1.7	–1.01	1.0	–1.05	1.6	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
	EA	–1.08	1.9	–1.01	1.0	–1.03	1.4	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
	Japan	–0.99	1.1	–1.03	1.4	–0.92	1.9	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Software	US	–0.94	1.7	–1.11	2.2	–1.04	1.5	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
	EA	–1.08	2.0	–1.02	1.3	–1.10	2.1	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
	Japan	–0.93	1.8	–1.04	1.5	–1.10	2.1	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Telecom	US	–1.06	1.7	–0.96	1.5	–1.02	1.2	–1.73	15.4	–0.97	1.4	–0.91	2.0
	EA	–1.08	1.9	–1.00	0.5	–1.04	1.6	–1.66	11.6	–1.00	0.9	–0.91	2.1
	Japan	–1.04	1.5	–0.98	1.2	–0.92	1.9	–1.28	3.8	–1.04	1.5	–1.13	2.4
Utilities	US	–1.23	3.3	–1.04	1.5	–1.44	5.9	–1.22	3.2	–1.11	2.2	–1.06	1.7
	EA	–1.24	3.4	–1.00	0.7	–1.09	2.0	–1.23	3.3	–1.07	1.8	–1.08	1.9
	Japan	–1.27	3.7	–0.99	0.9	–0.98	1.2	–1.19	2.9	–1.05	1.7	–1.01	1.1

Source: Authors' calculations based on Thomson Reuters and Bloomberg LP data.
Note: Estimations of equation (1) on weekly data. Half-lives of shocks (number of days) in shaded areas. All beta coefficients are statistically significant at the 5 per cent level. A beta coefficient of –1 corresponds to full convergence. The half-life (H-L) of a shock to the returns differential between two territories is the period in which the shock declines to half its initial value. A lower H-L value means faster beta-convergence.

Table A2. Beta-convergence of sectoral returns: coefficients and half-lives of shocks – mean values across sectors

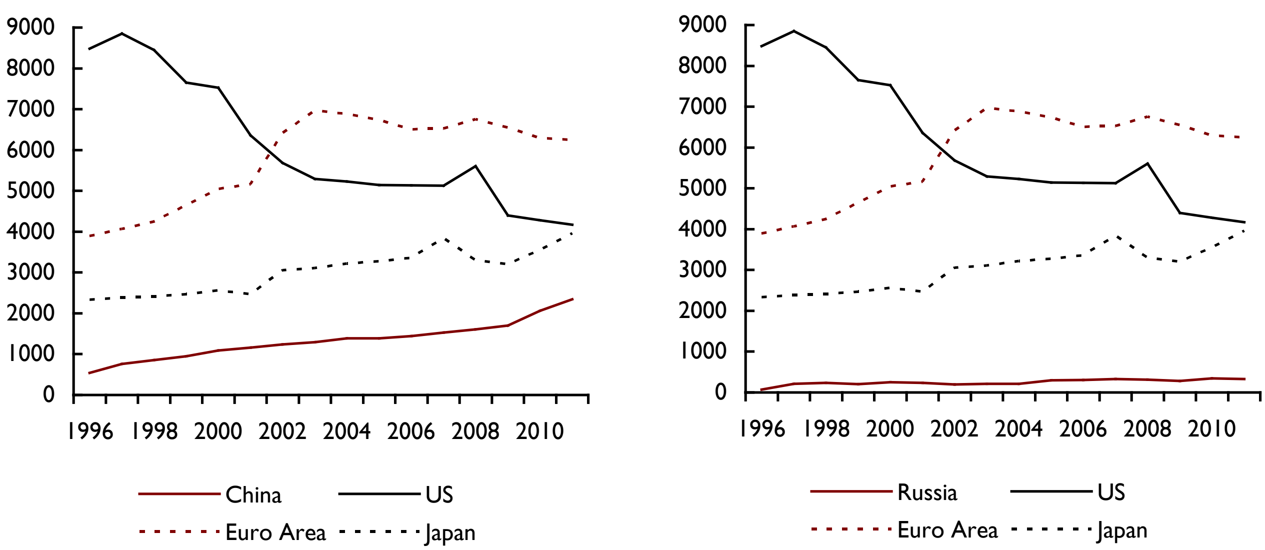
Sector	China vis-à-vis territory i						Russia vis-à-vis territory i					
	1995–1998		1999–2006		2007–2010		1995–1998		1999–2006		2007–2010	
Airlines	–1.12	2.3	–1.13	2.4	–1.05	1.9	n.a.	n.a.	–1.04	1.4	–1.05	1.6
Automobiles	–1.04	1.6	–1.04	1.5	–1.06	1.9	–1.59	10.1	–0.97	1.3	–1.08	1.7
Bank	–0.82	2.9	–1.01	1.3	–1.07	1.8	–1.12	2.3	–0.90	2.1	–1.08	1.9
Beverages	–1.14	2.4	–1.01	1.2	–1.00	1.2	n.a.	n.a.	–0.93	1.8	–0.99	1.3
Brewers	–1.15	2.5	–1.00	1.4	–0.99	1.4	n.a.	n.a.	–0.95	1.6	–0.89	2.2
Chemicals	–1.06	1.7	–0.90	2.1	–1.09	2.0	n.a.	n.a.	n.a.	n.a.	–1.03	1.9
Electricity	–1.25	3.5	–1.01	1.1	–1.18	3.1	–1.21	3.1	–1.08	1.9	–1.05	1.6
Financials	–1.05	1.6	–1.07	1.8	–1.19	3.0	–1.11	2.2	–0.90	2.1	–1.11	2.2
Industrials	–1.15	2.5	–0.94	1.6	–1.06	2.3	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Mining	–1.15	2.5	–1.14	2.5	–1.04	2.1	n.a.	n.a.	–1.03	2.3	–1.09	2.0
Oil & Gas	–1.05	3.1	–1.16	2.7	–1.05	1.6	–1.38	5.0	–1.07	1.7	–1.24	3.5
Pharmacy	n.a.	n.a.	–1.11	2.1	–1.06	1.7	n.a.	n.a.	n.a.	n.a.	–1.07	2.0
Real Estate	–1.04	1.6	–1.02	1.1	–1.00	1.6	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Software	–0.98	1.8	–1.06	1.7	–1.08	1.9	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Telecom	–1.06	1.7	–0.98	1.1	–0.99	1.6	–1.56	10.3	–1.00	1.3	–0.98	2.2
Utilities	–1.25	3.5	–1.01	1.0	–1.17	3.0	–1.21	3.1	–1.08	1.9	–1.05	1.6

Source: Authors' calculations based on Thomson Reuters and Bloomberg LP data.
Note: Estimations of equation (1) on weekly data. Half-lives of shocks (number of days) in shaded areas. All beta coefficients are statistically significant at the 5 per cent level. A beta coefficient of –1 corresponds to full convergence. The half-life (H-L) of a shock to the returns differential between two territories is the period in which the shock declines to half its initial value. A lower H-L value means faster beta-convergence.

Figure A1. Total number of listed domestic companies (1996–2011)

(a) China with benchmark territories

(b) Russia with benchmark territories

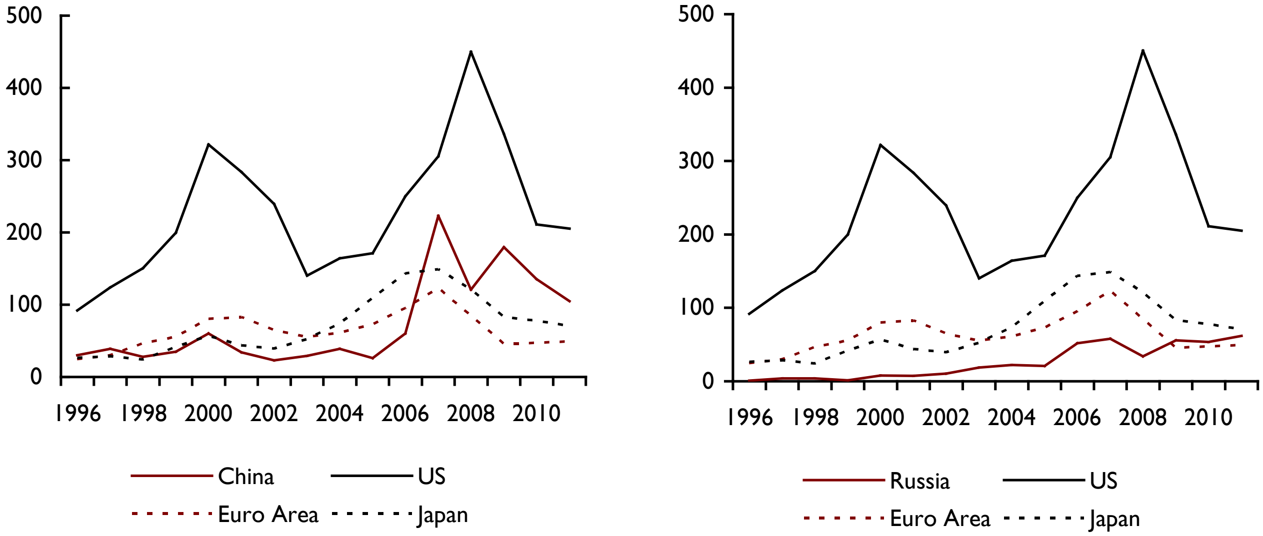


Source: The World Bank.

Figure A2. Stocks traded, total value (as a percentage of GDP, 1996–2011)

(a) China with benchmark territories

(b) Russia with benchmark territories

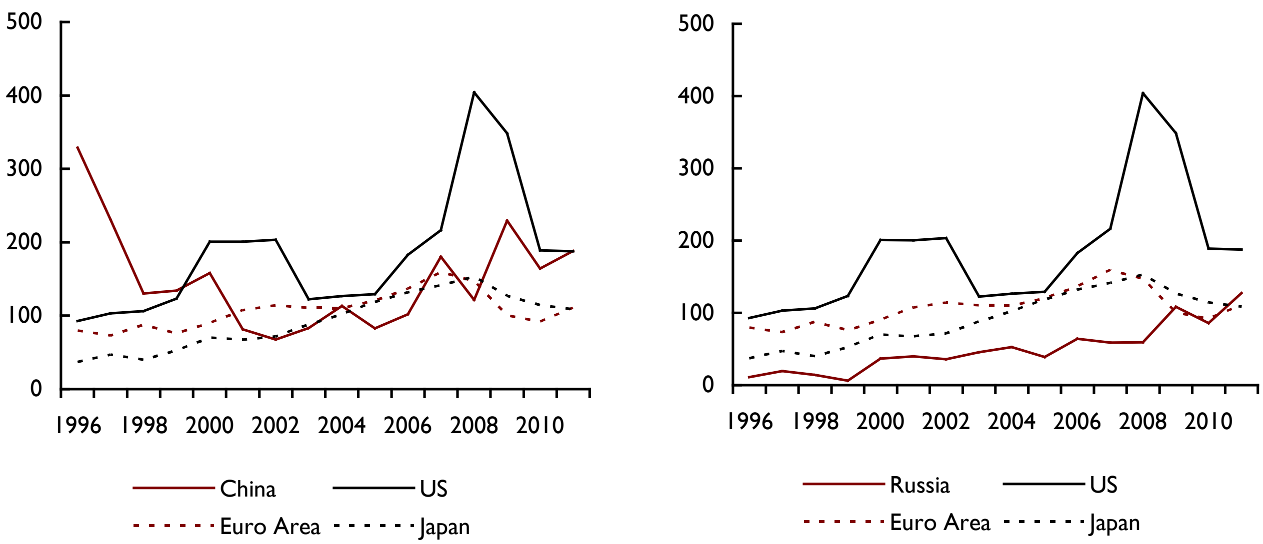


Source: The World Bank.

Figure A3. Stocks traded, turnover ratio (as a percentage, 1996–2011)

(a) China with benchmark territories

(b) Russia with benchmark territories



Source: The World Bank.

INFLATION IN CHINA INCREASINGLY DRIVEN BY DOMESTIC FACTORS

Christian Dreger* and Yanqun Zhang**

The article investigates the determinants of consumer price inflation in China. While inflation has been entirely driven by international factors, such as food and energy prices, in the period preceeding the financial crisis, domestic drivers like monetary developments and nominal wages have become increasingly important since then. Due to tight trade linkages and the presence of Chinese firms in international production chains, the changing pattern is also relevant to other countries.

Keywords: Chinese inflation; domestic and foreign factors; money demand

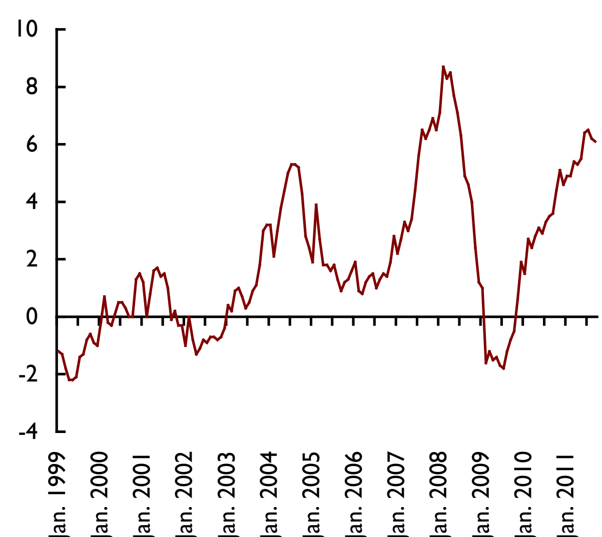
JEL Classifications: E31; E41; C32

1. Introduction

Despite the inflation slowdown observed in recent months, the determinants of consumer prices in China are of high economic relevance. Rising prices reduce the purchasing power of Chinese households and can trigger lower consumption expenditures. Therefore, they pose a risk to the successful transformation of the Chinese economy, where growth should be driven by domestic demand to a higher extent. Since poor families have to spend up to half of their income on food, increasing prices in this segment can raise the risk of social unrest. On the one hand, inflation is attributed to developments in the world economy (Research Group of China's Growth and Macroeconomic Stability, 2008); prices for food, energy and raw materials are primarily formed on international markets.[1] With a slowdown of world demand, lower inflation is transmitted without any further intervention by the Chinese government. On the other hand, however, the conclusions are quite different if inflation is heavily linked to domestic factors. Increases in liquidity and real wages beyond their fundamental values can drive inflation. Due to trade linkages and the presence of Chinese firms in international production chains, a change in the inflation drivers can trigger global consequences (Dreger and Zhang, 2011). The analysis presented here explores the determinants in the inflation process, where international and domestic drivers are distinguished. The results point to a rising weight of domestic variables to explain inflation.

In the year following the financial crisis, inflation accelerated to rates of more than 6 per cent. Former record levels from the run-up to the financial crisis were

Figure 1. Consumer price inflation in China



Source: Wind Datafeed Service.

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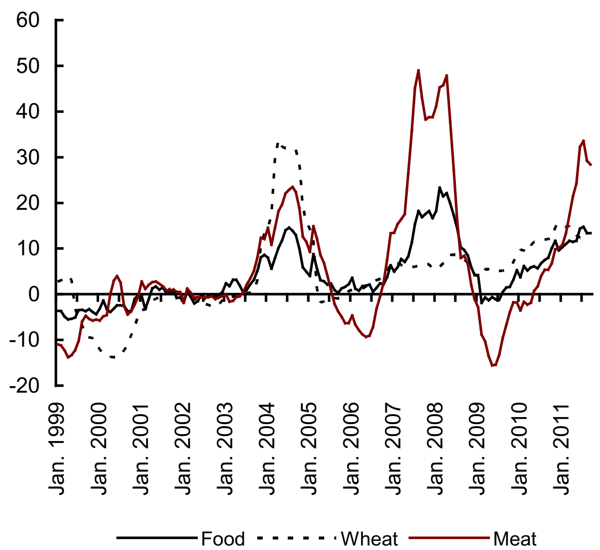
Figure 1. Food inflation in China



Source: Wind Datafeed Service.

almost hit again (figure 1). With rates of 14 per cent, food became increasingly expensive. As food receives a weight exceeding 30 per cent in the consumer basket, price trends in this area are highly relevant for overall inflation. Meat prices have been 30 per cent higher compared with the previous year, while prices of pork increased by 45 per cent (figure 2). This evolution reflects changes in the consumer habits of a growing Chinese middle class, but also an epidemic disease in 2007, which caused shortages in supply. Prices for goods such as clothing, telecommunications, leisure and education increased, but at a slower pace.

The government implemented restrictive measures to prevent an overheating of the economy due to accelerating demand. This can be studied in the car market, which has expanded at a slower pace. The earlier development was fostered by tax reliefs and subsidies, which have not been renewed. In addition, the registration of new cars has been limited to improve traffic conditions in huge cities. Furthermore, the People's Bank of China increased official interest rates, leading to higher credit costs. The minimum reserves of banks were raised to take excess liquidity from the economy. These measures have taken effect gradually so inflation has started to decline. At the same time, the slower expansion of global demand led to weaker price pressure on food, energy and raw materials. In recent years, however, the weight of domestic factors for inflation might have become larger (Zhong, 2011). Liquidity (M2) expanded massively to avoid a slowdown of the economy in the financial crisis. Nominal wages increased at annual rates of about 15 per cent.

The rest of the paper is structured as follows. In the next section (section 2), the fundamental path of the development of potential domestic inflation drivers is defined, and liquidity and production costs are considered. Section 3 presents the inflation equation and documents the higher relevance of domestic variables in the inflation process in recent years. Finally, section 4 concludes.

2. Monetary and wage developments

National factors are proxied by liquidity growth and the development of costs, in particular wages. While oil and food prices directly affect consumer prices, monetary and wage developments have an impact on inflation only if they exceed their fundamental values. For example, higher real incomes or declining opportunity costs of holding money generate a higher money demand. This does not increase inflation, as it is in line with fundamental macroeconomic development. Furthermore, real wages can increase in line with productivity, without any additional inflationary pressures. Therefore, the empirical strategy is first to determine the balanced path of money supply and real wages. Second, the differences to the observed series serve as a measure of the excess development in the respective variables that might have inflationary effects.

Fundamental development of monetary aggregates

The fundamental evolution of money stocks is determined in the context of money demand. According to standard specifications, the demand for real money balances is based on real income, which can be seen as a proxy for the transaction volume in an economy and the opportunity cost of money holdings, which might include nominal interest rates and annualised inflation (Ericsson, 1998).

Higher income raises the demand for liquidity to handle a larger transaction volume. In contrast, money demand will decline in response to higher opportunity costs, as money holdings become more expensive relative to real and financial assets. The inflation rate is focused on the substitution between money and goods. However, the variable serves also as a correction factor. Due to the inclusion of inflation, the imputed homogeneity between nominal money supply and prices can be relaxed in the short run (Dreger and Wolters, 2010). Therefore, the interpretation of its coefficient is no longer unique.

Table 1. Money demand behaviour

$$(m-p)_t = \underset{(0.094)}{5.303} + \underset{(0.019)}{1.125}\, y_t - \underset{(0.040)}{0.293}\, i_t + \underset{(0.182)}{0.392}\, \pi_t$$

Note: Sample period 2002Q1–2010Q4. Seasonally adjusted quarterly data from Datastream. Monetary aggregate M2 (*m*), consumer price index (*p*) real income (*y*), short-term nominal interest rate (*i*), inflation rate (π). Series are in logs with the exception of the nominal interest rate and the rate of inflation, the latter proxied by the annualised first difference of consumer prices. Standard errors are shown in parentheses below the coefficients.

The empirical results underline that a standard money demand function for China can be justified (table 1). The income elasticity of money demand is close to unity, implying that there is no money illusion. Both semi-elasticities of money with respect to the nominal interest rate and the inflation rate are negative and of similar magnitude to the industrial countries.[2] The deviations from the relationship are mean reverting, as can be shown by unit root tests. Thus, the equation can be interpreted as a long-term relationship between real money balances and their macroeconomic determinants, where the sign and size of the coefficients are in line with economic arguments. In the analysis of inflation drivers, the residuals are used as measures of excess liquidity.

Fundamental development of real wages

If real wages and productivity move in parallel, the income distribution between wages and profits remains unchanged, and no additional upward pressure on prices is generated. But a rise in real wages beyond productivity growth can trigger higher inflation. It should be noted, however, that higher real wages are quite desirable for the government, as they can help facilitate the intended transformation of the economy. According to the new five-year plan, domestic demand should play a more prominent role for Chinese growth. Hence, faster growing wages might be a precondition for higher consumption.

Table 2. Real wages and productivity

$$(w-p)_t = \underset{(0.078)}{11.40} + \underset{(0.019)}{1.060}(y-l)_t$$

Note: Sample period 2002Q1–2010Q4. Seasonally adjusted quarterly data from Datastream. Nominal wages (*w*), consumer price index (*p*) real income (*y*), employment (*l*). Series are in logs. Standard errors in are shown in parentheses below the coefficients.

By the same argument, minimum wages increased in many regions, for example in Shanghai by 15 per cent (China Daily: "New wave of minimum wages hike in China", July 3, 2010). These measures should also help to counteract social unrest.

A regression of real wages on labour productivity reveals a productivity coefficient slightly above unity, i.e. real wages have risen more than productivity (table 2). Again, the equation can be seen as a cointegrating relationship, as the deviations are stationary. They can be exploited to investigate the inflationary development.

3. Domestic and foreign drivers of inflation

Once the international and national determinants of the development of consumer prices are known, they can be used in a regression model to explain the inflation process. International price developments are captured by the price of oil per barrel (Brent) and food prices. National drivers include excessive liquidity and excessive real wages, both defined as deviations from their fundamental path.

Table 3. Drivers of inflation

A. Sample period 2002–10

$$\pi_t = \underset{(0.001)}{0.003} + \underset{(0.004)}{0.012}\,\Delta oil_t + \underset{(0.015)}{0.127}\,\Delta meat_t + \underset{(0.027)}{0.065}\,dm_{t-3} + \underset{(0.024)}{0.080}\,dw_{t-3} + \underset{(0.095)}{0.198}\,\pi_{t-1}$$

$$R2 = 0.802,\quad Q(1) = \underset{(0.323)}{0.976},\quad Q(4) = \underset{(0.051)}{9.506},$$

$$ARCH(1) = \underset{(0.703)}{0.149},\quad JB = \underset{(0.679)}{0.775}$$

B. Sample period 2002–8

$$\pi_t = \underset{(0.001)}{0.002} + \underset{(0.008)}{0.015}\,\Delta oil_t + \underset{(0.017)}{0.129}\,\Delta meat_t + \underset{(0.042)}{0.035}\,dm_{t-3} + \underset{(0.068)}{0.029}\,dw_{t-2} + \underset{(0.124)}{0.229}\,\pi_{t-1}$$

$$R2 = 0.773,\quad Q(1) = \underset{(0.406)}{0.692},\quad Q(4) = \underset{(0.098)}{7.834},$$

$$ARCH(1) = \underset{(0.443)}{0.611},\quad JB = \underset{(0.742)}{0.596}$$

Note: Inflation rate (π), oil prices (*oil*), meat prices (*meat*), excess liquidity (*dm*) and wages (*dw*). All series are measured in logs. Δ denotes the first difference operator. *R2* is the coefficient of determination. *Q* test for autocorrelation, *ARCH* test for heteroscedasticity and Jarque-Bera (*JB*) test for for normally distributed residuals. The corresponding lag length is shown in parentheses after the respective test statistics. Values in brackets following the regression coefficients refer to standard errors, after the test statistics to the *p* values.

The estimates are consistent with theoretical reasoning. Rising oil and food prices put higher inflation pressure on consumer prices. Furthermore, domestic factors are relevant to explain the inflation experience. This holds for excessive liquidity as well as for excessive real wages. The usual specification tests do not detect any particular problems with the inflation equation. The residuals are neither autocorrelated nor heteroscedastic and display no significant deviations from the normal distribution.

The relevance of domestic variables is new and can represent a gradual change in the drivers of inflation. To provide evidence on this issue, the regression is carried out in a subsample period that ends just before the financial crisis. While the influence of international factors remains unchanged, the national variables are no longer significant. Their importance has grown just in the recent years of the sample.

4. Conclusion

The article investigates the determinants of consumer price inflation in China. While inflation has been entirely driven by international factors, such as food and energy prices, in the period preceding the financial crisis, domestic drivers like monetary developments and nominal wages have become increasingly important since then. Due to foreign trade linkages and the presence of Chinese firms in international production chains, the changing pattern is also relevant to other countries.

NOTES

1 Chinese demand for food and energy also affects global prices. Structural effects are also relevant, as production in China is more energy-intensive than in Western Europe.

2 This finding suggests that Chinese data are quite reliable. The same impression applies to other relationships such as consumer and investment demand. See Chow (2006, 2010).

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REAL-TIME WARNING SIGNS OF EMERGING AND COLLAPSING CHINESE HOUSE PRICE BUBBLES

Xi Chen* and Michael Funke**

The recent increase in Chinese house prices has led to concerns that China is vulnerable to asset price shocks. In this paper, we apply recently developed recursive unit root tests to spot the beginning and the end of potential speculative bubbles in Chinese house price cycles. Overall, we find that except for 2009–10 actual house prices are not significantly disconnected from fundamentals. Thus, the evidence for speculative house price bubbles in China is in general weak.

Keywords: House prices; China; speculative bubbles; recursive unit root tests

JEL Classifications: C15; G01; G12; R31

1. Introduction

Issues related to Chinese house prices have become an international concern. China's extraordinary real estate boom began in the early 2000s and was further boosted in 2009 by China's huge financial crisis stimulus package. In the aftermath of the global financial crisis in 2008–9, the Chinese government urged banks to increase lending. Buyers took advantage of looser real estate lending terms and lower mortgage rates. Increasing rates of urbanisation, rising income, and rapid economic growth have also contributed to high real estate demand. Furthermore, the expansionary monetary policy stance has not only boosted house prices but has also generated a shift in house price expectations and spurred excessive risk-taking in the banking sector.[1] As a result, real estate in many cities has become unaffordable for broad sections of the population in China.

Ultimately, house prices have also become an important and topical issue for Chinese policymakers.[2] The property sector now makes up about 12 per cent of GDP. Furthermore, property is a sizable component of household and corporate balance sheets. Therefore, a sudden collapse in house prices may have negative spillover effects on the overall macroeconomic situation and may pose macroeconomic and financial stability risks.[3] Just as a quick reminder, the build-up of property price overvaluations triggered the Asian financial crisis of the late 1990s. In response to the sustained run-up in house prices, therefore, the Chinese government imposed in spring 2010 several market-cooling measures and restrictions intended to bring house prices down to a 'reasonable level'. In addition, the People's Bank of China benchmark mortgage lending rate was raised in summer 2011. As a result, multiple indicators suggested a slight market downturn in 2011. It must be pointed out that it remains an open question whether the latest market dip may be a short-term episode since high and rising real estate prices may be in line with market fundamentals.

Recent research has also focused on central banks' incentives. Kocherlakota and Shim (2007) demonstrate that the utility-maximising central bank's response to house price increases is conditioned on the real time probability of a future house price collapse. If this is high *ex ante*, proactive corrective action is optimal. Otherwise the central bank shows forbearance towards instability.

The uncertainties in defining a sustainable house price level and identifying emerging housing bubbles in real time have not lessened substantially in past decades.

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Even worse, it may turn out not to be very useful to identify bubbles in real time. Even if statistically significant bubble characteristics are found and monetary policymakers are confident that a speculative housing bubble has emerged, the question of the timeliness of the policy response remains. The problem is the timing of the detection of the bubble relative to the timing of its collapse. The risk is that the subsequent interest and/or macroprudential policy response occurs not long before the bubble collapses on its own. Given the lags associated with monetary policy, the resulting contractionary effects of the proactive policy tightening would occur just when the bubble bursts, worsening rather than mitigating the effects of the bubble's collapse. Thus, those seeking to identify significant warning signs of future housing bubbles may turn out to be the Don Quixotes of housing research. Is it therefore time to call off the quest?

The plan of the paper is as follows. Section 2 reviews some theoretical and econometric issues related to housing valuation and bubble identification. Section 3 proceeds by discussing the data and the results of the econometric diagnostics. Section 4 draws some conclusions.

2. Theoretical and econometric considerations in relation to detecting property price bubbles

In the first stage, we need to define bubble periods. Based on this, we can then identify inflated house prices and bubble periods. Rational house price bubbles can arise because of the indeterminate aspect of solutions to rational expectations models. The house price that agents are prepared to pay today depends on the expected house price at some point in the future. But the latter depends on the expected house price even further in the future. The resulting process governing house prices does not pin down a unique house price level unless, somewhat arbitrarily, a transversality condition has to be imposed to obtain a unique solution. However, in general, the possibility that house prices may systematically deviate from their fundamental value cannot be ruled out. Even if risk-neutral agents are perfectly rational, the actual house price may contain a bubble element, and thus there can be a divergence between the house price and its fundamental value. The resulting real estate bubble is an upward house price movement over an extended range that then suddenly collapses.[4]

Our goal is to find how house prices evolve over time, given the behaviour of fundamentals. Time is discrete. In the modelling framework, fundamental house prices H_t can be represented as follows:

$$H_t = \left(\frac{1}{1+r}\right)E_t(R_t + H_{t+1}), \qquad (1)$$

where E_t is the expectations operator, R_t is the rent, and r is the discount rate. To solve the model, we need to eliminate the term involving the expectation of the future value of the endogenous variable. It is straightforward to show that the fundamental house price H_t^F can be solved under rational expectations by repeated forward substitution. This implies

$$H_t^F = \Sigma_{j=1}^{\infty}\left(\frac{1}{1+r}\right)^j E_t(R_{t+j}). \qquad (2)$$

The logic of equation (2) is that house market prices contain expectations of future rents. No specific assumptions are made about the process followed by R_t.[5] The rational bubble components B_t follow

$$B_t = \left(\frac{1}{1+r}\right)E_t(B_{t+1}). \qquad (3)$$

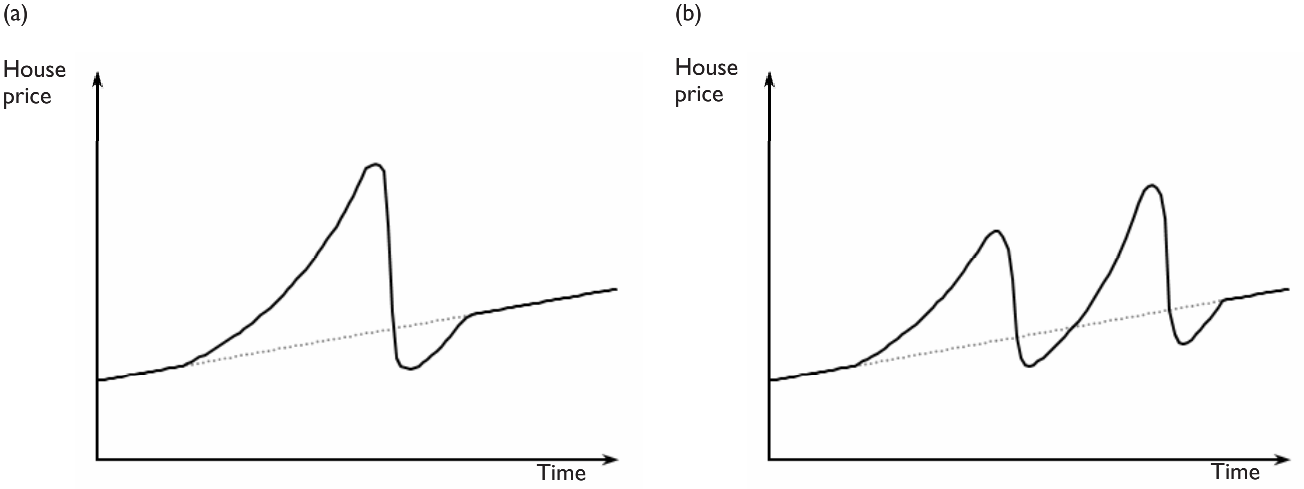
Solving for H_t finally yields

$$H_t = H_t^F + B_t. \qquad (4)$$

Equation (4) breaks up house prices into a 'fundamental' and a 'bubble' component. Without a bubble, house prices equal the fundamental value H_t^F. Under bubble conditions house prices may show an explosive behaviour inherent in B_t.[6] What kind of house price bubble is B_t? Mathematically, the explosive bubble term is a *deus ex machina* arising as an alternative solution to the process governing house prices. The origin of the bubble cannot be explained, and only the dynamics of the bubble are given by the model. If a bubble is present in the house price, equation (4) requires that any rational investor must expect the bubble to grow. If this is the case, and if B_t is strictly positive, this builds the stage for speculative investor behaviour; a rational investor is willing to buy an 'overpriced' house, since he/she believes that through price increases he will be sufficiently compensated for the extra payment he has to make as well as the risk of the bubble bursting. In that sense, the house price bubble is a self-fulfilling expectation. Eventually, the bubble implodes, house prices fall with a sharp correction and deleveraging occurs.

Next we discuss how the theoretical framework can be linked to an econometric testing strategy. In the econometric literature, identifying a bubble in real time has proved challenging. In addition, severe econometric problems result from finite samples. Standard unit root

Figure 1. Stylised one-off bubble *vs* periodically collapsing bubbles



and cointegration tests may be able to detect one-off exploding speculative bubbles, as in panel (a) of figure 1, but are unlikely to detect periodically collapsing bubbles, as in panel (b) of figure 1. In other words, efforts to identify significant warning signs of future housing bubbles have been impeded by the necessity to spot multiple starting and ending points. The reason is that traditional unit root tests are not well equipped to handle changes from I(0) to I(1) and back to I(0). This makes detection by cointegration techniques harder, due to bias and kurtosis (Evans, 1991).

A nuanced and persuasive approach to identification and dating multiple bubbles in real time has recently been pioneered by Phillips and Yu (2011) and Phillips *et al*. (2012).[7] The idea is to spot speculative bubbles as they emerge, not just after they have collapsed. Their point of departure is the observation that the explosive property of bubbles is very different from random walk behaviour. Correspondingly, they have developed a new recursive econometric methodology interpreting mildly explosive unit roots as a hint for bubbles. If we consider the typical difference of stationary *vs* trend stationary testing procedures for a unit root, we usually restrict our attention to regions of 'no more than' a unit root process, i.e. an autoregressive process where $\rho \leq 1$. In contrast, Phillips and Yu (2011) model mildly explosive behaviour by an autoregressive process with a root ρ that exceeds unity but is still in the neighbourhood of unity. The basic idea of their approach is to calculate recursively right-sided unit root tests to assess evidence for mildly explosive behaviour in the data. The test is a right-sided test and therefore differs from the usual left-sided tests for stationarity. More specifically, consider the following autoregressive specification estimated by recursive least squares:

$$x_t = \mu + \rho x_{t-1} + \varepsilon_t \qquad \varepsilon_t \sim iid(0,\sigma^2). \tag{5}$$

The usual H_0: $\rho = 1$ applies, but unlike the left-sided tests which have relevance for a stationary alternative, Phillips and Yu (2011) have H_1: $\rho > 1$, which, with $\rho = 1 + c/k_n$, where $c > 0$, $k_n \to \infty$ and $k_n/n \to 0$, allows for their mildly explosive cases. Phillips and Yu (2011) argue that their tests have discriminatory power, because they are sensitive to the changes that occur when a process undergoes a change from a unit root to a mildly explosive root or *vice versa*. This sensitivity is much greater than in left-sided unit root tests against stationary alternatives. But this is not all. It should be added that bubbles usually collapse periodically. Therefore, standard unit root tests have limited power in detecting periodically collapsing bubbles.[8] To overcome this drawback, Phillips and Yu (2011) have suggested using the supremum of recursively determined Dickey-Fuller (DF) *t*-statistics. The estimation is intended to identify the time period where the explosive property of the bubble component becomes dominant in the price process. The test is applied sequentially on different subsamples. The first subsample contains observations from the initial sample and is then extended forward until all observations of the complete sample are included. The beginning of the bubble is estimated as the first date when the DF *t*-statistic is greater than its corresponding critical value of the right-sided unit root test. The end of the speculative bubble will be determined as the first period when the DF t-statistic is below the aforementioned critical value.

Formally, Phillips *et al.* (2011, 2012) suggest calculating a sequence of DF tests. Let $\hat{\rho}_\tau$ denote the OLS estimator of ρ and $\hat{\sigma}_{\rho,\tau}$ the usual estimator for the standard deviation of $\hat{\rho}_\tau$ using the subsample $\{y_1,\ldots y_{[\tau T]}\}$. The forward recursive DF test of H_0 against H_1 is given by

$$\sup DF(r_0) = \underbrace{\sup}_{r_0 \le \tau \le 1} DF_\tau \qquad (6)$$

where $DF_\tau = \frac{\hat{\rho}_t - 1}{\hat{\sigma}\rho_t}$. Note that the DF statistic is computed for the asymmetric interval $[r_0,1]$. In applications, r_0 will be set to start with a sample fraction of reasonable size. The limiting distribution is

$$\underbrace{\sup}_{r_0 \le \tau \le 1} DF_\tau \overset{D}{\rightarrow} \underbrace{\sup}_{r_0 \le \tau \le 1} \frac{\int_0^\tau W dW}{\int_0^\tau W^2} \qquad (7)$$

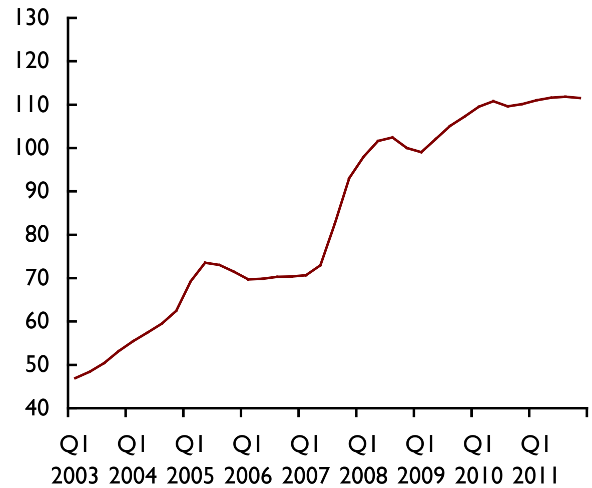
where '$\overset{D}{\rightarrow}$' denotes convergence in distribution and W is a standard Wiener process.

Analogously, the augmented supADF (SADF) test can be derived. In addition, Phillips *et al.* (2012) have suggested employing the 'generalised' supADF (GSADF) test as a dating mechanism. The GSADF diagnostic is also based on the idea of sequential right-tailed *ADF* tests, but the diagnostic extends the sample sequence to a more flexible range. Instead of fixing the starting point of the sample, the GSADF test changes the starting point and ending point of the sample over a feasible range of windows. Phillips *et al.* (2012) demonstrate that the moving sample GSADF diagnostic outperforms the SADF test based on an expanding sample size in detecting explosive behaviour in multiple bubble episodes and seldom gives false alarms, even in relatively modest sample sizes. The reason is that the GSADF test covers more subsamples of the data. In the next section of the paper we shall apply these two bubble dating algorithms to locate periodic explosive sub-periods.[9] They also show that the diagnostics perform accurately even with relatively small sample sizes. This gives us confidence in the potential applicability of the proposed testing strategy to Chinese house price data under real-time conditions, as shown below.

3. Data and estimation results

Prior to the econometric analysis, we briefly describe the data set. Our data set for mainland China covers nationwide nominal house prices (H_t) and the price-to-rent ratio (H_t/R_t) over the period 2003Q1–2011Q4. This period coincides with China's peak phase of urbanisation and the private housing market boom.[10]

Figure 2. Nationwide Chinese house price cycles, 2003Q1–2011Q4, seasonally adjusted index 2008Q4=100

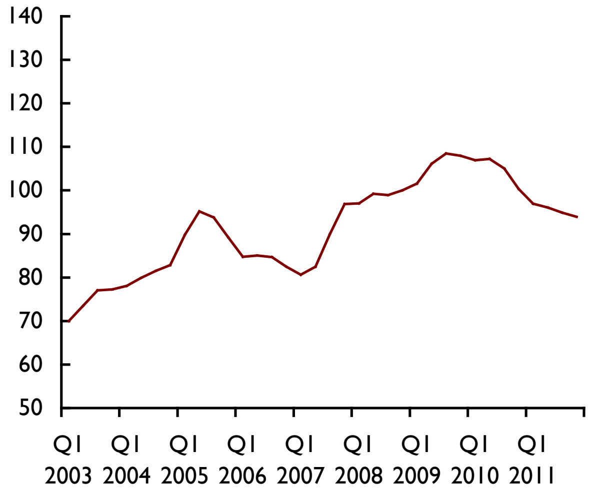


Source: Igan and Loungani (2012).

Figure 2 documents the magnitude of the nationwide surge in Chinese house prices. At first glance, the plot of the time series appears to justify the expression 'speculative housing bubble'. Chinese house prices rose rapidly until 2005. They accelerated again sharply in 2008, fuelled by the fiscal stimulus package, low interest rates and massive credit expansion.[11] Chinese house prices soon regained a steep upward trend until mid-2010 when, against the risk of a speculative bubble in the housing market, the Chinese government announced a number of measures to cool the market. The campaign intensified in 2011. The measures included (i) increasing downpayments for first-time buyers' mortgages from 20 per cent to 30 per cent, and for second homes from 50 per cent to 60 per cent; (ii) a total ban on mortgages for third home purchases; (iii) introduction of new restraints on house purchases by non-locals; (iv) introduction of new property taxes in Shanghai and Chongqing: between 0.4 per cent and 0.6 per cent in Shanghai, and between 0.5 per cent and 1.2 per cent on luxury homes in Chongqing; (v) elimination of mortgage discounts for first-time home buyers; and (vi) raising of the benchmark interest rate to 6.56 per cent in July 2011. Subsequently, the pace of house price increases began to slow.

In order to identify speculative house price bubbles, the fundamental part of house prices has to be separated from the speculative part. There are various ways to estimate

Figure 3. Nationwide Chinese price-to-rent ratio, 2003Q1–2011Q4, seasonally adjusted index 2008Q4=100



Source: Igan and Loungani (2012).

the fundamental value of house prices. The asset pricing equation (2) suggests looking at the Chinese price-to-rent ratio as a yardstick, i.e. house price changes should be in line with rent changes, given constant interest rates. A corollary of this is that the price-to-rent ratio (H_t/R_t) should be constant over time in the absence of a speculative bubble. When house prices are low relative to rent, future increases in house prices are likely to be high. Thus, the price-to-rent ratio (H_t/R_t) can be viewed as "an indicator of valuation in the housing market" (Gallin, 2008, p. 635).[12]

Figure 3 shows the Chinese nationwide house price-to-rent ratio from 2003Q1 to 2011Q4. A mere look at the plot of this time series indicates that the price-to-rent ratio increased until 2010 and has decreased since. It should be noted that a rising price-to-rent ratio is only a necessary but not a sufficient condition for speculative misalignment from fundaments. Below we therefore test for significant overvaluation using the recursive testing procedure suggested by Phillips *et al.* (2012).

Identifying speculative bubbles is no easy task even in mature markets with long time series. In China, time series for house prices and in particular for the price-to-rent ratio are short. Phillips *et al.* (2012) have demonstrated that higher-frequency data significantly improve the finite sample power of recursive tests. Taking this into account, we have first generated monthly price-to-rent ratios using the proportional Denton (1971) method.[13] Next we employ the recursive right-tailed *ADF* statistics

Figure 4. Recursive calculation of the SADF test for r_0=0.3

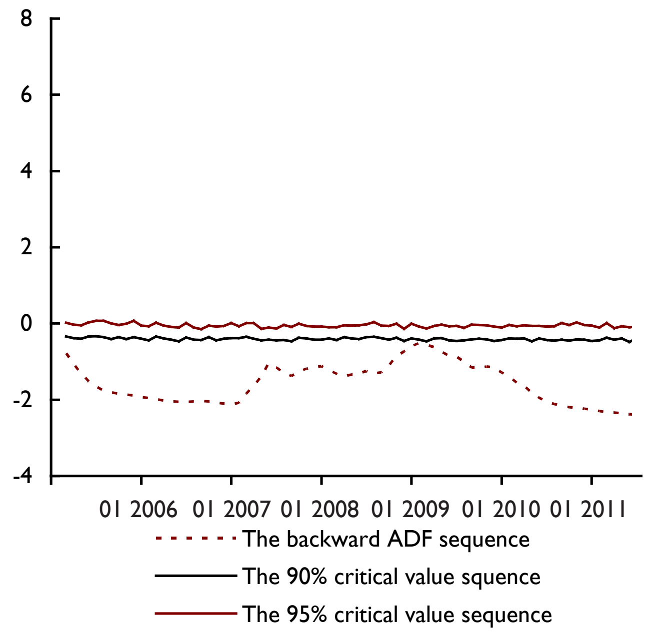


Figure 5. Recursive calculation of the SADF test for r_0=0.4

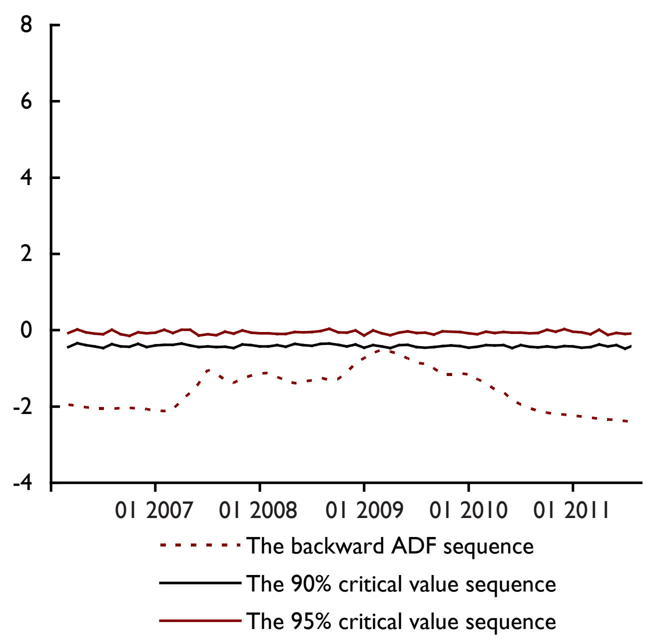


Figure 6. Recursive calculation of the GSADF test for r_0=0.3

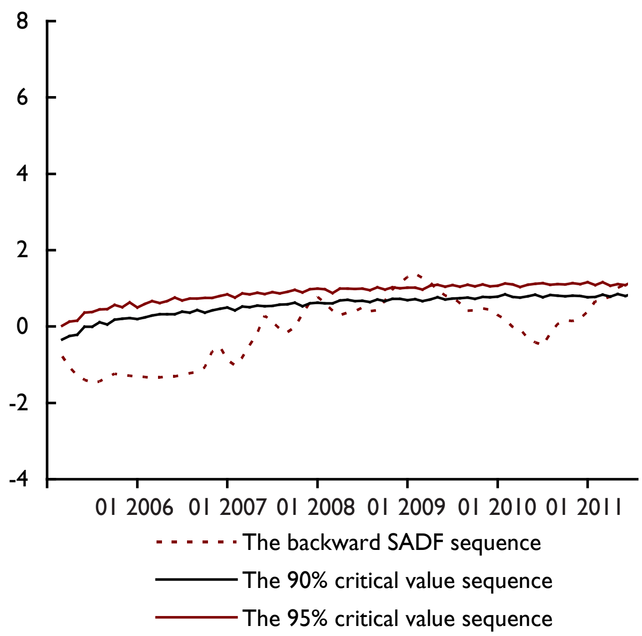
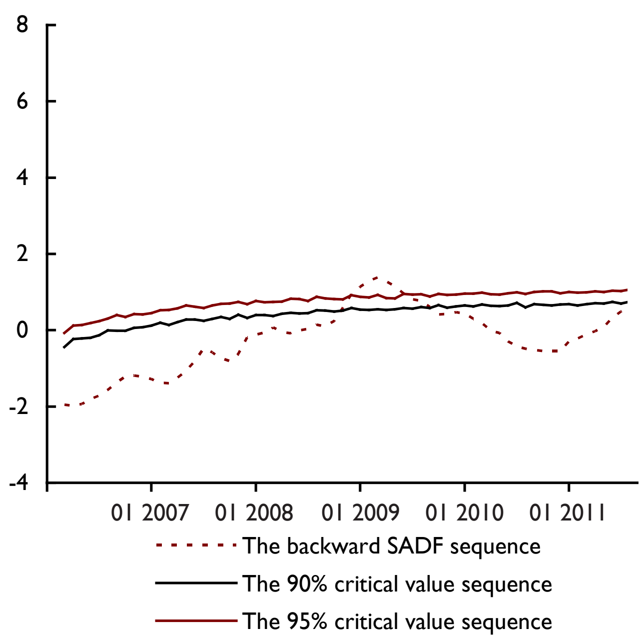


Figure 7. Recursive calculation of the GSADF test for r_0=0.4

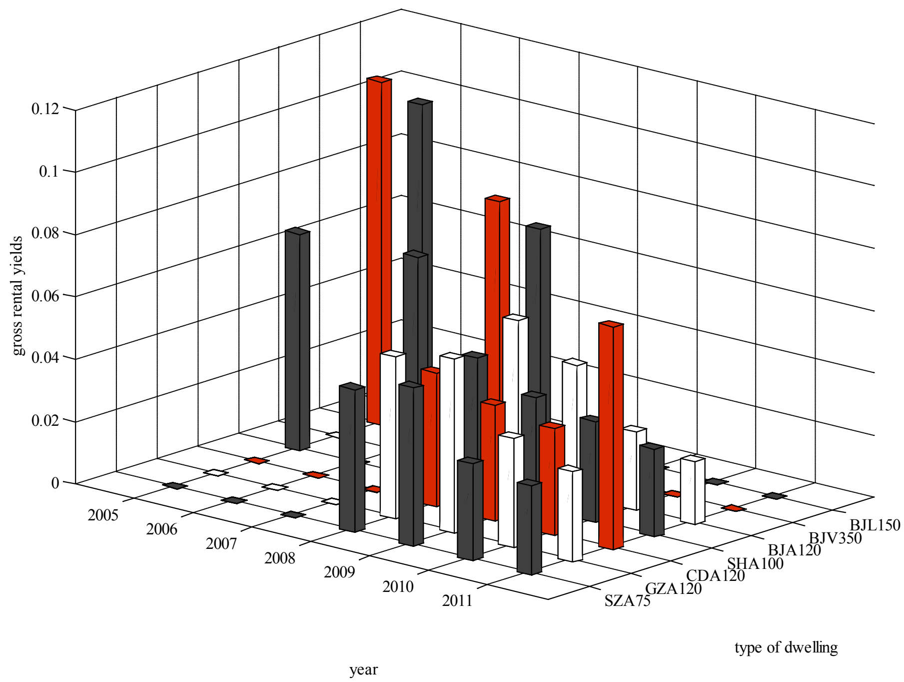


to scrutinise for speculative bubbles in Chinese housing markets. For the *SADF* and *GSADF* tests, r_0 has to be chosen. If the number of observations is small, r_0 needs to be large enough to ensure there are enough observations for initial estimation. In our application, we choose $r_0 = 0.3$ and $r_0 = 0.4$, respectively.[14] The finite sample critical values are obtained via Monte Carlo simulations with 2,000 iterations. Observations above the respective critical values signal a warning to policymakers as when to start to 'lean against the wind' in order to restrain undesirable and unsustainable trends. All computations were generated using a programme in MATLAB.

Figures 4–7 provide an overall picture of Chinese house price valuation over the sample period under consideration. The dotted red lines in figures 4–7 show the recursively calculated univariate backward *ADF* and *SADF* statistic sequences, respectively. The black and red solid lines show the associated critical values. The graphs lend themselves to several conclusions. Firstly, the *GSADF* tests flag a statistically significant periodic misalignment in 2009–10. The periodic bubble period is short but exceeds the minimum time span log(n) suggested by Phillips *et a*l. (2012), where n is the sample size. It is noticeable that this confirms the preliminary results from glancing at figure 2. Secondly, as expected, the *SADF* diagnostic turns out to be more conservative in detecting exploding sub-periods. Thirdly, except for that, sub-period house prices were not overly and significantly disconnected from fundamentals. Thus, the administrative measures to dampen house price inflation appear to be having the desired effect. Finally, it is an encouraging sign that the testing procedure is able to give warnings even when the speculative bubble period is short-lived.

It is worth emphasising that price-to-rent indices have obvious disadvantages and shortcomings. Certainly, it is true that the indices provide information about the dynamics of the price-to-rent ratio over time. However, they do not provide any information about the actual level of the price-to-rent ratio. Therefore, we additionally provide information about gross rental yields (R_t/H_t) across major Chinese cities and various market segments from 2005 to 2011. The gross rental yield is the rent over the course of one year, expressed as a percentage of the purchase price of the property. While this supplementary shorthand measure may not resolve all our interpretation difficulties, it may give us a better sense of where we are currently going in China. The disaggregated data also provide an important comparison with the nationwide trend and therefore round up the image.

Figure 8. Gross rental yields across major Chinese cities and market segments, 2005–11

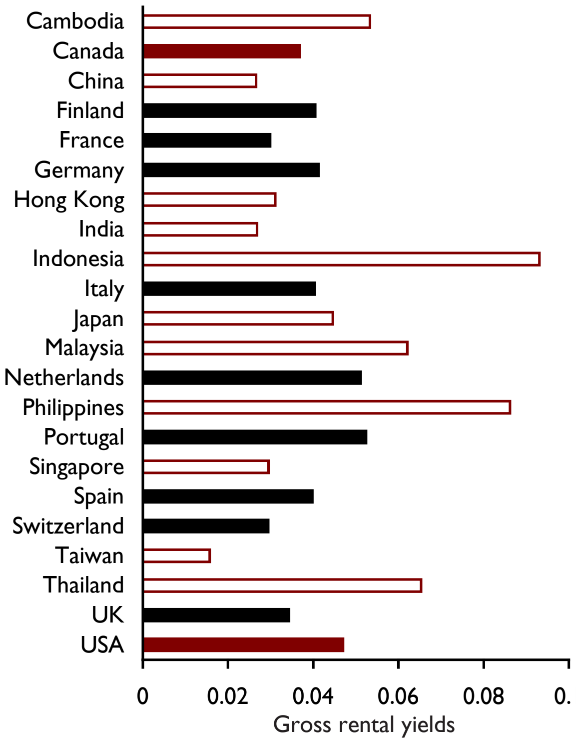


Source: *Global Property Guide Research* (http://www.globalpropertyguide.com).
Notes: The yield is defined as the gross annual rental income, expressed as a percentage of property purchase price. The yields are constructed by compiling and processing transaction-level data from a variety of market sources. Only resale apartments and houses are researched. Yields for newly built properties are not included. No data is available for the year 2006. BJL150: Beijing luxury apartments 150 m^2; BJV350: Beijing villas 350 m^2; BJA120: Beijing apartments 120 m^2; SHA100: Shanghai apartments 100 m^2; CDA120: Chengdu apartments 120 m^2; GZA120: Guangzhou apartments 120 m^2; SZA75: Shenzhen apartments 75 m^2.

Gross rental yields across cities have been quite heterogeneous, as is clear from the cross-city, cross-time data in figure 8.[15] Although yields are correlated across most cities, aggregate Chinese house price changes clearly mask sharp regional differences. In 2005, rental yields in all categories of Beijing property were above 9 per cent. In Shanghai, returns were lower than in Beijing, with gross rental yields ranging from 5.4 per cent to 7 per cent. In 2011, rental yields in Beijing were below 3 per cent, and in Shanghai below 3.5 per cent. The data send a clear message – during the period of study, property prices have been climbing steeply, while rents have not moved much.[16] The degree of price misalignment is particularly pronounced in the mass markets of a number of coastal cities like Beijing and Shanghai. The substantial heterogeneity in house prices and the house price-to-income ratio dynamics highlight the complexity of an appropriate policy response in situations where asset prices are not rising uniformly. The heterogeneity and idiosyncratic pattern may reflect the fact that city-level house prices include significant local variables. This is particularly true for so-called ‘superstar cities’, where local circumstances can result in a prolonged period of higher than average growth in house prices (see Himmelberg *et al*., 2005).

While there is no sign of significant nationwide overvaluation in figures 4–7 after introduction of the cooling measures in 2010–11, there are still signs that house prices in some coastal cities and market segments are disconnected from fundamentals. Overall, these results are consistent with the extant, rather scant empirical literature on the dynamics of Chinese city-level house prices. For example, Ahuja et al. (2010) have also concluded that, over the period 2000Q1–2009Q4, Chinese house prices were not significantly higher than would be justified by underlying fundamentals, while signs of overvaluation were present in some cities’ mass-market and luxury segments. The balance of nationwide econometric and cross-city descriptive evidence points towards the conclusion that the period of market overheating cooled off in 2011 but remains at a high

Figure 9. Gross rental yields in 2011: an international comparison



Source: *Global Property Guide Research*.
Notes: The gross annual rental income for a 100–150m² apartment in a premier city location, expressed as a percentage of the purchase price. Only high-quality resale apartments and houses are included. The yields are constructed by compiling and processing transaction-level data from a variety of market sources.

level. But in light of the government´s corrective action, it is inconceivable that they will rise as fast as 2011.

Another natural temptation is to compare the gross rental yields in China to those of other countries. This can provide a more condensed picture of the Chinese housing market. Last, but not least, we therefore provide the cross-country gross rental yields for 2011 (figure 9). This may allow for a comprehensive picture and balanced assessment of the Chinese housing market.

Several descriptive results are obtained. The first thing to note is the considerable variation across countries. Yields below 3 per cent are usually considered to be a sign of an overvalued market, leading early warning signals to flash red. By international comparison, China had rather low rental yields in 2011. The same is true for Taiwan, where yields have reached unsustainably low levels. After three years of unbroken house price rises, gross rental yields are unusually low, at an average of 2.8 per cent. One trigger for rising Taiwanese property prices is speculation about future investment by mainland Chinese. At the other end of the scale are Indonesia and the Philippines. Despite high growth rates in recent years, the housing market in Indonesia has faltered. Some of the major factors that have made a decisive contribution to this development include high mortgage rates, high tax rates and restrictions on foreign ownership. Similarly, housing markets in the Philippines were held back by several obstacles, including high taxation, fake land titles and high transaction costs. Superficially, yields on property therefore look attractive. Property in the United States is now relatively inexpensive from an international perspective.[17] All in all, the evidence in figure 9 provides a more nuanced understanding of Chinese house price developments. The evidence also indicates that in several countries the ongoing housing downturn still has further to go.

4. Wrapping up: signalling Chinese house price bubbles with time series methods

Few areas have received the same amount of focus and scrutiny over the past couple of years as house prices. The collapse of the financial markets and the need for additional regulatory and macroprudential policies has overturned previously accepted wisdom about risk and self-regulation in a market economy. Monetary policymakers have two different strategies to deal with a possible asset price bubble: the 'conventional' strategy and an 'activist' strategy. A central bank following the conventional strategy does not attempt to use monetary policy to influence the speculative component of asset prices, on the assumption that it has little ability to do so and that any attempt will only result in suboptimal economic performance in the medium term. Instead, the central bank responds to asset price movements, whether driven by fundamentals or not, only to the degree that those movements have implications for future output and inflation. In contrast, an activist strategy takes extra action by tightening policy beyond what the conventional strategy would suggest. This requires that policymakers can identify emerging bubbles in real time with reasonable confidence.

In this paper we have employed the newly developed testing strategy pioneered by Phillips and Yu (2011) and Phillips *et al.* (2012) aimed at identifying explosive bubbles in real time. We believe that this new approach to identifying growing bubbles and their collapse will make a significant impact on the construction of early warning systems, and we have therefore used the method as a signpost for periodically collapsing Chinese housing bubbles.[18] The results flash a heightened probability of an emerging Chinese house price bubble in 2009–10. During other years, the Chinese housing market does not display significant signs of unsustainable overvaluation. Another contribution of this paper lies in its comprehensive approach. To measure and benchmark Chinese house prices, the paper presents and analyses several datasets and measures of house price overvaluation. In focusing on various measures, the paper provides empirical shape and substance to the multifaceted concept of house price bubbles. One conclusion is that the considerable house price variation across Chinese cities requires differentiated local policy responses to trigger price corrections.

NOTES

1 For the impact of the monetary policy stance on the banking sector, see Altunbas *et al.* (2010). Chinese banks are now much more exposed to the property market than they were in the early 2000s, with real estate loans now accounting for about 20 per cent of total loans.

2 There has been a considerable debate among economists on the evolution of Chinese property prices and the empirical evidence remains at best ambiguous, varying with the selected empirical methodology. For example, Wu *et al.* (2010) have argued that a real estate bubble has emerged in recent years, spurred by the fiscal stimulus after the great recession. In contrast, Ren *et al.* (2012) have found no evidence to support the existence of speculative price bubbles in China. The fragility of the results likely stems from the inherent difficulty of identifying bubbles. A review of traditional econometric tests for asset price bubbles is available in Gürkaynak (2008) and Mikhed and Zemcik (2009).

3 See Ciarlone (2011) and Chen *et al.* (2011).

4 Martin and Ventura (2011) have recently presented a rational bubble model with investor sentiment shocks and imperfect financial markets. In their framework, the size of the bubble depends upon investor sentiment. On the other hand, financial frictions allow efficient and inefficient investments to coexist. Introducing financial frictions can thus explain why bubbles can temporarily lead to expansions in the capital stock and in GDP although a bubble is nothing but a pyramid scheme. This happens when the bubble raises the net worth of efficient investors, allowing them to increase investment.

5 Much of the modelling appeal is clarity, not realism. Because of the complexity of the fundamental $E_t(R_{t+j})$ and the lack of agreement about its key ingredients, the frameworks stop short of being a fully specified model.

6 One implication of rational house price bubbles is that they cannot be negative, i.e. $B_t < 0$. This is because the growing bubble term falls at a faster rate than house prices increase and thus a negative bubble ultimately ends in a zero house price. Rational agents realise that and know that the bubble must eventually burst. By backward induction, the bubble must then burst immediately, as no investor will pay the 'bubble premium' in the earlier periods.

7 The diagnostic for multiple speculative bubbles modifies a previous method for identifying one-off bubbles suggested in Phillips *et al.* (2011). A different class of tests for identifying periodically collapsing bubbles based on Markov-switching models has been explored in Funke *et al.* (1994) and Schaller and van Norden (2002), among others.

8 Busetti and Taylor (2004), Kim *et al.* (2002) and Leybourne *et al.* (2006) have shown that traditional unit root tests have low power in the case of gradually changing persistence and/or the existence of persistence breaks.

9 Skipping, for the sake of brevity, further technical details, the interested reader is referred to the above-mentioned papers introducing the right-tailed unit root testing strategy. A technical supplement providing a complete set of mathematical derivations of the limit theory underlying the unit root tests is available at http://sites.google.com/site/shupingshi/TN_GSADFtest.pdf?attredirects=0&d=1.

10 Reliable Chinese house price indices are hard to come by. The official 70 cities house price index published by the Chinese National Bureau of Statistics (NBS) is mistrusted and has been widely criticised for underestimating house price inflation. Given the suspicion and criticism, the NBS suspended publication of the housing data in February 2011. See http://online.wsj.com/article/SB10001424052748703373404576147792827651116.html for more details. Therefore, we employ the house price and price-to-rent data in Igan and Loungani (2012). They pay particular attention to data coverage and computation leading to discrepancies among different data sources. Longer time series of Chinese house price data may not improve the results since China has experienced a regime shift in the housing market in the late 1990s. Indeed, until the late-1990s, the allocation of apartment units to most urban households was determined by employers, primarily government institutions and state-owned enterprises.

11 On the surface, the Chinese house price increases seem to share many of the features of the Japanese property price bubble in the 1980s. This does not in any way imply that a Chinese bubble, were it to exist, would collapse like the Japanese one. China is still years behind pre-bubble Japan and has abundant room for driving its maturing export-driven economy into one more geared towards consumption. Furthermore, Chinese banks are still majority-owned by the state and therefore policy restraints aimed at deflating bubble periods would be more effective in China than in Japan. Therefore, China is hardly a Japan in the making.

12 Also see Case and Shiller (2003) and Himmelberg *et al.* (2005).

13 The Denton procedure is a standard tool for compiling higher-frequency data. The technique generates monthly series which are both consistent with the quarterly data (i.e. the average of the monthly indices is equal to the quarterly indices) and as close as possible to the movements of a monthly reference series. The monthly house price index of the Chinese National Bureau of Statistics is used as the indicator series. The interpolation problem is nonlinear and can be solved using standard optimisation procedures, as discussed by Bloem *et al.* (2001) and Denton (1971).

14 In robustness checks, we used several r_0s and find that the results are not particularly sensitive to the precise choice. The qualitative results also remain unchanged when the logged price-to-rent ratio is used for the diagnostic tests.

15 At the city level, rental and price information for different market segments is even more limited and only selected annual data are available. Therefore, formal bubble tests cannot be employed.

16 Chengdu is an exception. For reasons unknown so far, yields appear healthy there. On the other hand, this may also represent just a statistical artifact.

17 However, house prices in the US were pushed up by consumers who borrowed heavily, while China´s house prices were pushed up by high savings and a lack of alternative investment. On the other hand, this may not resolve the problem in the long run since this is at least partially the result of distorted financial markets in China. So any liberalisation of financial markets may render high house prices unsustainable.

18 It is paramount to remember that we rely on limited observations. While the test results yield reasonable results, more work is needed to confirm our findings. Data availability limits the number of observations available for a more definitive evaluation. Further research with longer time series is therefore desirable to corroborate our assessment.

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COST COMPETITIVENESS COMPARISONS AND CONVERGENCE IN CHINA

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We investigate trends in regional cost competitiveness in China's four regions (Coastal, Northeast, Interior and West) over the past thirty-five years. We find that the Coastal region lost its initial cost competitiveness as its higher relative labour productivity (RLP) was offset by rapidly rising relative nominal labour costs (RNLC) due to rising wages. The Northeastern region still has cost advantages in the traditional Manufacturing sector. The Interior and West regions improved their competitiveness in most industries due to low RNLCs. There is convergence of relative unit labour cost (RULC) in all industries before 1995, but only in Finance after 1995. However there is convergence in RLP in five industries in 1978–95 and 1995–2009, offering prospects for robust growth for China into the future.

Keywords: Unit labour cost; regional development planning; China

JEL Classifications: J30; R58

1. Introduction

Unit labour costs (ULCs) are widely used as a metric for international competitiveness comparisons (van Ark *et al*., 2005). Notable studies between China and other economies include UNCTAD (2002), which compared ULCs in manufacturing for China relative to the US, Sweden and some non-EU countries in 1998. Cox and Koo (2003) calculate China's labour productivity relative to the US and Mexico in 2001. Banister (2005) reports labour costs for Chinese manufacturing in 2002, but does not include productivity or unit labour costs analysis. Szirmai *et al*. (2005) provide a long-run series of labour productivity relative to the US for 21 manufacturing subsectors in China from 1980 to 2002.[1] However, there are huge regional disparities in Chinese economic development which are often overlooked when making international comparisons. For China to maintain its growth trajectory as a nation, it is arguable that it must facilitate convergence across regions in productivity and labour costs. Failure to do so may create frictions within the Chinese economy (wage inflation, labour unrest, resource underutilisation) which may threaten its long-term growth path.

This paper analyses China's regions' cost competitiveness over the period 1978–2009 for nine major industrial sectors.[2] Despite policy interest in the factors driving disparities in unit labour costs in China (Peneder, 2009), empirical work on the issue is sparse. Ceglowski and Golub (2007) analyse China's labour productivity and unit labour costs in Manufacturing over the period 1980–2002, but provide no information for the service industries and regional disparities. Chen *et al*. (2009) focus on comparisons of relative levels of productivity, labour compensation, unit labour costs and convergence trends for 28 manufacturing subsectors and 30 provinces for only two years (1995 and 2004). They argue that unit labour costs have been falling because labour productivity growth is faster than the labour compensation growth. They find convergence in competitiveness in labour-intensive industries, but divergence among capital/skill intensive industries.[3] However, they do not consider the fast developing service industries in China, which is our contribution in this paper.

We investigate trends in unit labour costs for China's regions across nine one-digit sectors from 1978 to 2009. We consider regions' competitiveness based on RULCs to identify which regions rely most heavily on relatively high labour productivity to be cost competitive and which rely more on relatively low nominal labour costs. Sectoral

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competitive advantage shifts with relative nominal wages and productivity growth across regions. We focus on the drivers of unit labour costs and decompose regions' cost competitiveness into its productivity and cost components. This paper is structured as follows: section 2 introduces the measure method and discusses the construction of the dataset; section 3 outlines findings and examines competitive differences by industry and region; section 4 provides a decomposition of unit labour costs growth into relative changes of productivity and nominal labour costs; section 5 shows the convergence or divergence trends which have taken place across regions by industry. The final section comments on the implications of the findings.

2. Measurement and Data

In order to calculate unit labour costs, we need information on value added, price deflators of value added, labour compensation, annual hours worked of staff and workers.[4] For cross-regional comparisons, the formula for relative unit labour costs in sector *j* and region *r* (or province *p*) (baseline is Chinese national level *b*), i.e. $RULC_j^{rb}$, can be calculated by:

$$RULC_j^{rb} = \frac{ULC_j^r}{ULC_j^b} = \frac{LC_j^r / Y_j^r}{LC_j^b / Y_j^b} \qquad (1)$$

where LC_j^r and Y_j^r are labour compensation and value added in sector *j* and region *r*. Similarly, LC_j^b and Y_j^b are labour compensation and value added in sector j of the average national level and then relative labour productivity in sector *j* and region *r*, i.e. RLP_j^{rb}, can be calculated by:

$$RLP_j^{rb} = \frac{LP_j^r}{LP_j^b} = \frac{Y_j^r / H_j^r}{Y_j^b / H_j^b} \qquad (2)$$

where H_j^r is the annual hours worked by staff and workers in sector *j* in region *r*. H_j^b is the annual hours worked by staff and workers in sector *j* at national level. Finally, relative nominal labour costs in sector *j* and region *r*, i.e. $RNLC_j^{rb}$, can be calculated by:

$$RNLC_j^{rb} = \frac{NLC_j^r}{NLC_j^b} = \frac{LC_j^r / H_j^r}{LC_j^b / H_j^b} \qquad (3)$$

Since unit labour costs are all relative to China's average national level, figures greater (lower) than one indicate a labour cost disadvantage (advantage) for the region relative to the national average level.

Our dataset is constructed from two sources: Hsueh and Li (1999) and Chinese Statistics Yearbooks (CSYs). Hsueh and Li (1999) provide information for twelve sectors for the period 1978–95.[5] The CSYs have information for six sectors in two years, 1996 and 1997, twelve sectors for the period 1997–2003, and nine sectors during the period 2004–9.[6] There are many missing values in the consistent nine one-digit tertiary sectors after 1995. We impute missing values using data on the tertiary sector in 1995, such as gross value added, number of staff and workers and labour compensation from Hsueh and Li (1999).[7] We derive the implicit prices of gross value added from the ratios of value added at current prices and constant prices. The price deflators of gross value added for missing tertiary sectors are assumed to be the same as the respective price deflators of the total Tertiary sector.

The year 1994 marks the country-wide spread of 'market based economy' ideas, a change linked to Deng Xiaoping's 'South Trip' in 1992.[8] The year 1994 also marked a shift to the decentralisation of fiscal revenue to promote economic growth. Local governments are better positioned than the central government to locate and monitor fiscal expenditure more efficiently. This, in turn, led to the imposition of hard budget constraints on SOEs and promotion of economic growth through huge lay-offs (Qian and Weingast, 1997; Ma and Norregaard, 1998; Oates, 1972). Following Fleisher *et al.* (2010) we use the year 1994 as a structural break point for the economic transition process in China and divide the entire time period into two parts (1978–95 and 1995–2009) and also compare results for these two periods.

The National Bureau of Statistics of China records the number of staff and workers in post in the CSYs after 1998. Our data for the number of staff and workers during 1978 and 1997 include the laid-off workers. By assuming the ratio of redundant workers to on-post workers before 1998 is the same as the ratio in 1998 we obtain a consistent number of staff and workers from 1978 to 2009.

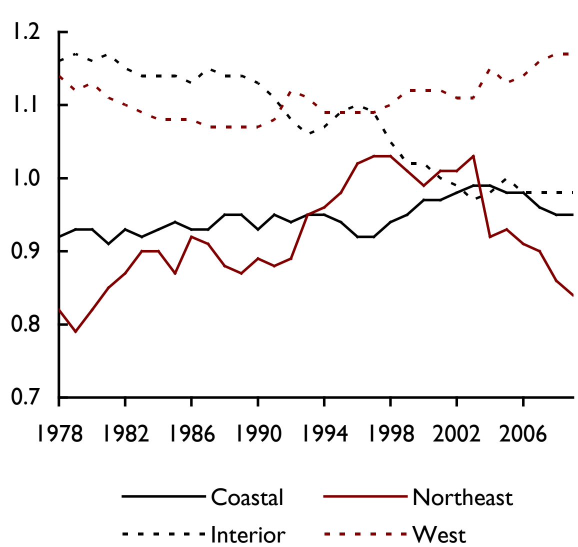
Annual working hours are not available in Chinese official statistics. So we follow the calculation of Jefferson *et al.* (2000). They derive working hours from labour regulation which changed three times during 1978–2009. Until 1994, a 6-day and 48-hour week was the norm for workers throughout Chinese industry. Then, from 1 March, 1994, staff and workers worked 8 hours a day and 44 hours a week, and from 1 May, 1995 they have worked 8 hours a day and 40 hours a week. Hence, during the period between 1978 and 1993, the standard annual working time was 2400 hours a year (= 48 hours/week *50 weeks). In 1994 the standard annual working time was 2233 hours (= 2400*(2/12) + 2200*(10/12)), and in 1995 it was 2067 hours (= 2200*(4/12) + 2000*(8/12)). The standard annual working time declined to 2000 hours (= 40 hours/week*50 weeks) subsequently. By assuming that individual annual working hours do not vary across industries, total working hours are imputed using the number of staff and workers.

3. Results

First we present the findings of average relative unit labour costs (RULC). Figure 1 shows the RULCs of the Total Economy by region from 1978 to 2009. We find that RULCs in the Coastal, Interior and West regions are fairly stable prior to 1995. This may be due to the imposition of strict wage control by the state. The Northeastern region had a particularly high concentration of loss-incurring SOEs, so the RULCs in the industrial Northeast kept rising. After 1995, RULCs in the Coastal and West regions increase a little, while the Interior and Northeastern regions experience sharply decreased labour costs following huge lay-offs in loss-making SOEs.

Next, we investigate the RULCs by industry and region, and then the extent to which competitiveness, defined by relative unit labour costs (RULC), is determined by a nominal labour cost advantage or a relative productivity advantage (RLP). A relative unit labour cost lower than one with respect to the average national level indicates a relatively competitive situation for a region. It means that its labour costs are lower, or its labour productivity is higher. Each of these outcomes is likely to have different policy implications and, from this perspective, it is useful to have a better understanding of which component of relative unit labour costs measurement is driving the level. Thus, the most interesting sectors are those where there is the greatest gap between nominal labour costs and labour productivity.

Figure 1. RULCs of the total economy by region (1978–2009)



Sources: Hsueh and Li (1999), and Chinese Statistics Yearbooks (CSYs), own calculations.

Table 1 presents the average RULC, RNLC and RLP in the nine one-digit sectors by industry and region, compared with the average national level over 1978–95 and 1995–2009. Before 1995, the Coastal region – known as the "land with fish and rice" – was cost competitive in most industries due to its higher RLPs. This may be because it was the region that was exposed to the economic reforms early on. After 1995, however, the Coastal region experienced rapidly rising wages which offset its continuing labour productivity advantage. In contrast, the Interior and the West regions maintained cost competitiveness in most industries, benefiting from their relatively low labour costs.

In Agriculture cost competitiveness prevailed in the Coastal (0.96) and the Northeast (0.97) regions before 1995, but the Interior (0.89) and the West (0.86) regions became the most cost competitive after 1995. The cost competitiveness of the Coastal and Interior regions comes from the high RLPs (1.73 and 1.35); in contrast, the Northeast and West regions benefit from low RNLCs (0.37 and 0.60). The industrial Northeastern region has the highest cost competitiveness in the manufacturing (D) industry, across the two periods (0.91 and 0.90) with the lowest nominal labour costs across regions (0.80 and 0.85). The average RLPs in the Coastal region are highest (1.21 before 1995 and 1.13 afterwards), but they are offset by the high RNLCs. For the Construction (F) industry, cost competitiveness was in the Coastal region (0.91) before 1995 due to high RLP (1.22), and moved to the Northeast (0.90), the Interior (0.83) and the West (0.82) regions, which all benefit from their low labour costs. For both the Trade (G) and Transportation (I) industries across the four regions, the lowest RULCs (both 0.94) are in the Coastal regions before 1995 because of the highest RLP, and the lowest RULCs (0.83 and 0.93) are in the West region after 1995 from the lowest RNLCs.

The Coastal regions have cost competitiveness in the Finance (J) industry across the two periods (0.61 and

Table 1. RULC, RNLC and RLP by industry and region (1978–95 and 1995–2009)

		RULC		RNLC		RLP	
	Region	1978–95	1995–2009	1978–95	1995–2009	1978–95	1995–2009
Agriculture (A to B)	Coastal	**0.96**	1.14	1.66	2.30	**1.73**	**2.02**
	Northeast	**0.97**	1.01	**0.37**	**0.39**	0.38	0.38
	Interior	1.03	**0.89**	1.33	1.20	**1.29**	**1.35**
	West	1.03	**0.86**	**0.78**	**0.60**	0.76	0.69
Manufacturing (D)	Coastal	**0.99**	1.05	1.19	1.18	**1.21**	**1.13**
	Northeast	**0.91**	**0.90**	**0.80**	**0.85**	0.88	0.95
	Interior	1.07	1.03	**0.89**	**0.93**	0.83	0.91
	West	1.05	**0.91**	**0.90**	**0.75**	0.86	0.82
Construction (F)	Coastal	**0.91**	1.20	1.11	1.44	**1.22**	**1.21**
	Northeast	1.01	**0.90**	**0.63**	**0.79**	0.62	0.90
	Interior	1.09	**0.83**	1.18	**0.73**	**1.08**	0.89
	West	1.05	**0.82**	**0.96**	**0.69**	0.92	0.85
Trade (G)	Coastal	**0.94**	1.11	1.20	1.38	**1.27**	**1.25**
	Northeast	1.14	**0.91**	**0.72**	**0.94**	0.64	**1.04**
	Interior	1.09	1.03	**0.87**	**0.68**	0.80	0.66
	West	**0.95**	**0.83**	1.01	**0.67**	**1.06**	0.82
Transportation (I)	Coastal	**0.94**	1.08	1.19	1.40	**1.27**	**1.31**
	Northeast	**0.99**	1.00	**0.84**	**0.66**	0.85	0.66
	Interior	1.13	**0.98**	**0.97**	**0.84**	0.86	0.86
	West	1.00	**0.93**	**0.82**	**0.70**	0.82	0.77
Finance (J)	Coastal	**0.61**	**0.88**	**0.80**	1.20	**1.30**	**1.37**
	Northeast	1.21	1.39	**0.98**	**0.79**	0.83	0.58
	Interior	1.29	**0.94**	1.04	**0.61**	0.81	0.65
	West	1.70	1.50	1.33	1.13	0.78	0.76
Real estate (K)	Coastal	**0.88**	1.07	1.02	1.25	**1.15**	**1.16**
	Northeast	1.24	1.12	**0.71**	**0.83**	0.58	0.75
	Interior	**0.85**	**0.83**	**0.99**	**0.76**	**1.17**	0.92
	West	1.21	1.00	1.24	**0.74**	**1.04**	0.74
Education (M)	Coastal	**0.99**	1.14	**0.99**	1.39	1.00	**1.23**
	Northeast	1.02	1.04	1.05	**0.98**	**1.04**	0.95
	Interior	1.00	**0.86**	1.01	**0.71**	1.00	0.83
	West	1.02	**0.91**	**0.99**	**0.74**	0.97	0.81
Health (N)	Coastal	**0.93**	1.08	1.02	1.21	**1.10**	**1.13**
	Northeast	1.03	1.37	1.04	1.32	**1.02**	0.97
	Interior	1.03	**0.87**	**0.95**	**0.77**	0.92	0.89
	West	1.08	**0.86**	**0.99**	**0.74**	0.92	0.87

Sources: Hsueh and Li (1999), and Chinese Statistics Yearbooks (CSYs), own calculations, average figures over 1978–95 and 1995–2009.
Notes: The bold values represent the regions' advantage relative to the national level. The red bold values are those we discuss in this paper.

0.88) with highest RLPs (1.30 and 1.37), and the Interior region has cost advantage (0.94) after 1995 with the lowest RNLC (0.61). The Real Estate (K) industry has the lowest RULCs in the Interior region during two periods (0.85 and 0.83), both due to their low RNLCs (0.99 and 0.76). In the Education (M) and the Health (N) industries, the Interior (0.86 and 0.87) and the West (0.91 and 0.86) regions have cost competitiveness after 1995 with their low RNLCs. This is consistent with the hypothesis that provinces in the Interior and West regions accumulated human capital that helped them to catch up with the provinces in the Coastal region.[9]

Within each region, which provinces then contribute most to the regional cost competitiveness shown in table 1? Table 2 shows that in the Coastal region, Beijing has the lowest RULCs in the Agriculture (0.71), Trade (0.60) and Transportation (0.60) industries before 1995, and Shanghai has the lowest RULCs (0.26 and 0.34) in the Finance industry for both periods. Shanghai is

Table 2. RULC by industry and province (1978–95 and 1995–2009)

	1978–1995									1995–2009								
	AtoB	D	F	G	I	J	K	M	N	AtoB	D	F	G	I	J	K	M	N
Coastal	**0.96**	**0.99**	**0.91**	**0.94**	**0.94**	**0.61**	**0.88**	**0.99**	**0.93**	1.14	1.05	1.20	1.11	1.08	**0.88**	1.07	1.14	1.08
Beijing	**0.71**	0.79	0.88	**0.60**	**0.60**	1.03	**0.88**	1.04	**0.86**	**0.94**	1.43	1.37	1.40	**0.80**	**0.39**	1.56	**0.95**	1.43
Tianjin	**0.89**	**0.79**	**0.99**	**0.85**	**0.82**	**0.71**	1.23	1.11	1.06	1.44	1.21	1.49	1.31	1.48	**0.79**	1.80	1.02	1.10
Hebei	**0.98**	1.02	**0.92**	**0.98**	**1.00**	**0.59**	1.35	1.02	1.18	**0.93**	**0.92**	**0.86**	1.64	1.07	1.21	**0.97**	1.03	1.07
Shanghai	**0.86**	**0.75**	**0.91**	**0.64**	**0.79**	**0.26**	**0.55**	1.07	1.07	1.26	1.35	1.35	1.25	**0.79**	**0.34**	1.43	1.29	1.36
Jiangsu	1.01	**0.91**	**0.88**	**0.86**	1.14	**0.37**	**0.69**	**0.93**	1.01	1.21	1.11	**0.90**	1.04	1.39	**0.70**	**0.97**	1.15	1.20
Zhejiang	**0.91**	1.11	1.03	**0.72**	1.32	**0.52**	**0.52**	1.09	**0.91**	1.26	1.01	1.34	1.27	1.44	**0.55**	**0.85**	**0.95**	**0.76**
Fujian	1.05	1.35	1.04	1.46	1.19	**0.74**	1.15	**0.98**	**1.00**	1.13	1.08	1.29	**0.87**	**0.92**	**0.71**	**0.81**	1.07	1.05
Shandong	**0.95**	1.06	**0.89**	**0.97**	**0.84**	**0.87**	**0.60**	**0.88**	**0.81**	1.22	**0.87**	**0.94**	**0.88**	1.12	2.28	**0.75**	1.13	**0.88**
Guangdong*	**0.88**	1.37	**0.84**	1.55	**0.92**	**0.87**	1.09	**0.81**	**0.84**	1.20	1.04	1.74	**0.96**	**0.87**	1.16	**0.97**	1.59	1.21
Northeast	**0.97**	**0.91**	1.01	1.14	**0.99**	1.21	1.24	1.02	1.03	1.01	**0.90**	**0.90**	**0.91**	1.00	1.39	1.12	1.04	1.37
Liaoning	**0.99**	**0.84**	1.00	**0.76**	**0.86**	**0.53**	1.26	**0.95**	**0.96**	**0.97**	**0.96**	1.09	**0.88**	**0.80**	1.59	1.12	1.07	1.44
Jilin	**0.95**	1.15	1.07	1.88	1.29	1.72	1.02	1.02	1.08	**0.93**	1.02	**0.67**	**0.96**	**1.00**	1.32	**0.92**	1.02	1.03
Heilongjiang	**0.96**	**0.93**	1.02	1.59	1.09	1.77	1.42	1.09	1.12	1.15	**0.76**	**0.79**	**0.87**	1.31	1.10	1.15	**0.95**	1.37
Interior	1.03	1.07	1.09	1.09	1.13	1.29	**0.85**	1.00	1.03	**0.89**	1.03	**0.83**	1.03	**0.98**	**0.94**	**0.83**	**0.86**	**0.87**
Shanxi	**0.94**	1.18	1.09	1.03	1.08	**0.68**	1.28	1.08	1.12	**0.84**	1.20	1.02	**0.78**	**0.91**	**0.91**	1.11	**0.93**	**0.77**
Anhui	1.02	1.11	1.13	1.04	1.06	2.00	**0.71**	1.13	1.18	1.02	**0.93**	**0.83**	**0.93**	**0.42**	**0.94**	**0.67**	**0.70**	**0.60**
Jiangxi	1.02	1.11	1.11	1.42	1.62	1.60	**0.75**	**0.65**	**0.64**	**0.95**	1.01	**0.67**	1.04	**0.79**	1.33	**0.64**	1.15	1.28
Henan	1.02	1.12	1.01	1.11	**0.90**	**0.89**	**0.72**	1.00	1.06	**0.90**	1.18	**0.69**	1.05	**0.97**	1.06	**0.81**	**0.87**	1.09
Hubei	**0.98**	**0.95**	1.01	1.15	1.30	1.55	**0.98**	1.08	1.07	**0.96**	**0.73**	1.01	1.27	1.35	**0.73**	1.21	**0.96**	1.01
Hunan	1.09	1.04	1.17	**0.98**	1.23	1.53	**0.73**	1.12	1.12	**0.81**	1.09	**0.90**	1.01	1.27	1.11	**0.61**	**0.76**	**0.70**
West	1.03	1.05	1.05	**0.95**	1.00	1.70	1.21	1.02	1.08	**0.86**	**0.91**	**0.82**	**0.83**	**0.93**	1.50	1.00	**0.91**	**0.86**
Inner Mongolia	**0.83**	1.09	1.04	1.26	1.08	1.46	1.19	1.07	1.12	**0.96**	1.15	1.12	1.11	**0.86**	1.11	1.16	1.18	1.04
Guangxi	1.02	**0.98**	1.18	1.16	**0.98**	2.59	1.06	**0.93**	1.05	**0.74**	1.13	**0.66**	**0.67**	1.06	3.37	**0.97**	**0.74**	**0.81**
Sichuan*	1.02	1.07	1.06	**0.75**	**0.84**	1.36	**0.98**	**1.00**	1.06	**0.89**	**0.97**	**0.98**	**0.71**	**0.75**	1.15	**0.74**	**0.91**	**0.81**
Guizhou	1.03	1.06	1.05	1.12	**0.90**	1.32	1.31	1.17	1.15	**0.78**	**0.95**	**0.66**	**0.78**	1.07	1.20	**0.76**	**0.80**	**0.67**
Yunnan	1.08	**0.62**	**0.95**	1.23	**0.86**	1.17	1.36	**0.82**	**0.88**	**0.97**	**0.58**	**0.85**	**0.79**	1.13	2.19	**0.97**	1.06	**0.65**
Shaanxi	1.02	1.21	1.08	1.27	1.04	3.39	1.47	1.15	1.20	**0.89**	**0.93**	**0.49**	1.30	**0.95**	1.44	1.37	**0.84**	1.03
Gansu	**0.97**	1.27	**0.94**	**0.80**	1.38	1.65	1.65	**0.99**	**0.97**	**0.67**	1.10	**0.64**	1.09	1.02	1.54	1.59	**0.96**	1.29
Qinghai	1.05	1.35	1.11	**0.71**	1.59	1.76	1.68	**0.94**	1.11	**0.82**	1.01	**0.95**	**0.74**	1.17	1.40	1.70	1.01	1.07
Ningxia	1.14	1.08	1.07	**0.76**	**0.94**	**0.69**	1.09	**0.96**	1.00	1.07	1.04	**0.75**	**0.75**	**0.86**	1.29	1.14	**0.81**	**0.82**
Xinjiang	1.02	1.04	1.13	**0.70**	1.05	1.27	2.14	1.24	1.28	**0.84**	**0.60**	**0.99**	**0.84**	1.12	1.11	1.65	**0.97**	1.01

Sources: Hsueh and Li (1999) and Chinese Statistics Yearbooks (CSYs), own calculations, average figures over 1978–95 and 1995–2009.
Notes: The bold values represent the provinces' advantage relative to the national level. The red bold values are those we discuss in this paper. The industry names are Agriculture (A to B), Manufacturing (D), Construction (F), Trade (G), Transportation (I), Finance (J), Real estate (K), Education (M) and Health (N). Guangdong* is the combination of Guangdong and Hainan provinces, and Sichuan* is the combination of Sichuan and Chongqing provinces.

China's finance centre and attracts funds worldwide. In addition to huge foreign investments and advanced banking systems, Zhejiang, Jiangsu and Fujian also have traditional informal finance from citizens and foreign remittances.

In the Northeastern region, Jilin has the lowest RULCs in the Agriculture (0.95) and Construction (0.67) industries, due in large part to its vast land and low population densities. The lowest RULCs in the Manufacturing industry are in Liaoning (0.84) before 1995 and Heilongjiang (0.76) afterwards. In the Interior region, Anhui province has the lowest RULCs in the Real Estate (0.71), Education (0.70) and Health (0.60) industries. Within the West region, Guangxi province has the lowest RULCs in the Trade (0.67) and Education (0.74) industries after 1995. Shaanxi province has the biggest cost advantage in the Construction (0.49) industry.

4. Decomposition of relative unit labour costs

Changes in relative unit labour costs (*RULC*) can be decomposed into two component parts: changes in relative nominal labour costs per hour (*RNLC*) and relative labour productivity (*RLP*):

Table 3. Decomposition of RULC by industry and region (1978–95 and 1995–2009)

		dulc		dnlc		dlp	
	Region	1978–95	1995–2009	1978–95	1995–2009	1978–95	1995–2009
Agriculture	Coastal	0.003	0.008	0.006	0.026	**0.003**	**0.017**
(A to B)	Northeast	**–0.005**	**–0.003**	**–0.002**	**–0.020**	**0.003**	–0.017
	Interior	0.003	**–0.013**	**–0.008**	0.007	–0.011	**0.020**
	West	**–0.004**	**–0.006**	**–0.004**	**–0.016**	0.000	–0.009
Manufacturing	Coastal	0.000	0.007	0.008	**–0.016**	**0.008**	–0.023
(D)	Northeast	0.003	**–0.001**	**–0.025**	0.031	–0.027	**0.032**
	Interior	0.004	**–0.010**	0.009	0.011	**0.005**	**0.021**
	West	**–0.008**	**–0.015**	**–0.012**	0.005	–0.004	**0.021**
Construction	Coastal	0.004	0.016	0.022	0.000	**0.018**	–0.017
(F)	Northeast	**–0.001**	**–0.013**	0.001	0.042	**0.003**	**0.055**
	Interior	0.000	**–0.027**	**–0.028**	**–0.021**	–0.029	**0.006**
	West	0.000	**–0.015**	**–0.012**	**–0.012**	–0.012	**0.003**
Trade	Coastal	0.004	0.008	0.014	**–0.003**	**0.009**	–0.011
(G)	Northeast	**–0.017**	0.008	**–0.018**	0.033	0.000	**0.025**
	Interior	0.008	**–0.010**	**–0.009**	**–0.012**	–0.017	–0.002
	West	**–0.001**	**–0.003**	**–0.011**	**–0.009**	–0.010	–0.006
Transportation	Coastal	**–0.005**	0.019	0.010	**–0.001**	**0.015**	–0.020
(I)	Northeast	**–0.001**	**–0.002**	**–0.033**	0.007	–0.032	**0.009**
	Interior	0.003	**–0.016**	0.001	**–0.006**	–0.001	**0.010**
	West	0.008	**–0.024**	**–0.003**	**–0.006**	–0.011	**0.018**
Finance	Coastal	0.017	0.006	0.019	0.000	**0.003**	–0.006
(J)	Northeast	**–0.013**	0.033	**–0.015**	0.007	–0.003	–0.026
	Interior	**–0.021**	0.011	**–0.035**	**–0.001**	–0.014	–0.012
	West	0.000	**–0.008**	0.006	**–0.006**	**0.006**	**0.001**
Real estate	Coastal	0.003	0.013	0.003	0.005	**0.000**	–0.007
(K)	Northeast	**0.000**	**–0.002**	0.013	0.015	**0.014**	**0.017**
	Interior	0.012	**–0.013**	**–0.009**	**–0.013**	–0.021	0.000
	West	**–0.002**	**–0.012**	**–0.008**	**–0.022**	–0.006	–0.010
Education	Coastal	0.002	0.014	0.017	0.007	**0.015**	–0.006
(M)	Northeast	0.005	0.005	**–0.008**	0.006	–0.013	**0.001**
	Interior	0.000	**–0.015**	**–0.016**	**–0.016**	–0.016	–0.001
	West	**–0.002**	**–0.012**	**–0.009**	**–0.006**	–0.007	**0.005**
Health	Coastal	**–0.001**	0.016	0.007	0.006	**0.007**	–0.011
(N)	Northeast	0.013	0.019	0.012	0.006	–0.001	–0.013
	Interior	0.005	**–0.019**	**–0.006**	**–0.011**	–0.011	**0.008**
	West	**–0.005**	**–0.019**	**–0.013**	**–0.006**	–0.008	**0.013**

Sources: Hsueh and Li (1999) and Chinese Statistics Yearbooks (CSYs), own calculations, average figures over 1978–95 and 1995–2009.
Notes: The bold values represent the regions' advantage (dulc<0, dnlc<0 and dlp>0). The red bold values are those we discuss in this paper.

$$\Delta\ln(RULC) = \Delta\ln(RNLC) - \Delta\ln(RLP) \quad (4)$$

where a negative change in *dulc* (unit labour costs) indicates a gain in region competitiveness, and a negative change in *dnlc* (nominal labour costs) indicates a relative decrease in region nominal labour costs. A positive change in *dlp* (labour productivity) indicates a relative improvement in region labour productivity.

Table 3 decomposes the competitiveness gains or losses of the four regions for the nine one-digit industries. In general, the improving relative competitiveness of the Northeast, Interior and West, as measured by changes in RULCs, are driven by falling nominal labour costs, rather than improving labour productivity, but there is substantial heterogeneity across industries. Since 1995, RULCs have fallen in eight out of nine sectors in the Interior and West regions. In five of these industries this is due to falling RNLCs, with no significant change in RLPs. In the other three industries the fall in RULCs is due to a combination of falling RNLCs and rising RLP. The one exception, Agriculture, experienced a decline in RULCs in the Interior due to rising labour productivity alone. Turning to the Northeast, it experienced a decline in RULCs in five industries between 1995 and 2009. In four industries this was due solely to improvements in RLP, and in one case it was due to falling RNLCs.

In Agriculture, the highest gain of region competitiveness occurs in the Northeast (–0.005) before 1995, with both a decrease in RNLC by –0.002 and an increase in RLP by 0.003. After 1995, the highest cost gain is in the Interior region (–0.013) and is due to a relative increase in RLP (0.020). In Manufacturing the biggest gain in cost competitiveness is in the West region for both periods (–0.008 and –0.015). In the early period it is due to falling RNLC (–0.012) and, from 1995, increasing RLP (0.021). In Construction the gain in competitiveness for the Northeast (–0.001) before 1995 comes from the increase of RLP (0.003). The gain in the Interior's (–0.027) competitiveness is from both a decreasing RNLC by –0.021 and increasing RLP by 0.006.

In Trade, the largest gain in cost competitiveness is in the Northeast (–0.017) region before 1995 and in the Interior (–0.010) region afterwards; both are from the decrease of RNLC. In Transportation, the gain in cost competitiveness before 1995 in the Coastal region (–0.005) is due to rising RLP (0.015). After 1995, the highest gain across regions is in the West region (–0.024) and comes from both the decrease in labour costs (–0.006) and rising labour productivity (0.018). In Finance, the biggest gain in cost competitiveness before 1995 is in the Interior region (–0.021) with a decrease of RNLC by –0.035. After 1995, the biggest gain across regions is in the West region (–0.008) with both the decrease of labour costs by –0.006 and the increase of labour productivity by 0.001 contributing. In Real Estate and Education, the highest gain in cost competitiveness before 1995 is in the West region (–0.002 and –0.002) and the highest gain after 1995 is in the Interior region (–0.013 and –0.015). These are due to falling labour costs in the West by –0.008 and –0.009 respectively, and in the Interior (–0.013 and –0.016 respectively). In Health, the highest gain is in the West region (–0.005 before 1995, and –0.019 afterwards) and is due to falling relative labour costs (–0.013 and –0.006 respectively). After 1995, labour productivity also increases by 0.013.

5. Convergence in RULC, RLP and RNLC

To have a better understanding of the degree of convergence that has taken place across provinces, we present the dispersion of the relative levels of ULC, LP and NLC in table 4. It shows the annual growth rate of the coefficients of variation for RULC, RNLC and RLP for the provincial comparisons by nine industries over 1978–95 and 1995–2009.

Three important points emerge. First, convergence in RULC growth rates is apparent for all industries in the period prior to 1995, with the exception of Finance. In the period after 1995, Finance is the only sector in which there is ULC growth convergence across provinces. Second, most of the convergence in RNLC occurs in the earlier period. Third, there are signs of convergence in labour productivity growth rates in both periods, but in only two industries – Manufacturing and Real estate – do we observe labour productivity convergence across provinces in both periods.

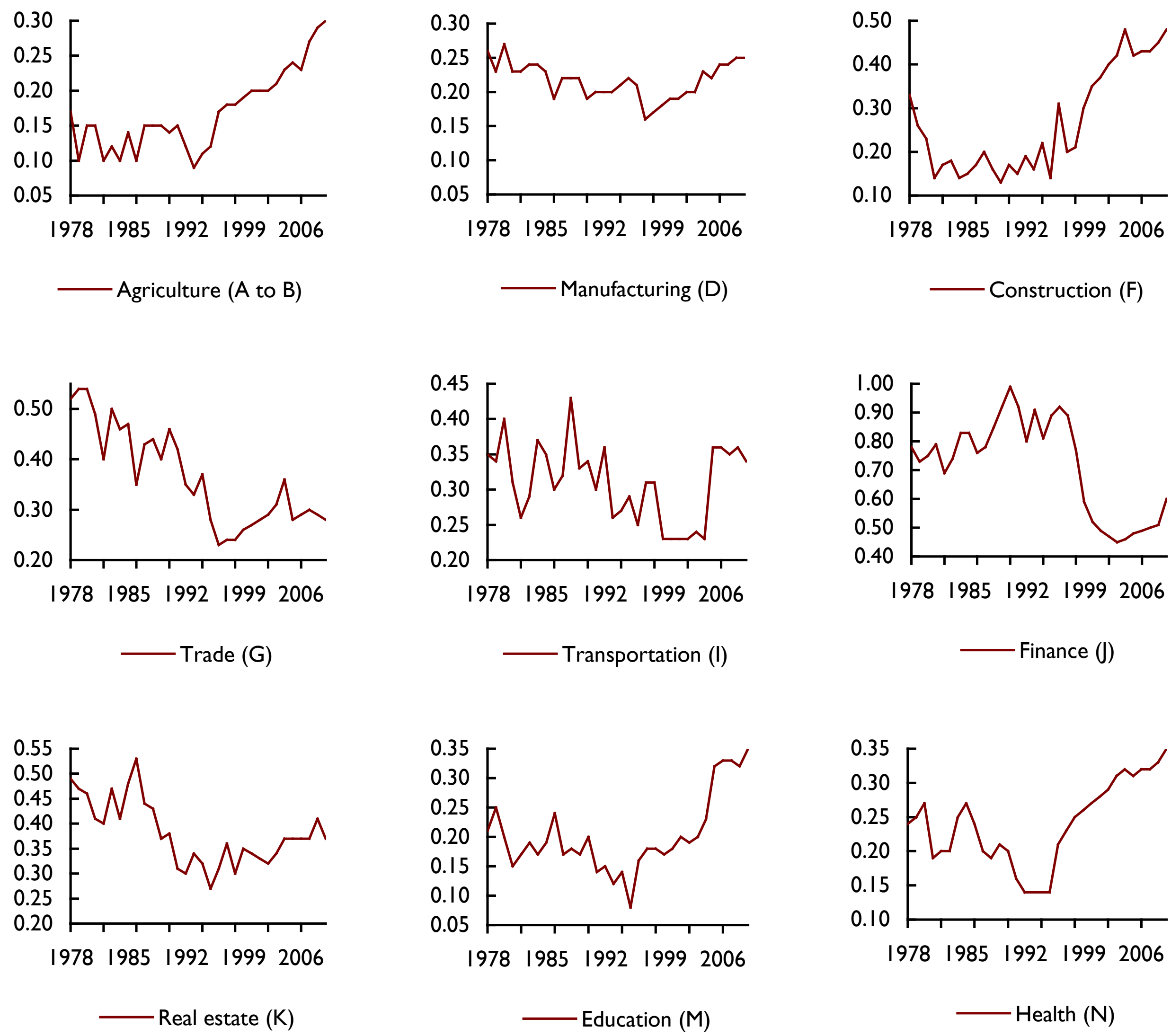
Table 4. Annual growth rates of coefficients of variation across provinces

	AtoB	D	F	G	I	J	K	M	N
RULC									
1978–1995	**–0.02**	**–0.01**	**–0.05**	**–0.04**	**–0.01**	**0.01**	**–0.03**	**–0.06**	**–0.03**
1995–2009	0.07	0.01	0.09	0.00	0.01	**–0.03**	0.02	0.11	0.07
RNLC									
1978–1995	**–0.01**	0.01	**–0.02**	0.00	0.02	0.02	**–0.04**	**–0.04**	**–0.07**
1995–2009	0.02	**–0.02**	0.02	0.01	0.00	**–0.01**	0.02	0.05	0.03
RLP									
1978–1995	**–0.01**	**–0.01**	0.00	0.01	0.01	0.00	**–0.01**	**–0.03**	**–0.06**
1995–2009	0.01	**–0.03**	0.00	**–0.01**	**–0.02**	**–0.01**	**–0.01**	0.04	0.01

Sources: Hsueh and Li (1999) and Chinese Statistics Yearbooks (CSYs), own calculations, average figures over 1978–95 and 1995–2009.

Notes: The bold values represent convergence of coefficients of variation of RULC across provinces. The red bold values are those we discuss in this paper. The industry names are Agriculture (A to B), Manufacturing (D), Construction (F), Trade (G), Transportation (I), Finance (J), Real estate (K), Education (M) and Health (N).

Figure 2. Coefficients of variations of RULC across provinces



Sources: Hsueh and Li (1999), and Chinese Statistics Yearbooks (CSYs), own calculations.

Figure 2 presents trends in the coefficients of variations of RULC for provincial comparisons from 1978 to 2009. What is striking is the degree of heterogeneity in trends across industries. For example, Agriculture and Construction have divergent trends after 1994. Manufacturing has a convergent trend before 1997 then diverges afterwards. Trade exhibits sharp convergence before 1996, then diverges until 2004, and then converges again. In Transportation, Finance, Real Estate, Education and Health industries have a 'W' curve with sharp convergence and divergence firstly, then converge until the end of 1990s, and diverge afterwards.

6. Conclusions

This paper is the first to examine regional and provincial trends in labour costs and productivity across industries, including the service sector, for over three decades. We establish whether there has been divergence or convergence in relative unit labour costs (RULCs) since the late 1970s, which is often identified as the beginning of market reforms in China. We decompose these trends into relative convergence or divergence in nominal labour costs (NLCs) and labour productivity (LP).

This exercise is important for three reasons. First, it helps us understand how regions compete with each other. Second, it draws attention to the heterogeneity in China's economy – both geographical and industrial – which is often ignored in international comparisons at whole economy level. This is particularly important in China's case because regional and provincial disparities in labour costs and productivity are substantial. Third, it provides evidence which gives us insights into just how sustainable China's growth trajectory is likely to be.

If we take all sectors together, figure 1 showed a remarkable improvement in the relative competitive position of the Interior as measured by declining RULCs, such that its level of ULCs is now on a par with the Coastal region, which is renowned as the most dynamic region in terms of productivity. There has been relative stability over the whole period in competitiveness of the West and Coastal regions, with the West having by far the highest levels of labour costs.

When drilling down to a more disaggregated level, it is apparent that there is very substantial heterogeneity with respect to trends in both labour costs and labour productivity across industry and region. But, in general, the Interior, the West and the Northeastern regions improved their competitive position relative to the Coastal region, primarily through lower relative labour costs than through productivity growth, though the latter were apparent in a sub-set of industries. One might argue that convergence of this nature is good news for China, since it implies a more efficient economy beyond the Coastal region, one which should, in the long run, be better equipped to generate the goods and services that the burgeoning middle classes will demand.

There is no literature at present on the extent to which lagging regions or provinces in China benefit from productivity catch-up mechanisms such as foreign direct investment, knowledge and technology transfer, imitation and adaptation of production methods and types of work organisation adopted in more advanced regions/provinces. The challenge in future research is for analysts to begin to examine what lies behind the trends we have identified in this paper.

NOTES

1 They use industry of origin unit value ratios for the benchmark year 1995 to convert Chinese value added into US dollars, and find that value added for Chinese manufacturing was 43 per cent of US value added in 2002, against 12 per cent in 1980. After 1992, there was a rapid and accelerating process of catching up for China, the comparative labour productivity increased from 5.3 per cent of the US level in 1995 to 13.7 per cent in 2002.

2 The four regions are defined geographically as the Coastal region (including Beijing, Tianjin, Hebei, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, and Guangdong*), the Northeastern region (including Heilongjiang, Jilin and Liaoning), the Interior region (including Shanxi, Anhui, Jiangxi, Henan, Hubei and Hunan) and the West region (including Guangxi, Sichuan*, Guizhou, Yunnan, Inner Mongolia, Shaanxi, Gansu, Qinghai, Ningxia and Xinjiang). Because Hainan was separated from Guangdong in 1988, and Chongqing was separated from Sichuan province in 1996, we combine Guangdong with Hainan into Guangdong*, and Sichuan with Chongqing into Sichuan*, to ensure consistency over the entire period of 1978–2009. We do not study Tibet due to data limitations. The geographic graph is shown in Appendix figure A1.

3 The capital/skill-intensive industries have a strong central planning heritage and are still under state monopoly or tight control for national strategic purposes (petroleum, basic chemicals, chemical fibres, and non-ferrous metals) and tax purposes (tobacco) (Chen *et al.*, 2009)

4 The CSYs provide the definition of Staff and workers as persons who signed labour contracts with working units and working units would pay wages, social insurance and housing funds for them. Persons who have their work posts but are temporarily absent from work for reasons of study or on sick, injury or maternal leave and still receive wages from their working units are also included.

5 The twelve sectors are total economy (TOT), primary sector (AtoB), total manufacturing (D), construction (F), wholesale and retail trade (G), transportation, post and telecommunications (I), banking and insurance (J), real estate (K), government agencies, party agencies and social organisation (L), education, culture, arts and television broadcasting (M), health, sports and welfare (N), social service, science research and general technical services (O).

6 The six sectors in 1996 and 1997 are TOT, AtoB, D, F, G and I. The twelve sectors in 1997–2003 are TOT, AtoB, D, E, F, G, I, J, L, M, N and O. The nine sectors in 2004–9 are TOT, AtoB, D, F, G, H, I, J and K.

7 See the technical appendix for details.

8 In the spring of 1992, Deng Xiaoping visited the east region of China (Guangdong and Shanghai). His main idea was 'To Get Rich Is Glorious'. This phrase captures the spirit of his ideas, although he may never have uttered these words.

9 Li (2003) finds that the returns to education are higher in less-developed Gansu province (6 per cent) for an additional year of schooling than the developed Guangdong province (4 per cent) in 1988, because unskilled labour is abundant but educated people are scarce in the less-developed regions. Zhang *et al.* (2005) use fourteen consecutive annual surveys of urban

households conducted by China's National Bureau of Statistics from 1988 through 2001 in six provinces, and also find that in 1988, the returns to education in the west Shaanxi province (6.3 per cent) for an additional year of schooling are more than twice as great as in Beijing (2.8 per cent). This difference declined over time, but the western Sichuan province (12.3 per cent) still has higher returns of education than Beijing (10.5 per cent) in 2001. This suggests that the provinces in the Interior and West regions should take advantage of the cost advantages of the education sector to accumulate human capital for further economic growth and catching-up with the provinces in the Coastal region.

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Technical Appendix

Hsueh and Li (1999) and the Chinese Statistics Yearbooks (CSYs) have the same definitions of Gross value added (GVA), Prices of gross value added (PGVA), Number of staff and workers, Annual hours and average wage of staff and workers. But Hsueh and Li (1999) present more information in detailed industries. Hence, we splice two datasets for the two periods using the overlapping year 1995 and produce a consistent series of variables for the entire period.

For missing values, we recode data using reasonable assumptions as follows:

Gross value added (GVA)

Hsueh and Li (1999) provide 1978–95 data for all industries, while the Chinese Statistics Yearbooks (CSYs) provide 1996–7 data except for industries J, K, M and N, 1998–2003 data for all industries, and 2004–9 data except the M and N industries. The CSYs have 1995–2009 data for the aggregated Tertiary sector, which is composed of the tertiary industries G, I, J, K, M, N and others. We impute the missing values in the J, K, M and N industries in 1995–7 by assuming that the ratios of each missing tertiary industry in 1995–7 are the same as the ratio in 1995. For example:

GVA_{96} in J industry = GVA_{96} in the Tertiary sector * (GVA_{95} in J industry / GVA_{95} in the Tertiary sector)

We impute the missing values in the M and N industries in 2004–9 by assuming that the ratios for each missing tertiary industry are the same as in 2003. For example:

GVA_{04} in M industry = GVA_{04} in the Tertiary sector * (GVA_{03} in M industry / GVA_{03} in the Tertiary sector)

Prices of gross value added (PGVA)

Hsueh and Li (1999) provide 1978–95 data for all industries, and the CSYs provide 1996–7 data except the J, K, M and N industries, 1998–2003 data for all industries, and 2004–9 data except for industries M and N. We imput the missing prices by assuming they are the same as the price of the Tertiary sector for each year. For example:

$PGVA_{96}$ in J industry = $PGVA_{96}$ in K industry = $PGVA_{96}$ in M industry = $PGVA_{96}$ in N industry = $PGVA_{96}$ in the Tertiary sector

Number of staff and workers

For the 'number of staff and workers', the 1978–95 data is from the Hsueh and Li (1999) and the 1996–2008 data from the Chinese Statistics Yearbooks (CSYs). The missing 2009 data need to be imputed with the 'number of employed persons in urban units' at the end of 2008 and 2009, thus:

The number of staff and workers_{09} = the number of staff and workers_{08} * (the number of employed persons in urban units_{09} / the number of employed persons in urban units_{08})

The CSYs record 'number of staff and workers' since 1998 as the number of staff and workers in post, implying that the figures in 1978–1997 include laid-off workers. The 1978–95 data is from Hsueh and Li (1999). Luckily, the CSYs provide two tables of number of staff and workers in 1998, one with the laid-off workers and the another one without the laid-off workers. To make the dataset consistent, we impute the number of staff and workers in 1978–97 by assuming the ratios of on-post workers in 1978–97 are the same as the ratios in 1998. For example:

The imputed number of staff and workers without laid-off workers_{97} = the number of staff and workers with laid-off workers_{97} * (the number of staff and workers without laid-off workers_{98} / the number of staff and workers without laid-off workers_{98})

Annual hours worked of staff and workers

Annual hours worked are not available in Chinese official statistics. So we follow the calculation of Jefferson *et al*. (2000). They derive working hours from labour regulation which changes three times over 1978–2009. Until 1994, a 6-day and 48-hour week is the norm for workers throughout Chinese industry. Then, from 1 March, 1994, staff and workers work 8 hours a day and 44 hours a week, and from 1 May, 1995, they work 8 hours a day and 40 hours a week. Hence, during the period between 1978 and 1993, the standard annual working time is 2400 hours a year (= 48 hours/week*50 weeks). In 1994, the standard annual working time is 2233 hours (=2400*(2/12) + 2200*(10/12)), and in 1995 it is 2067 hours (=2200*(4/12) + 2000*(8/12)). From 1996 the standard annual working time declined to 2000 hours (= 40 hours/week*50 weeks). By assuming that individual annual working hours do not vary across industries, the total working hours are imputed using the number of staff and workers:

Annual hours worked of staff/workers in 1978–1993 = number of staff/workers * 2400 hours per year
Annual hours worked of staff/workers in 1994 = number of staff and workers * 2233 hours per year
Annual hours worked of staff/workers in 1995 = number of staff and workers * 2067 hours per year
Annual hours worked of staff/workers in 1996–2009 = number of staff and workers * 2000 hours per year

Labour compensation

Labour compensation of staff and workers = number of staff and workers * average wage of staff and workers

For the 'average wage of staff and workers', the 1978–95 data is from Hsueh and Li (1999) and the 1996–2008 data from the CSYs. The 2009 data need to be imputed with the 'average wage of employed persons in urban units' at the end of 2008 and 2009:

The average wage of staff and workers_{09} = the average wage of staff and workers $_{08}$ * (the average wage of employed persons in urban units_{09} / the average wage of employed persons in urban units_{08})

Appendix figure A1. Geographic graph of four regions

Note: We do not study Tibet due to data limitation.