Business Cycle Accounting of the BRIC Economies

Chakraborty, Suparna and Otsu, Keisuke

University of San Francisco, University of Kent at Canterbury, UK

30 August 2012

Deconstructing Growth - A Business Cycle Accounting Approach with application to BRICs*

Suparna Chakraborty† University of San Francisco

Keisuke Otsu‡ University of Kent

August 30, 2012

Abstract

What are the economic mechanisms that account for sudden growth spurts? Are these mechanisms similar across episodes? Focusing on the economic resurgence of the BRICs over the last decade, we employ the Business Cycle Accounting methodology developed by Chari, Kehoe and McGrattan (2007) to address these questions. Our results highlight that while efficiency wedges do contribute in a large part to growth, especially in Brazil and Russia, there is an increasing importance of investment wedge especially in the late 2000s, noted in China and India. The results are typically related to the stages of development with Brazil and Russia coming off a crisis to grow in the 2000s, while India and China were already on a stable growth path. Our conclusions are robust to alternative methodological extensions where we allow shocks to the trend component of efficiency as opposed to traditional shocks to the cyclical component, as well as to standard modifications where we allow for investment adjustment costs. Relating improvements in wedges to institutional and financial reforms, we find that financial development and improvements in effective governance in BRICs are consistent with improvements in investment and efficiency wedges that led to growth.

JEL Codes: E32, E33

Keywords: BRIC, business cycle accounting, efficiency, market frictions, trend shocks, investment adjustment costs

*We thank Jagjit Chadha and Miguel Leon-Ledesma for helpful comments and Tetsuaki Takano for research assistance.

†Dept. of Economics, University of San Francisco, 2130 Fulton Street | San Francisco, CA 94117-1080; Tel: +1 415 422-4715; Email: schakraborty2@usfca.edu

‡School of Economics, University of Kent, Canterbury, Kent, CT2 7NP, United Kingdom, Tel: +44 1227-827305; Email: K.Otsu@kent.ac.uk.

At its simplest, a growth economy should be regarded as one that is likely to experience rising productivity, which, together with favorable demographics, points to economic growth that outpaces the global average.....but an economy also needs sufficient size and depth in order to allow investors not only to invest, but also to exit when appropriate. So we opted for the following: any economy outside the so-called developed world that accounts for at least 1% of current global GDP should be defined as a growth economy. ——————Jim O' Neill (M.D. & Head of Global Economic Research at Goldman Sachs)

1 Introduction

In the last decade, the world economic scenario saw some new players- Brazil, Russia, India and China. Jim O'Neill, who coined the term "BRIC" to identify this group, predicted in 2001[1] that, within the next decade, "weight of BRICS, especially China in the world economy would grow". The predictions have proved to be quite accurate. Cumulative share of the BRIC nations in the world gross domestic product (GDP) has grown from about 16% in 2000 to 26% in 2011. In the current world GDP ranking by the International Monetary Fund (IMF), China and India occupy the second and third spots (the top spot still belongs to the United States), while Russia and Brazil take the sixth and the seventh spots (**Table 1**). The trade volume of the group currently takes up 15% of the world trade[2]. Jointly, this group of countries is home to about 40% of the world population.

While recent growth literature has focused on identifying economic factors (primitive shocks) that made this growth possible, a less explored but equally important task is to identify the mechanisms through which these shocks work. Is there a single mechanism at work, or are the mechanisms as varied as the countries themselves? We explore this question in this paper. To this end, we employ a Business Cycle Accounting (BCA) "wedge" methodology formulated by Cole and Ohanian (2004), Mulligan (2005) and Chari, Kehoe and McGrattan (henceforth CKM, 2007) amongst others, to account for the broader role played by the classical economic mechanisms - changes in productivity and changing factor market distortions- in accounting for the economic growth in Brazil, Russia, India and China. Our hope is that the answers we find might provide guidelines for other nations embarking on a similar development path.

[1] "Building Better Global Economic BRICs" - Global Economics Paper No. 66

[2] This was reported by China Daily on April 14, 2011 when the third BRICS summit took place in Sanya, China (the "S" in BRICS stands for South Africa that joined BRIC group in 2010 to form BRICS).

Comparing the remarkable performance of the BRICs in the last decade with that of the earlier decade of the 1990s[3], we identify two distinct mechanisms at work: i) in Brazil and Russia, that emerged from a crisis to experience sharp growth over the last two decades, distortions in the investment market are responsible for the *relative* stagnation during the 1990s while improvement in production efficiency is the single most important factor in accounting for the rapid growth in the 2000s; ii) in contrast, in India and China which were on a relatively stable growth path since the 1990s, while changes in production efficiency account for a large part of the output fluctuation in the 1990s , decline in the investment market distortions are the main source of the rapid growth in the 2000s, particularly accounting for growth in the latter half. What is also interesting is that in none of the economies do labor wedges capturing labor market distortions play any role in accounting for growth in the 2000s. Government consumption wedges capturing changes in government expenditure partially aids China[4] but is ineffective in the other three nations. These findings suggest that whatever policy or institutional changes were responsible for the rapid growth of the 2000s worked primarily by increasing production efficiency or by reducing investment market frictions.

Next, we use the "equivalence results" of BCA analysis to tie the observed accounting results to some indices reflecting institutional and policy changes in a bid to examine which reforms are consistent with observed improvements in production efficiency and decline in investment market distortions. We observe an improvement in credit worthiness as well as access to credit in all the BRIC nations that is consistent with declining investment market frictions and increasing efficiency. In addition, while not all institutional and governance indicators that we examine are consistent with observed improvements in efficiency and investment climate, improvements in political stability to some extent and government effectiveness to a large degree are consistent with observed time series patterns of efficiency and investment wedges. However, the BRICs still have a long distance to go to catch up to the developed West in other areas of governance like control of corruption or rule of law.

Our work can be related to two distinct strands of literature. Literature on BRIC nations have primarily focused on isolating the singular causes of growth. In the context of China, researchers have employed variations of the Real Business Cycle (RBC) model to study the impact of productivity and financial market access (Song, Storesletten and Zilibotti, 2011; Hsu and Zhao, 2009), resource reallocation

[3]We restrict the prior period to the 1990s and not before that since Russian Federation was formed only in the nineties and we want to have the same time period for all nations to make comparison easier.

[4]The role of government consumption wedges turn out to be model specific. While it plays a minimal role in our benchmark, its contribution increases in the alternative models considered.

from agriculture to non-agriculture (Dekle and Vandenbroucke, 2011), World Trade Organization membership (Bajona and Chu, 2010) as well as opening up to world trade (Fujiwara, Otsu and Saito, 2011) as potential causes of growth. Productivity growth in general (Bosworth and Collins, 2008) and service sector productivity in particular (Jones and Sahu, 2009) have been examined for their role in the Indian growth experience as well. Hsieh and Klenow (2009) employ an RBC framework to study a problem of a slightly different nature – how resource misallocation has actually kept China and India from realizing their full potential. Focus on the rise of the other two BRIC nations, Brazil and Russia has been limited. While the creation of the oil stabilization fund in Brazil has been analyzed for its role in stabilizing the economy (Merlevede, Schoors and Aarle, 2007), most studies on Brazil and Russia focus on causes of business cycle downturns (Braguinsky and Myerson, 2007; Merlevede, Schoors and Aarle, 2007; Kanczuk, 2004), and not growth, *per se*. What distinguishes our study from these previous strands of research is that while most of the earlier literature focuses on the drivers of growth (referred to as "primitives" in BCA literature), our focus is on identifying the *channels* through which these external drivers might have worked to successfully accelerate the BRIC economies.

While identification of primary drivers is important, simply adding various exogenous shocks to a classical RBC model just to replicate data moments is not very useful for business cycle analysis (Cooley and Hansen, 1995; CKM 2007) . Equally important to finding the key shocks is the identification of the channels through which these shocks operate – something at the heart of the BCA methodology. The BCA methodology applies a two-pronged approach to deconstruct economic or business cycle movements that is particularly suited for our analysis. In step one, various economic frictions are modelled as "wedges" that distort equilibrium conditions in a standard RBC model and keep an economy from achieving the first best outcome[5]. The original BCA methodology contains efficiency, government consumption, investment and labor wedges that are estimated using the relevant equilibrium conditions and the data of output, consumption, investment and labor. In step two, the estimated wedges are fed back into the model to ascertain their marginal contributions in generating the observed economic outcome. These wedges are the "channels" through which external forces like institutional or policy changes affect the economy.

Most existing BCA studies have employed the framework to study economic fluctuations, in particular crisis episodes (CKM, 2007; Kersting, 2008; Chakraborty,

[5]Efficiency wedges appear as time-varying productivity. Labor and investment wedges appear as "taxes" on labor and capital income, where "taxes" represent not just actual tax rates but broadly the distortions affecting the labor and investment decisions. Government consumption wedge appears as government expenditure (in a closed economy setup, net exports are also added to government expenditure) .

2009; Kobayashi and Inaba, 2006). Once again, majority of these studies focus on a single country. In terms of conducting a comparative multi-country analysis employing the BCA methodology, our paper is closer to Cho and Doblas-Madrid (2012), Otsu (2010a) as well as Lama (2011). While, overwhelmingly, BCA approach to date has been employed to dissect a crisis, theoretically there is no reason why the BCA procedure cannot be used to deconstruct growth as we do here, though such use of BCA in literature is limited. Some studies that have applied the BCA procedure to the BRIC nations include Graminho (2006) for Brazil during $1980-2000$; Chakraborty (2010) for India during $1982-2002$; Ljungwall and Gao (2009) for India during $1981-2006$ and China during $1978-2006$; He, Chang and Shi (2009) for China during $1978-2006$ and Lahiri and Yi (2009) who compared the growth experience of two of the Indian states - Maharashtra and West Bengal[6].

Two factors distinguish our study from the existing literature. First, data shows that growth in the BRIC nations in the last decade really took off in the second half, a period that none of the existing studies look at. In our study, in order to focus on the rapid growth period during the 2000s, we use data covering the $1990-2009$ period. The time dimension turns out to be extremely important as there is a trend break around 2005, when investment wedge emerges as major growth source in India and China outweighing the contribution of efficiency wedges, a finding that earlier studies miss due to the truncation of their sample, thus erroneously concluding that investment market channel has limited importance in accounting for growth[7]. Second, unlike the previous studies that mostly focus on isolated growth episodes, our attempt here is to bring all four BRIC nations on the same platform instead of studying them as isolated cases, to analyze to what extent are growth spurts alike. Our study enables us to directly compare the accounting results of BRIC nations with each other since our data are consistent across countries in terms of the time frame, the 1990s and 2000s, and the measurement units[8]. Such a comparison will

[6]Graminho (2006) applies BCA to Brazil over the $1980-2000$ period and finds that efficiency wedges are important in accounting for the stagnation during the 1980s while in the 1990s, it is the labor wedge. Chakraborty (2010) shows that efficiency wedges are important in accounting for the growth in India over the $1982-2002$ period. Ljungwall and Gao (2009) studies the fluctuations in China and India during $1978-2006$ and $1978-2006$ respectively and find that efficiency wedges are the main driving force of business cycles in both economies during this period. He, Chang and Shi (2009) finds that efficiency wedges are the most important wedge in accounting for business cycles in the Chinese economy over the $1978-2006$ period. To the best of our knowledge, our paper is the first to conduct a BCA analysis for the Russian economy.

[7]Lu (2012) who studies the East Asian growth miracle also stresses the importance of time dimension in BCA studies to interpret roles of wedges.

[8]We primarily use the Penn World Tables data base which reports variables in PPP adjusted 2005 international dollars. Since we use the same data source for all countries, we can avoid discrepancies in the definition of variables and price deflators. Furthermore, we treat expenditures on consumer durables as investment following standard BCA tradition while existing studies tend

aide future researchers in ascertaining if a single growth model will be applicable to a wide variety of cases, or there would be need for multiple models to study different growth clusters, with the added advantage of having the identified mechanisms aid in designing detailed models with primitives that would be successful in quantitatively replicating the growth facts.

Applying the BCA procedure to the BRIC nations, while we do detect variations in the ability of different wedges to account for growth suggesting different mechanisms at work, a common pattern does emerge once we come to the $2000s$, particularly the second half. In Brazil, deteriorations in investment and labor wedges account for the stagnation in output during the $1990s$ while improvements in the efficiency wedge is the main source of the rapid growth during the $2000s$[9]. In Russia, the deterioration in investment wedges account for the recession in the $1990s$. However, the rapid output growth in the $2000s$ is the handiwork of improvements in efficiency wedge, similar to the Brazilian experience. In India and China, efficiency wedges alone can account for the output fluctuation almost perfectly up to the mid-$2000s$. However, the rapid growth that was observed during the second half of the $2000s$ in India is mainly due to the improvement in investment wedges while the deterioration in efficiency wedges during this latter half actually had a dampening effect on output. In China, while improvements in efficiency wedges marginally contribute to the rapid growth during the later $2000s$, the major force that led to growth, as is the case in India, is a reduction in investment market frictions that show up in the BCA model as an improvement in the investment wedges. Government consumption wedges are not important in accounting for changes in output, which is a common result to those in existing BCA studies[10]. However, as we discuss in this paper, this does not mean that government policies are unimportant as they can manifest themselves as shocks to other wedges. While most existing BCA literature find little impact of investment on output during sharp recession periods, we find that investment wedges are important in accounting for the decade long recession in Russia and the medium to long run growth in India and China through gradual capital accumulation.

To test the robustness of our findings, we conduct two checks. The first check is to allow for shocks to the growth trend (as opposed to level) and analyze the outcome comparing it with the results of the standard BCA application. In the traditional BCA approach, following in the lines of traditional RBC models, the shocks to productivity are designed as shocks to its "level"- assuming a stable growth trend.

to include them in consumption.

[9]The only instance when labor wedges seem to play a role is to explain the stagnation of the Brazilian economy in the $1990s$, and it never emerges as an important mechanism to explain later growth, either in Brazil or elsewhere in the other three nations.

[10]Since net exports are included in government consumption, changes in the trade balance in not important in accounting for output changes.

However, as argued by Aguiar and Gopinath (2007), emerging markets are characterized by substantial volatility to the trend growth itself, rendering the assumption of a stable trend somewhat unrealistic. Potentially, these alternative formulation of shocks can have non-trivial consequences on the BCA accounting outcome as the efficiency wedges are modeled after TFP and investment wedges depend on the future expectations of TFP. The modification indeed affects the measurement of efficiency and investment wedges, however, we essentially find that the roles played by them are similar to those in the benchmark case. Secondly, we add capital adjustment costs assuming that it is technologically costly to convert output into installed capital. As argued by Christiano and Davis (2006), the model simulations with investment wedges is sensitive to inclusion or non-inclusion of investment adjustment costs and can non-trivially affect the conclusions. When we allow investment adjustment costs in our benchmark model, we find that our primary conclusions do not change.

So far, the existing literature and our first part of the study helps us isolate the broader channels of growth. What is also of interest is given the myriad institutional and policy changes in the BRIC nations in the last decade, can we tie these institutional and economic reforms with our accounting results? In the second part of our study, we use the "equivalence results" of the BCA theory to map the wedges from our accounting results to some suggested drivers of growth, primarily focusing on institutional and financial market reforms. We find that over the two decades of financial liberalization, all of the BRIC nations improved their credit rating, ease of access to credit by businesses as well as costs associated with capital access, with particular development since 2000. Increased availability of capital encourages investment, which lowers the expected return on investment due to diminishing marginal product of capital. Therefore, the gap between the intertemporal marginal rate of substitution and the expected return on capital would shrink, and result in an improvement in the investment wedge. Tying the improved investment climate with commonly used institutional and governance indicators, we find that while not all the indicators examined are consistent with the time series features of particular wedges, improvements to some degree in political stability (particularly in Russia) since mid-2000s and to a much larger extent in government effectiveness noticed in all BRIC nations are consistent with observed improvements in production efficiency and declines in investment market distortions.

Our findings are related to the growing literature on financial liberalization and growth. As documented in Kose, Prasad, Rogoff and Wei (2009), while existing empirical literature has found little evidence of a positive relationship between capital account liberalization and growth, equity market liberalizations do tend to have significant growth effects. Furthermore, the effect of financial liberalization on growth can be divided into the direct effect through investment growth and the indirect effect

through productivity growth. Gourinchas and Jeanne (2006) state that investigating the latter effect is far more important than considering the former. In theory, credit inflows can affect production efficiency by technology spillover (Findlay 1978), improvement in investment quality (Obstfeld 1994) and improvement in quality of governance (Rajan and Zingales 2003). Empirical literature on the relationship between financial liberalization and productivity growth seems to support this linkage in emerging economies[11]. Tying our accounting findings with that of the equivalence study, our results imply that if financial liberalization during the 2000*s* was the main driver of the rapid growth in the BRIC nations, they must have operated through the efficiency channel in Brazil and Russia, and through the investment channel in India and China, opening up the interesting possibility of essentially the same set of policies acting through different channels to affect different nations.

The remainder of the paper is organized as follows. In section 2 we review the growth experiences in the BRIC nations. In section 3 we describe the business cycle accounting model. In section 4 we explain the business cycle accounting procedure and present the results. In section 5 we provide sensitivity analysis results. In section 6 we discuss the underlying factors that can explain the evolution of wedges. Section 7 concludes the paper.

2 Historical Evolution of Growth - One BRIC at a time

While Brazil, Russia, India and China share impressive growth experiences in the 2000*s* leading economists to club them into one group, each has its unique history and time path to present growth. To better understand the "BRIC" patterns of growth, we start by looking deeper into their economic performance and policies that led to their economic resurgence, one country at a time.

In **Table 2**, we summarize the growth rates in GDP (marked column (1)) as well as GDP per capita (marked column (2)) in the BRIC nations since the 1960*s* and compare them with that of United States and OECD countries[12]. A few interesting

[11] Borensztein, De Gregorio and Lee (1998) find that FDI improves productivity if the host country has a sufficient stock of human capital. Bekaert, Harvey and Lundblad (2011) find that financial liberalization leads to growth through an increase in total factor productivity rather than capital stock accumulation. Alfaro, Kalemli-Ozcan and Sayek (2009) find that FDI leads to a significant increase in TFP in countries with well-developed financial markets. Mitton (2006) finds that firm-level measures of stock market liberalization leads to an improvement in firms'efficiency. Kose, Prasad and Terrones (2009) find that FDI and portfolio equity liabilities boost TFP growth while external debt actually reduces it.

[12] The exception is Russia for which World Bank or Penn World Tables (PWT) data is non-existent before the 1990*s* when the present Russian Federation came into existence in 1991.

facts emerge. While Brazil and India started the 1960s closer to their US and OECD counterparts, China faltered[13]. During the 1970s, while China played catch-up and Brazil continued its economic growth, Indian growth started to decline. The tables turned in the 1980s with Brazilian growth slowing as India made a come-back. China continued on its path of economic growth. The 1990s saw a deep divide in each country's experience. Brazilian growth remained slow and Russia (for which we have data since early 1990s) was on a decline. India and China continued growing at a same pace as the eighties. Finally, during the last decade of 2000s, all BRIC nations made a remarkable come-back, with China leading the pack with double-digit economic growth.

<Table 2 about here>

In our study, we focus on the last two decades. **Figure 1** presents the linearly detrended macroeconomic variables in Brazil, China, India and Russia for our sample period of $1990-2009$[14]. "Output (Y)" includes GDP and the imputed service flow from consumer durables. It is decomposed into "Consumption (C)" that consists of household consumption of non-durables and services (where the imputed service flow from consumer durables are included) and "Investment (X)" that includes gross domestic capital formation and household expenditures on consumer durables while the residual is defined as "Government Consumption (G)" so that $Y = C + X + G$[15]. "Labor (L)" represents total hours worked which consists of total employment and hours worked per workers. All variables are divided by the adult population[16]. Output, consumption and investment are linearly detrended by the average per adult output growth rate over the $1990-2009$ period setting 1990 at the trend level[17]. The data is primarily collected from the Penn World Tables edition 7.0 and its extension made by Duncan Foley[18]. The detailed sources and data construction methods are listed in the data appendix.

<Figure 1 about here>

[13]Growth of per capita GDP was lower in Brazil in comparison to the developed economies, but aggregate GDP growth was slightly higher due to the increase in population.

[14]The variables are plotted as log deviations from their 1990 value (1992 in case of Russia).

[15]Therefore, G includes government purchases of goods and services as well as net exports. The inclusion of net exports in government consumption follows the tradition of a closed economy BCA model (Chari, Kehoe and McGrattan (2007)).

[16]We use total population for China due to data availability.

[17]Therefore, the output series will start at the trend level in 1990 and end at the trend level in 2009.

[18]Source: https://sites.google.com/a/newschool.edu/duncan-foley-homepage/home/EPWT

2.1 Brazil

Brazil has experienced turbulent periods of boom and bust since the early $20th$ century. During the late $1930s$ well into the $1940s$, external shocks like the Great Depression and World War II as well as internal focus on protectionism isolated Brazilian economy from much of the developed world. However, the proactive role of the Alliance for Progress and the Inter-American Development Bank ensured the growth of trade and a period of economic recovery during the later $1950s$ and $1960s$. The government and the private sector borrowed heavily from abroad to generate this high economic growth, which was proved unsustainable as the accumulated foreign debt caused a debt crisis when oil prices increased in both 1974 and 1979 and the interest rates rose in 1980 (Cardoso and Teles, 2010)[19]. The $1980s$ came to be known as the lost decade of Brazil illustrated with low economic growth accompanied by a decline in productivity (Graminho 2006). As the government tried to finance the fiscal imbalances through seigniorage, it created high inflation over the decade.

In the early $1990s$, in order to turn around the stagnant economy and reduce government debt, the government moved towards privatization of inefficient state-owned-enterprises, which increased productivity (Schmitz and Teixeira, 2008), and output started to recover in 1993. Following the East Asian growth model, financial liberalization took place as prohibition on FDI into certain sectors was lifted and bureaucratic obstacles were reduced ('de Paula 2007). In order to contain the inflation, the government instituted the "Real Plan" in 1994 pegging its currency to the US dollar. However, the fixed exchange rate regime collapsed in 1999. After the currency crisis, as a condition on the $41 billion loan received in 1998, the government accepted the IMF Article $VIII$ obligations which precludes members from imposing foreign exchange restrictions. To further improve the investment climate, "2000 Fiscal Responsibility Act" was put in place, imposing severe penalties on administrators who exceed budget limits. Federal debt was restructured, eliminating currency-indexed bonds, reducing inflation-indexed debt and increasing fixed-rate proportion. These measures upgraded Brazil's investment grade status (BNY Mellon). While net inflows of FDI slowed down after the crisis, their percentage to GDP averaged 2.7% during the $2000s$, almost doubling over the previous decades.

A virtuous cycle of BRIC emergence helped Brazil during the $2000s$ as growing China increased its demand for commodities, of which Brazil had a comparative advantage. As reported by ISI Emerging Markets "Brazil's exports to China grew by a Compound Annual Growth Rate (CAGR) of 46.9% annually while imports from China grew by a CAGR of 37.8% annually from 1999 to 2010. The growth rates are high compared to its aggregate exports and imports which saw a CAGR of 12.7% and 11.5% respectively. By 2009, growth in Brazil-China trade catapulted China

[19]While average annual growth rate of exports of goods and services stood at 10.5% during the later $1970s$ and early $1980s$, the growth rate dropped to 5.3% in mid to late $1980s$ and early $1990s$.

as Brazil's largest trade partner, overtaking the United States. China presently accounts for 14.7% of Brazil's total trade flows". Overall average annual growth rate of exports increased to 7.13% almost catching up with the pre-1980s numbers.

2.2 Russia

The political disintegration of the erstwhile Soviet Block in 1991 and formation of the Russian Federation makes Russia a unique country for our analysis. Since the economic and political movements of the earlier Soviet Union are too vast to concisely summarize in our paper, we begin our discussion by an analysis of the newly found Russian Federation. After the break-up of the Soviet Union in 1991, the world saw a transition of yet another socialistic economy to a more market based economic structure. President Boris Yelstin, who took the reins of the new country, vowed radical, market-oriented reforms, referred to as a "shock therapy" for its abrupt nature.

Russia's initial experience with market economy did not go smoothly as hyperinflation coupled with unsustainable government budget deficits prevailed during the 1990s. In addition, political unrest due to the emergence of oligarchs who now came to control the vast earlier state-owned enterprises bred discontent while the war in Chechnya did not help matters. The failure of exchange rate-based stabilization in 1995 and disappointing macroeconomic performance eventually led to the Russian Financial Crisis in 1998 (Merlevede, Schoors and Van Aarle 2009). When the Asian Financial Crisis led to a decline in the demand for crude oil (one of Russia's biggest exports), the economy was further hit and growth numbers turned negative. Annual growth rate of exports fell to the tune of 1.8%, while aggregate GDP growth fell by 4.8% (per capita GDP fell by 4.9%), requiring a $22.6 billion bailout from IMF and World Bank. To stabilize Russia, leaders of the $G-8$ also agreed to explore ways to write-off the old Soviet debt that Russia had assumed. Government of Russia also took pro-active steps to curtail the effects of a sudden decline in oil prices- a hard lesson learned during the East Asian Crisis- with the set-up of the Oil Stabilization Fund of Russian Federation in 2004.

After surviving the political turmoil of early 1990s and the 1998 crisis, Russia too instituted strong reforms outlined in two resolutions: (a) Measures Planned by the Government of the Russian Federation and the Central Bank of the Russian Federation to Stabilize Socioeconomic Conditions in Russia (Nov 16, 1998) and (b) Letter of Development Policy for the Third Structural Adjustment Loan ($July$ 19, 1999). While the first plan was more consistent with Russian system of state control, the second plan was formulated after consultations with international financial institutions. In a move towards privatization, 15 companies were identified to be privatized by early 2000s. The government also lifted the January 1999 moratorium on insolvency claims of companies, encouraging private investment. However, on the trade

front, government re-introduced export tariffs and quotas in a bid to reign in Russian over-dependence on international trade.

President Vladimir Putin, who succeeded Boris Yelstin, spearheaded a concerted effort to revamp infrastructure and increase production, both industrial and agrarian. The Oil Stabilization Fund played a crucial role in maintaining the fiscal surplus through the oil revenue. According to 'de Paula (2007), "some flexibility in the fiscal policy was introduced in 2006 with the creation of an Investment Fund in the federal budget. The aim of the fund is to finance infrastructure investment and innovation related projects in joint public-private partnerships". The recent 2008 global crisis hit Russia comparatively harder than its BRIC peers due to Russian dependence on crude oil and commodities trade for its economy[20]. However, the recovery was also swift as output growth turned positive in mid-2009, and by 2010, GDP growth rate reached 4.0%, after a negative growth of -7.8% in 2009 (GDP per capita growth rates are comparable).

2.3 India

After emerging from its colonial era in 1947, India embarked on a socialistic development path by successive formulation of the "Five Year Plans" of economic growth. The central tenets of the growth plans were an emphasis on the public sector, strong move towards licensing and import restrictions and agrarian development. After a relative slowdown in the $1970s$, reform measures in India started in the $1980s$, with a move towards de-licensing and infrastructural investment accompanied by a pro-business attitude (Bosworth and Collins, 2008 ; Rodrik and Subramanian, 2005).

India faced a serious crisis in 1991 during the first gulf war and was at the verge of defaulting on its domestic loans reaching a crisis point in terms of foreign exchange reserves. India asked for a $1.8 billion bailout loan from the IMF, which in return demanded reforms. The reforms since then, initiated by the then Finance Minister (current Prime Minister) of India, Dr. Manmohan Singh, was a complete reversal of the earlier era of socialistic growth. Following the East Asian model, India initiated a two-pronged reform approach: major macroeconomic management reforms and structural and sector specific economic reforms. India started widespread privatization and financial liberalization, de-licensing the "License Raj" and encouraging foreign direct investment in many major industries. Subsidies to agriculture (particularly fertilizer and food) was reduced to narrow the budget deficit. Taxes were lowered, export subsidies were abolished and import tariffs were reduced. India initiated the formation of special economic zones, with a gradual liberalizing of organized manufacturing sector. India continues its liberalization effort initiating a move to-

[20]The ruble fell 35% against the dollar from the onset of the crisis to January 2009, as the foreign exchange reserves fell by $210 billion.

wards foreign direct investment in retail sector (which is still to pass muster with all political parties) and setting up of agro-economic zones to encourage agricultural exports.

These moves catapulted India in the last decade into the elite group of top ten nations, primarily aided by a strong service sector and information technology industry. According to Bollard, Klenow and Sharma (2012), manufacturing TFP growth in India saw substantial speedup at over 5 percentage points per year during $1993-2007$ as opposed to the previous decade. While its economic transition was threatened during the current global crisis, India weathered the 2008 crisis well, as seems to be true of most BRIC nations. While average output growth did slow down to 7.0% during $2008-2009$, since then it has recovered to 9.0% , with a per capita GDP growth of 7.4%[21]. For the first time in decades, average annual growth rate of Indian exports crossed the double digit mark, reaching 14.4% during the last decade, as opposed to an average increase of 7.6% during the previous decades. The same trend was evident in inflows of foreign direct investment that totaled 1.6% of GDP during the 2000*s* as compared to an average of 0.15% of GDP during the previous decade[22].

2.4 China

China is one of the classical growth stories of development economics. Primarily formed as a communist country after the 1949 revolution by its patriarch, Mao Zedong, China yielded minimal economic power till the late 1970*s* and was known as a slow growth, tightly reined communist nation. During this period, the Chinese trade policy was focused on import substitution. The government protected the steel and machinery industries from foreign competition by controlling imports and foreign exchange transactions. Trade was limited to the Central Foreign Trade Ministry and its twelve trade corporations. These trade corporations exported agricultural and primary goods in order to finance the controlled imports of industrial equipment.

In late 1970*s* Deng Xiaoping introduced the *Gaige Kaifang* (Reform and Opening-up) policy. Since then the Government of China has pursued aggressively a pro-reform, market-oriented growth agenda, making China one of the most successful examples of state led capitalism today. 1978 marked the year when China started allowing foreign direct investment into "special economic zones" that became conduits for growth while dramatically increasing the number of firms that are allowed to engage in foreign trade. Since 1984, economic reforms picked up in earnest with a decline in government intervention, coupled with increases in decentralization and

[21] As reported by the World Development Indicators, at its worst in 2008, output growth declined to 4.9% before recovering.

[22] The growth in exports started in the 1990*s* in response to privatization and liberalization and exports grew by almost 12% in the mid to late 1990*s*. However, inflows of FDI did not pick up till the 2000*s*.

privatization of the state sector. Gradually through the 1980s, China started adopting an export-oriented growth model.

While the 1990s was a period of political volatility and the East Asian Crisis that affected Chinese growth to some extent, China continued on the reform process. "In 1996 China accepted the IMF Article VII, that resulted in the liberalization of foreign exchange controls related to current account transactions" ('de Paula 2007). China entered a new era in December 2001 by joining the World Trade Organization (WTO) and agreeing to a host of globalization measures. Import quotas were removed and tariffs were gradually reduced. Production and exports shifted toward labor-intensive goods while imports of consumer durables and investment goods increased dramatically. Institutional changes were also apparent since the Chinese Communist Party's meeting in 2003 that encouraged protection of property rights and massive public investment in infrastructure development that would further encourage foreign investment. The liberalization policies were successful and by 2005, domestic private sector accounted for more than 50% of Chinese GDP. The efforts have borne fruit and during the first half of the last decade, the average growth rate of GDP has averaged roughly 10%- the highest in the world.

The Chinese government, as its BRIC counterparts, was also well equipped to deal with the global crisis. China announced a stimulus package to the tune of RMB 4 trillion (approximately US $586 billion) that would be used for public investment. In addition, China is turning from export dependence to home market to keep up growth. Given China's success in stemming the crisis from affecting its economy, World Bank revised its estimate of Chinese growth forecast from 6.5% to 7.3% in 2010. China was successful in attaining an actual GDP growth rate of 10.4% (per capita GDP growth rate of 9.83% - World Bank estimates). For its part, exports still played a very important role in Chinese growth with average annual exports growing by almost 20% during the 2000s, ably aided by an equally robust growth in FDI inflows that reached almost 4% of Chinese GDP, and was the largest amongst the BRIC nations[23].

3 The Model

In this section, we describe a standard, closed economy BCA model with a representative household, firm and a government. The representative firm hires labor

[23] Chinese dominance in terms of its export growth and ability to lure FDI preceded that of India and in terms of timing was closer to Brazil's resurgence. Both China and Brazil saw an uptick in export growth and inflows of FDI in the 1990s. It took another decade for India to follow in the same path. As for Russia, we only have numbers for the last two decades, and it certainly seems to be the case that the Russian resurgence also happened in the last decade, following a time-line similar to India.

and capital from the household to produce output using a constant returns to scale technology, which is affected by time-varying production efficiency. The representative household decides on consumption, labor and investment each period. The household faces a budget constraint where its expenditure is limited by its labor and capital income. In addition, as the ultimate owner of the firm, the consumer receives the profits. The consumer pays distortionary taxes on labor and capital income to the government. In the BCA framework, these distortionary taxes represent broader economic distortions that affect the factor markets. The government uses its tax revenue to finance government consumption. Any remaining amount is transferred back to the households as lump sum transfers. Exogenous shocks to production efficiency, government consumption and distortionary tax rates are revealed in the beginning of each period and affect economic incentives.

3.1 Firm

The representative firm borrows capital K_t and labor L_t from the household in order to produce output Y_t according to a Cobb-Douglas production function:

$$Y_t = K_t^{\theta}(A_t L_t)^{1-\theta},$$

where A_t denotes exogenous production efficiency. Labor is defined as total hours worked (product of employment and hours worked per worker).

Productivity can be divided into a trend component Γ_t and a cyclical component γ_t, i.e. $A_t = \gamma_t \Gamma_t$, where we assume a constant growth rate in the trend component:

$$\frac{\Gamma_t}{\Gamma_{t-1}} = a.$$

Labor grows over time due to growth in population N_t where we assume a constant growth rate in population:

$$\frac{N_t}{N_{t-1}} = n.$$

Output and capital grows over time due to both population and productivity growth. All variables are detrended by the growth trends in order to define a stationary problem:

$$y_t = \frac{Y_t}{N_t \Gamma_t}, k_t = \frac{K_t}{N_t \Gamma_t}, l_t = \frac{L_t}{N_t}, \gamma_t = \frac{A_t}{\Gamma_t}.$$

Firms maximize profits π_t:

$$\max \pi_t = y_t - r_t k_t - w_t l_t \tag{1}$$

where r_t and w_t denote the real return on capital and the real wage respectively. The detrended production function can be rewritten as

$$y_t = k_t^{\theta}(\gamma_t l_t)^{1-\theta}. \tag{2}$$

For the benchmark model, we follow CKM (2007) and define the efficiency wedges as

$$\omega_{e,t} = \gamma_t. \tag{3}$$

3.2 The Household and Government

The representative household gains utility from consumption c_t and leisure $1 - l_t$ where we assume a log-linear utility function for our analysis:

$$u(c_t, 1 - l_t) = \Psi \ln c_t + (1 - \Psi) \ln(1 - l_t).$$

Total hours available is normalized to one[24].

The household maximizes its expected lifetime utility:

$$\max E_t \sum_t \beta^t \left[u(c_t, 1 - l_t)\right],$$

where β is the subjective discount factor. The household budget constraint is

$$(1 - \tau_{l,t})\, w_t l_t + (1 - \tau_{k,t})\, r_t k_t + \pi_t + \tau_t = c_t + x_t, \tag{4}$$

where τ_{lt} and τ_{kt} are distortionary labor and capital income taxes while τ_t is the lump-sum government transfers. Investment x_t is defined by the capital accumulation law:

$$nak_{t+1} = x_t + (1 - \delta)k_t. \tag{5}$$

The government collects distortionary taxes from the household in order to finance government consumption while the remainder is transferred to the household in a lump-sum fashion. Therefore, the government budget constraint is

$$g_t + \tau_t = \tau_{lt} w_t l_t + \tau_{kt} r_t k_t. \tag{6}$$

[24] We assume the maximum work week as $14 \times 7 = 98$ and normalize hours worked per worker h_t as

$$h_t = \frac{\text{average work week}}{98}$$

which is bounded between 0 and 1. Therefore, the detrended labor

$$l_t = \frac{\text{average work week}}{98} \frac{\text{total employment}}{\text{total population}}$$

is also bounded between 0 and 1.

Combining the government budget constraint (6) and the household budget constraint (4) making use of the definition of profits (1), we obtain the resource constraint

$$y_t = c_t + x_t + g_t. \tag{7}$$

Labor and investment wedges $\{\omega_{l,t}, \omega_{k,t}\}$ are defined as:

$$\omega_{l,t} = 1 - \tau_{lt}$$

$$\omega_{k,t} = 1 - \tau_{kt}$$

Technically speaking, $\omega_{l,t}$ drives a wedge between the consumption-leisure marginal rate of substitution and the marginal product of labor while $\omega_{k,t}$ drives a wedge between the intertemporal marginal rate of substitution and the marginal return on investment. For convenience, we define government consumption wedges as the deviation of government purchases from its steady state level:

$$\omega_{g,t} = \frac{g_t}{g}. \tag{8}$$

3.3 Wedges

We define the efficiency, government consumption, investment and labor wedges $\omega_t = (\omega_{e,t}, \omega_{g,t}, \omega_{k,t}, \omega_{l,t})'$ such that an increase in each wedge should lead to an increase in output. Increases in efficiency wedge directly increases production and stimulates factor demand by increasing the marginal product of inputs. On the other hand, increases in labor and investment wedges stimulate output by encouraging the household to increase supply of factor inputs through an increase in the marginal income associated with them. Therefore we refer to increases in efficiency, investment and labor wedges as "improvements". High government consumption wedges should also increase output due to the increase in aggregate demand. However, we do not call an increase in government consumption as an "improvement" since this is associated with the crowding-out of household consumption and investment, which leads to household welfare deterioration.

Following CKM (2007), we assume that the wedges are exogenous and follow a stochastic process. Defining a vector of log-linearized wedges, $\widetilde{\omega}_t = (\widetilde{\omega_{e,t}}, \widetilde{\omega_{g,t}}, \widetilde{\omega_{k,t}}, \widetilde{\omega_{l,t}})'$ where $\widetilde{\omega}_t = \ln \omega_t - \ln \omega$, we assume that the wedges follow a first order VAR process:

$$\begin{aligned} \widetilde{\omega}_t &= P\widetilde{\omega_{t-1}} + \varepsilon_t \\ &\quad \varepsilon_t \sim N(0, V) \end{aligned} \tag{9}$$

where $\varepsilon_t = (\varepsilon_{e,t}, \varepsilon_{g,t}, \varepsilon_{k,t}, \varepsilon_{l,t})'$ are innovations to the wedges. Following CKM (2007) we allow spill-over of wedges through P and contemporaneous correlations of innovations in V.

3.4 Equilibrium

The competitive equilibrium is given by a price vector $\{r_t, w_t\}$ and an allocation of quantities $\{y_t, c_t, x_t, l_t, k_t, z_t, g_t, \tau_t, \omega_{e,t}, \omega_{g,t}, \omega_{k,t}, \omega_{l,t}\}$ such that: (a) the household maximizes utility given $\{r_t, w_t, \tau_t, \omega_{k,t}, \omega_{l,t}\}$; (b) the firm maximizes profits given $\{r_t, w_t, z_t\}$; (c) the government budget constraint (6) and the resource constraint (7) holds; and (d) the wedges follow the stochastic process (9).

The competitive equilibrium is characterized by a set of first-order conditions given by: (a) the Euler equation (first order condition with respect to capital) equalizing present discounted value of marginal utility of future consumption to its marginal cost:

$$\frac{1}{c_t} = \frac{\beta}{na} E_t \left[\frac{1}{c_{t+1}} \left(\omega_{k,t+1} \theta \frac{y_{t+1}}{k_{t+1}} + 1 - \delta \right) \right], \tag{10}$$

(b) the first-order equation with respect to labor equating marginal rate of substitution between consumption and leisure to the marginal product of labor:

$$\frac{1-\Psi}{\Psi} \frac{c_t}{1-l_t} = \omega_{l,t}(1-\theta)\frac{y_t}{l_t}, \tag{11}$$

(c) the resource constraint (7) given (8), (d) the capital law of motion (5), and (e) the production function (2) given (3).

4 Quantitative Analysis

4.1 Parameter Values

We now discuss the implementation of the BCA method. For each country, we first obtain the parameters of the model through usual calibration techniques. For calibration purposes, we assume that there are no distortions in the steady state so that $\omega = \{1, 1, 1, 1\}$. Capital share θ is calibrated to match the income share of capital derived from data. The productivity growth trend a is computed as the average growth rate of per capita output. Population growth trend n is directly computed from adult population data[25]. We construct the total capital stock series as the sum of net fixed capital stock and household durables in order to compute the total annual depreciation rate δ. The subjective discount factor β is calibrated using the steady state capital Euler equation (10) to match steady state capital-output ratio given the productivity growth trend a, population growth n, capital share θ and the depreciation rate δ. The preference weight Ψ is calibrated using the steady state labor first order condition (11) given the capital share θ, to match the steady

[25] We used total population for China since we do not have adult population data.

state consumption-output ratio and the steady state labor. The values are listed in **Table 3**.

Once we have the calibrated parameters, the next step is to estimate the stochastic process of the wedges (9) for which we employ the Bayesian techniques. Structural estimation is necessary for the business cycle accounting procedure since investment wedges are defined in the intertemporal equilibrium condition (10) that depends on expectations about the future state of the economy which is not directly observable. The estimated parameters are the lag parameters in P, the standard deviation of the errors, and the cross-correlations between the errors in V. Since there are 4 exogenous variables, we use the time series data of output, consumption, investment and labor as observable variables. The Bayesian priors and the parameters of the vector and the point estimates of these parameters are listed in the appendix.

4.2 Simulation

The first step in the simulation process is to solve the model for linear decision rules for linearized endogenous variables $\widetilde{k_{t+1}}$ and $\widetilde{q}_t = (\widetilde{y}_t, \widetilde{c}_t, \widetilde{x}_t, \widetilde{l}_t)'$:

$$\begin{aligned} \widetilde{k_{t+1}} &= A\widetilde{k}_t + B\widetilde{\omega}_t, \\ \widetilde{q}_t &= C\widetilde{k}_t + D\widetilde{\omega}_t. \end{aligned}$$

Note that the entire series of $\widetilde{k}_t$ can be directly generated from the equation (assuming an initial value $\widetilde{k}_0 = 0$):

$$\widetilde{k_{t+1}} = \frac{x}{nak}\widetilde{x}_t + \frac{1-\delta}{na}\widetilde{k}_t,$$

and the observed series of investment. Then the wedges can be computed as

$$\widetilde{\omega}_t = D^{-1}\left(\widetilde{q}_t - C\widetilde{k}_t\right).$$

Once the wedges are computed, they are used for simulation. We compute the endogenous reaction of selected variables to the changes in a chosen wedge $\widetilde{\omega_{j,t}}$ by plugging its time series into the linear decision rules of endogenous variables:

$$\begin{aligned} \widetilde{k_{t+1}^{\omega_j}} &= A\widetilde{k_t^{\omega_j}} + B\widetilde{\omega_{j,t}}, \\ \widetilde{q_t^{\omega_j}} &= C\widetilde{k_t^{\omega_j}} + D\widetilde{\omega_{j,t}}. \end{aligned}$$

By definition, plugging in all wedges into the model will exactly reproduce the observable data:

$$\widetilde{q}_t^{\omega} = C\widetilde{k}_t + D\widetilde{\omega}_t = C\widetilde{k}_t + DD^{-1}\left(\widetilde{q}_t - C\widetilde{k}_t\right) = \widetilde{q}_t.$$

Therefore, we can easily decompose the effects of each wedges on the observables due to linearity of the decision rules:

$$\widetilde{q_t^{\omega_e}} + \widetilde{q_t^{\omega_g}} + \widetilde{q_t^{\omega_k}} + \widetilde{q_t^{\omega_l}} = \widetilde{q_t^{\omega}}.$$

4.3 Results

Figure 2 plots the time paths of output and computed wedges for each country. In reporting our results, we show the log deviations of the variables with respect to the steady state (where the first year of data availability is taken as the steady state).

<Figure 2 about here>

For the most part, we do not find much commonality in wedge movements in the four nations. For example, while efficiency wedges have been above the trend in Brazil and Russia throughout the entire period, it has been below trend for most of the time in India and China. In Brazil, there was a temporary slow down in the growth of efficiency during $1997 - 2003$. In Russia, it took off in 1998 and kept growing at an enormous rate, suggesting a positive impact of efficiency on growth. In India, while efficiency wedges temporarily improved in 2005, since then it has suddenly collapsed. In China, while efficiency wedges deteriorated during the $1995 - 2001$ period, it shows a gradually improvement ever since. It is hard to find common patterns in government consumption wedges and labor wedges as well. In Brazil, India and China, while government consumption wedges have declined during the $1990s$, since then in Brazil and China they recovered rapidly and gone above the trend level, but not so in India. In Russia, government consumption wedges increase dramatically in the late 1990s, a foil to the other three nations, and gradually return to the trend level. As for the labor wedges, in Brazil, they deteriorate during the 1990s and remain below trend throughout the 2000s while in Russia, they are rising throughout the entire period. In India, they are relatively stagnant during the 1990s and slightly deteriorate throughout the 2000s. In China, the performance is worse and they deteriorate throughout the entire period.

Perhaps the common thread amongst all four nations is the evolution of investment wedges in the last decade. Investment wedges have been below the trend in Brazil and Russia and above trend in India and China throughout the entire period. However, they show improvements in all countries during the $2000s$, a common factor in an otherwise diverse experience of the BRICs. This suggests that improvements in investment market frictions potentially aided the resurgence of BRICs since the mid-$2000s$.

<Table 4 about here>

In **Table 4**, we report the standard deviation of wedges with respect to output and the correlations of wedges with output for various leads and lags[26] to ascertain various comovements. A positive correlation indicates a positive association between a given wedge and the observed economic outcome, and vice versa. Efficiency wedges, for the most part, are positively correlated with output in all countries except India, where the correlation turns negative contemporaneously and for the leads +1 and +2. Investment wedges also show a positive correlation with output in all countries, indicating a positive contribution of investment wedge to output. Labor wedges are positively correlated with output in Brazil and Russia, but negatively correlated in India. In China, while labor wedges become positively correlated for contemporaneous periods and leads +1, +2, the magnitude remains low. As for government consumption wedges, while they are positively correlated with output in Brazil (with the exception of the leads +1, +2), in India, and China, they are negatively correlated with output in Russia for all leads and lags.

Given our wedges, we next feed them one by one in our benchmark model and simulate output. **Table 5** presents the decomposition of the impact of each wedges on output and the investment to output ratio. We define a contribution indicator of each wedge ω_j on an endogenous variable v as:

$$\begin{aligned} cont_j &= corr(\widetilde{v_t^{\omega_j}}, \widetilde{v_t}) * \frac{std(\widetilde{v_t^{\omega_j}})}{std(\widetilde{v_t})} \\ &= \frac{cov(\widetilde{v_t^{\omega_j}}, \widetilde{v_t})}{var(\widetilde{v_t})}. \end{aligned}$$

Due to linearity,

$$\sum_j cont_j = 1,$$

as described in Otsu (2010*b*). Therefore, we can consider the value of the indicator as the contribution of each wedge to the fluctuation of the variable of interest.

4.3.1 Output

First, we provide the simulation results for output in **Table 5a**. Since the economies grew particularly rapidly since 2000, we also specifically discuss the period 2000 to 2009. **Figure 3a** plots the simulation results of each wedge on output for each country.

[26] As defined in CKM (2007), a "$k-th$ lag" is the correlation between the $t-k$ th value of the variable of interest with output at period t.

<Table 5a about here>
<Figure 3a about here>

In Brazil, efficiency, investment and labor wedges all contribute significantly to the output fluctuation over the entire period with efficiency, investment and labor wedges explaining 29.3%, 36.8%, and 49.0% of output respectively. Efficiency wedges are particularly significant in accounting for growth in the 2000*s* with a contribution of 93.2%, while the contributions of investment and labor wedges, though positive, are much lower. As the figure depicts, the model with only efficiency wedges while capturing the short run output fluctuation quite well, predicts a much higher output level throughout the entire period than witnessed in the data. By 2009, the model predicts output to be 13 percentage points above the trend. The growth in output that would have materialized with efficiency wedges alone are tempered by government consumption wedge. Investment and labor wedges for their part account for the sub-par economic performance of the 1990*s*, but they do marginally contribute to the recovery of the 2000*s*.

In Russia, during the overall sample period, efficiency wedges have a contribution higher than 100% while all other wedges have negative contributions. According to the figure, this is because the model with only efficiency wedges predicts the economy to recover much faster from the recession in the 1990*s* and grow much faster in the 2000*s* than it actually did. On the other hand, investment wedges predict a decline in output throughout the entire period. Therefore, investment wedges contribute to the downturn in 1990*s* while efficiency wedges aid Russia in recuperating much of the output loss in the 1990*s* to get back on the development track.

In India, investment wedges contribute the most to the fluctuation of output with an overall contribution of 87.4% over the entire period. This is mainly because of the 2000*s* where the contribution of investment wedge rises to 105.4%. Interestingly, during the 1990*s* the contribution of efficiency wedge at 79.6% was much higher than that of the investment wedge at 26.5%. When we run the model with only efficiency wedge, it performs quite well in predicting the fluctuation in output until 2005 . However, it fails to predict the rapid growth after 2005. This is where the investment wedge comes in and investment wedges alone do a better job of accounting for the rapid acceleration of Indian growth during the 2000*s* well to the sample end (refer to Figure 6 panel A and C for a clearer depiction of this phenomenon).

China presents a similar picture with efficiency wedges being the most important force in accounting for the output movement with a contribution of 72.6%. However, during the 2000*s* the contribution of investment wedges, 72.0%, becomes larger than that of efficiency wedges, 41.5%. According to the figure, the model with only efficiency wedges can almost perfectly reproduce the output fluctuations until 2004. However, mirroring the experience of India, it fails to account for the further rapid growth after 2004. On the other hand, investment wedges have significant impacts

on output fluctuation throughout the entire 2000s till the end of the sample period, much like in India.

The unique experience of each country nevertheless show some common patterns, particularly in the last decade. While Brazilian and Russian growth was facilitated primarily by improvements in production efficiency (Brazil also benefitting to some extent from decline in investment market frictions), India and China grew primarily as a result of decline in investment market frictions, particularly in the later half of the 2000s, though, to some extent, China also benefitted from efficiency improvements as it did not experience the sudden loss of productive efficiency as India did since 2005. The contribution of labor and government consumption wedges to growth is negligible in all four nations.

4.3.2 Investment-Output Ratio

Next, to investigate the contribution of wedges to capital accumulation, which we conjecture is an important avenue of growth, we simulate the investment-output ratio in each country[27]. The time series of the simulations are plotted in **Figure 3b** while the decompositions are presented in **Table 5b.**

<Table 5b about here>
<Figure 3b about here>

The results suggest that investment-output ratio in Brazil is primarily explained by the investment wedge whose contribution is 69.4%. Government wedges are also important, particularly during the 2000s with a contribution of 31.7%. Efficiency and labor wedges (during the 2000s) do not seem to play important roles in accounting for the investment-output ratio.

In Russia, investment and government wedges account for most of the fluctuation in the investment-output ratio over the entire period with contributions of 67.6% and 48.5% respectively. In fact, the contributions of both wedges increase to 158.1% and 78.5% in the 2000s respectively. The dramatic increase in government consumption wedges during the 1990s crowds out private investment, which leads to a decline in the overall investment-output ratio. Interestingly, while government wedges are still above trend during the 2000s, the investment-output ratio gradually increases since the cumulative decline in capital stock from the past decade hinders output growth, explaining the positive coefficient.

The decline in the investment-output ratio in response to the continuously growing efficiency wedge during the 2000s might seem puzzling at first (contribution

[27]Since ours is a closed economy model, the investment-output ratio is equivalent to the savings rate.

indicator of efficiency wedge being -1.05) as at the first glance, an increase in efficiency wedge tends to increase investment more than output, resulting in an *increase* in investment-output ratio. The reason for this negative association is that as the efficiency wedge continuously improves over the decade, capital stock continuously accumulates due to increased investment which facilitates an increase in output while suppressing investment due to diminishing marginal product of capital.

In India, investment wedges account for 80.2% of the fluctuation of the investment-output ratio over the entire period. In the 1990s, however, investment wedges have the lowest contribution amongst all wedges at 14.7%. The other wedges, namely, efficiency, labor and government wedges, account for 37.4%, 26.5% and 21.3% of the investment-output ratio fluctuation respectively. The importance of investment wedges emerges in the 2000s when the rise in investment-output ratio can be attributed solely to the investment wedges, mirroring the previous section's result of the increasing importance of investment wedges in accounting for Indian economic growth in the 2000s.

A similar picture emerges for China where the investment-output ratio is mainly accounted for by investment wedges whose contribution is 69.8% over the entire period and 112.9% during the 2000s. The deterioration of labor wedge depresses output (*the denominator*) throughout the entire period, resulting in a growth in the investment-output ratio itself, which explains the significant 27.7% contribution of labor wedges to its overall changes. As for the government consumption wedges, during the 1990s the contribution is significant at 31.2% but it turns negative during the 2000s. On the other hand, the contribution of the efficiency wedge on the investment-output ratio is marginal.

The improvement of investment wedges is clearly a major contributor to the growth in investment-output ratio during the 2000s in all countries. In particular, the importance of investment wedges in accounting for the output in India and China in the 2000s and its continued importance in accounting for the investment-output ratio suggests that the investment wedges during the 2000s in India and China led to their rapid growth through capital accumulation.

One possible policy initiative widely adopted in the BRIC nations was financial liberalization that might have resulted in a decline in investment-financing frictions, encouraging both foreign and domestic investment and might be a candidate in explaining the increased importance of investment wedges in the 2000s.

5 Sensitivity Analysis

5.1 Test 1: Efficiency Wedges as Productivity Growth

In CKM (2007) efficiency wedges are defined as temporary shocks to productivity. However, shocks to productivity might be permanent rather than temporary. Recall that in **Figure 1**, detrended output had fallen during the 1990s and then rapidly surged during the 2000s in all BRICs nations. In order to illustrate these medium term cycles better, it might be more appropriate to model efficiency wedges as shocks to the trend component of productivity rather than the cyclical component as suggested by Aguiar and Gopinath (2007). In this section, we alter the definition of efficiency wedges and compare the results to those in the benchmark model.

5.1.1 Model II

The only alteration we make from the benchmark model is the definition of efficiency wedges (3). First, we consider efficiency wedges as the growth in productivity between the previous period $(t-1)$ and the current period (t):

$$\omega_{e,t} = \frac{\gamma_t}{\gamma_{t-1}}.$$

We call this setting as model II. In model II, the realization of current productivity will define the growth of productivity and agents will anticipate the growth to gradually return to its trend rate according to (9). Therefore, the income effect caused by efficiency wedges should be stronger than that in the benchmark model.

5.1.2 Model III

An alternative way to model efficiency wedges as productivity growth is to assume that current efficiency wedges lead to a growth in productivity between the current period (t) and future period $(t+1)$:

$$\omega_{e,t} = \frac{\gamma_{t+1}}{\gamma_t}.$$

We denote this setting as model III. In this model, the agents know the one-period-ahead productivity level when they make decisions on current choice variables. Also, as in model II, the agents will consider efficiency wedges as permanent shocks.

5.1.3 Simulation

Model II and Model III are estimated and simulated in a similar fashion as the prototype model. One important modification is that since we are defining efficiency

wedges as shocks to the growth of productivity, we have to define the productivity level as an endogenous state variable. The linear decision rules of endogenous variables are:

$$\begin{aligned}\widetilde{s_{t+1}} &= A\widetilde{s_t} + B\widetilde{\omega}_t, \\ \widetilde{q}_t &= C\widetilde{s_t} + D\widetilde{\omega}_t,\end{aligned}$$

where we define the endogenous state variables $\widetilde{s_t} = \left(\widetilde{k_t}, \widetilde{A_t}\right)$. The entire series of $\widetilde{k_t}$ and $\widetilde{A_t}$ can be directly computed from

$$\begin{aligned}\widetilde{k_{t+1}} &= \frac{x}{nak}\widetilde{x_t} + \frac{1-\delta}{na}\widetilde{k_t}, \\ \widetilde{A_t} &= \frac{\widetilde{y_t}}{1-\theta} - \frac{\theta\widetilde{k_t}}{1-\theta} - \widetilde{l_t},\end{aligned}$$

assuming initial values $\widetilde{k_0} = 0$, $\widetilde{A_0} = 0$. Then the wedges can be computed as

$$\widetilde{\omega}_t = D^{-1}\left(\widetilde{q}_t - C\widetilde{s_t}\right).$$

Simulation is carried out in the same fashion as the benchmark model:

$$\begin{aligned}\widetilde{s_{t+1}^{\omega_j}} &= A\widetilde{s_t^{\omega_j}} + B\widetilde{\omega_{j,t}}, \\ \widetilde{q_t^{\omega_j}} &= C\widetilde{s_t^{\omega_j}} + D\widetilde{\omega_{j,t}}.\end{aligned}$$

5.1.4 Results

Since the growth shocks introduced in this section affects the expectations of the future, not only efficiency wedges but also investment wedges, that depend on expectations about future, are affected. The labor and government wedges are exactly the same as in the benchmark model. Figure 4 plots the efficiency and investment wedges in the benchmark model, Model II and Model III.

<Figure 4 about here>

By definition, efficiency wedges are equivalent to productivity in the benchmark model; productivity growth in model II; and future productivity growth in model III. Therefore, when the efficiency wedges in model II are positive, those in the benchmark model are growing. The efficiency wedges in model III are simply those in model II shifted one period ahead.

Since investment wedges are defined in the capital Euler equation (10) which is an expectational equation, when the definition of efficiency wedges changes the

expectation structure will also change. That is, in the benchmark model agents anticipate productivity to return to its steady state level whereas in model II and III agents believe that there is a shift in the steady state level. Therefore, the expected value of the variables in the right hand side will be affected and hence the investment wedges. The extent to which this affects the investment wedges depends not only on the steady state parameter values but also the estimated parameters in the stochastic process. Thus, there is no systematic relationship between the three different investment wedges series.

As in the benchmark model, we decompose the effects of the wedges under models II and III on output in **Table 6** and plot the simulation results in **Figure 5**.

<Table 6 about here>
<Figure 5 about here>

The simulation results under the alternative models turn out to be similar to those in the benchmark model for the most part. In Brazil, under both the alternative specifications, investment and labor wedges account for the stagnation in the 1990s while efficiency wedges are important in accounting for the rapid growth in the 2000s. In Russia, investment wedges cause the downturn during the 1990s while efficiency wedges salvage the economy in the 2000s. In India, efficiency wedges account for the output fluctuations up to the mid-2000s while investment wedges are important in accounting for the rapid growth in the later 2000s. In China, efficiency wedges play a very important role in accounting for output fluctuations in both decades. The contribution of investment wedges during the 2000s for model II and III, 35.8% and 20.6% respectively, are considerably lower compared to that in the benchmark model, 72.0%. Government consumption wedges have higher contribution than in the benchmark model to compensate for this. Nonetheless, investment wedges still play an important role in the rapid growth during the later 2000s.

It is important to note that the quantitative impact of the efficiency wedges are quite similar across the three models. Intuitively speaking, changing the definition of efficiency wedges does not change the realizations of productivity A_t but it affects the expectations on future productivity. The result that the effects of efficiency wedges on output are robust across the three models indicates that the effects of the realization of productivity is more important than the expectations they generate.

5.2 Test 2: Benchmark Model with Investment Adjustment Costs

In the benchmark model capital stock is accumulated following the capital law of motion (5). However, as CKM (2007) argues, investment adjustment costs can reflect

costs in converting output to capital in a detailed model, or financial frictions can manifest themselves as investment adjustment costs in a prototype RBC model. How does this modification affect our results?

The only equation that changes is the capital accumulation equation:

$$nak_{t+1} = x_t + (1-\delta)k_t - \Phi\left(\frac{x_t}{k_t}\right)k_t$$

where

$$\Phi\left(\frac{x_t}{k_t}\right) = \frac{\phi}{2}\left(\frac{x_t}{k_t} - \lambda\right)^2.$$

The constant λ is set at $\lambda = na - (1-\delta)$ so that the adjustment cost is equal to zero in the steady state. The parameter ϕ is calibrated to match the marginal Tobin's Q to one:

$$\frac{d\log q}{d\log\left(x/k\right)} = 1,$$

where q is the effective price of investment relative to consumption:

$$q = \frac{1}{1-\Phi'}.$$

This leads to $\phi = \frac{k}{x}$.

We plot the simulations of output under each of the four wedges in **Figure 6** (we also plot the results of the benchmark model for comparison). Output decompositions are presented in **Table 7.**

<Table 7 about here>
<Figure 6 about here>

Our primary results do not change. Efficiency, investment and labor wedges still account for most of output fluctuations in Brazil with efficiency wedges accounting almost wholly for the growth in $2000s$. Efficiency wedge, once again, emerges as the most important factor in accounting for Russian resurgence in $2000s$ while investment wedge can account for the output drop in the $1990s$. In India, while efficiency wedge itself still predicts a decline in output as opposed to data, investment wedge once again accounts for a major portion of output increase. However, in the model with investment adjustment costs, government consumption wedge as well as labor wedge account for a greater magnitude of output fluctuation in India as compared to the benchmark. In China, once again, output fluctuations are accounted for mostly by efficiency and investment wedges. Government consumption wedge plays a role in the $2000s$, but it is smaller than the role played by efficiency and particularly investment wedge.

The diagram on Panel A and C also makes it clearer that in India and China, while efficiency wedges perform quite well till about mid-2000s in accounting for output, it fails to account for the sharp increase in output thereafter and this is where investment wedge comes in handy. This pattern does not change even with a greater contribution of other wedges in the 2000s as compared to benchmark.

6 Decomposition, Wedges and Policies

While the experience of each BRIC nation has been unique, the underlying commonality seems to be the importance of efficiency or investment wedge (and sometimes both) as two of the most important channels accounting for output fluctuations in the BRIC nations. In this section, we take a look at some policy changes and institutional reforms that could potentially shed further light on movement of these wedges. Our discussion mainly focuses on the 2000s due to data availability. Analytically, it works for us since it is the 2000s when we witness a sharp turnaround in growth of the BRIC nations.

<Figure 7a about here>

The wedge diagnostics point to an important role of financial liberalization and to some extent, institutional reforms, along some particular dimensions.

As discussed earlier in section 2, the BRIC nations undertook widespread reforms to encourage financial liberalization and opening up of the markets. In order to quantify the effects of these reforms, we focus on the evolution of credit flows in the BRIC nations. **Figure 7A** plots the private credit share in GDP and the net FDI inflow to GDP ratio. All BRIC nations saw an increase in the flow of credit to private sector, where China outpaced the other nations[28]. FDI inflow also increased in all countries since the early 1990s when official steps to encourage liberalization were taken[29]. The growing trend in FDI continued till 2008 when there was a decline as a result of the global downturn. Interestingly, domestic credit to the private sector did not show any such decline, even though the BRIC nations suffered to some extent during the recent global crisis. Overall, financial liberalization seems to have boosted the flow of capital towards and within the BRIC nations.

Financial liberalization and the resulting development in the financial market is consistent with the observed improvement in investment wedges in our model. When investment wedges are low, the expected return on investment is high relative to the

[28] The hike in Brazilian domestic credit in the early 1990s corresponds to the hyperinflation period caused by seniorage.

[29] FDI inflow to Brazil and China as a share of GDP fell slightly in the early 2000s, but quickly bounced back.

intertemporal marginal rate of substitution as shown in (10). This can be caused by investment market distortions such as interest rate controls or capital controls which hampers the efficient flow of capital from the households to the firms. Financial liberalization increases the availability of capital by removing these distortions and enables firms to seize profitable investment opportunities. As a result, investment rises which brings down the expected return on investment due to diminishing marginal product of capital. Therefore, the gap between the intertemporal marginal rate of substitution and the expected return on capital should shrink.

<Figure 7B about here>

Increased capital flows suggest an improvement in credit worthiness borne out by the financial market indicators (**Figure 7B**) provided by the IMD World Competitiveness Yearbook (henceforth, WCY). The first panel shows the credit rating of the BRIC countries on a scale of 0 to 100 as assessed by the Institutional Investor magazine. All BRIC countries have shown a significant improvement in credit ratings during the 2000*s*. Russia showed the largest improvement from roughly 20 in 1999, right after the currency crisis, to above 70 in 2008, right before the recent crisis. The second panel plots an index of the ease of credit availability for businesses (IMD WCY executive survey index from 0 to 10). The figure shows that credit availability increased in all countries during the 2000*s* until the global crisis later in the decade. The increase in credit availability is consistent with the growth in private credit and FDI shown above. The third panel plots an index of how encouraging the cost of capital is for business development (IMD WCY executive survey). This further indicates that the increase in domestic capital was driven by an increase in the affordability of capital rather than the demand for it. These figures suggest that financial liberalization in the BRIC nations led to capital inflows fueled by rising credit ratings and increased the availability of capital for domestic businesses.

Financial development is also consistent with observed production efficiency. On one hand, an increase in production efficiency should increase capital inflows as higher (perceived) efficiency leads to higher expected growth and lower probabilities of default, which is reflected in the rise in the country credit ratings. On the other hand, an increase in capital inflows can affect production efficiency through various channels. First, as discussed in Findlay (1978), an increase in FDI inflows could generate productivity spillovers through the import of managerial and organizational capital from foreign firms with superior efficiency. This effect could be particularly important in the banking sector as it improves the domestic resource allocation and thus the economy-wide efficiency. Next, as shown in Obstfeld (1994), greater diversification of income risk can lead to production specialization and the pursuit of riskier investment projects with high expected return. Finally, as discussed in Rajan and

Zingales (2003), international financial integration will impose discipline on macroeconomic policies as transparency and good governance is essential to attract foreign capital and avoid capital flight.

An interesting question would be why financial development might have impacted growth in efficiency in Brazil and Russia to a greater extent than in India and China, which particularly becomes apparent after 2004[30]. One important difference in these economies is the development stage that they were at when the reforms commenced. Brazil and Russia were coming out of a stagnation in early 2000*s* while India and China were already on the stable growth track since the 1990*s*[31]. Therefore, it might be the case that in Brazil and Russia, the impact of financial development on growth is much stronger - a case of catching up - as compared to India and China which were already on a stable development track[32]. India, in particular, is an aberration where efficiency suddenly collapsed after mid-2000*s* and we conjecture that the positive impact of financial development was overwhelmed by other factors that caused the efficiency collapse.

While so far we have discussed the impact of financial liberalization on the domestic financial market, we now track some institutional and governance indicators that provide the necessary framework for successful financial development and growth. Empirical data on these indicators range from cross-sectional (cross country) measures like legal origin, judicial efficiency as included in the LLSV index (La Porta, Lopez-de-Silanes, Shleifer and Vishny 1997, 1998, 1999) to time-series measures as provided by the World Bank. Since our focus is to trace the development of BRIC policies *over time*, we focus on six time-series measures considered as conducive to economic development (definitions and explanations are in Appendix D)

<Figure 7c about here>

Figure 7c plots the six indices (Voice & Accountability, Political Stability & Non Violence, Government Effectiveness, Regulatory Quality, Rule of Law, Control of Corruption) over time for each BRIC country and compare them to US standards where the measure ranges from -2.5 (weak) to $+2.5$ (strong).

While it is clear that not all the indices show positive comovements with the time series of the estimated wedges, the two exceptions would be government effectiveness

[30]Bollard, Klenow and Sharma (2012) also find that FDI liberalization had little effect on the TFP growth in Indian manufacturing firms during the $1993-2007$ period.

[31]The growth trends in Brazil, Russia, India and China Shown in Table 3 are 1.0%, 1.8%, 4.1% and 7.4% respectively.

[32]Gente, Nourry and Leon-Ledesma (2012) show that financial liberalization can have positive or negative impacts on productivity growth depending on the national savings level in an endogenous growth setting with human capital accumulation.

and political stability to some extent. In terms of government effectiveness, BRIC nations registered considerable improvement particularly since early $2000s$, though still below the developed world. The indices in almost all instances move from negative to positive with almost doubling of the index value between 1996 and 2009. Even in case of Russia that scores the lowest, a 30% improvement in score is witnessed during the last decade. This translates to a $10 - rank$ climb in percentile ranks for all nations, with the exception of India that just climbs two spots.

In terms of political stability, which is related to non violence and absence of terrorism, we witness a decline in $1990s$ till about mid-$2000s$ when there is a turn-around. Brazil, the top scorer earns a score of -0.1 (still in negatives though an improvement from -0.35 in the 1990s). The most improvement was noticed in Russia that came out of the turbulent political transition of the $1990s$ to a more favorable domestic political climate. India is the only nation which seems to lag behind, not surprisingly due to its continued vulnerability to terrorism. In US too, political stability score has reduced from 0.9 to 0.5 over the last two decades as a fallout of the events of September $11, 2001$. Rule of law in BRICS also improved, though India, the top performer in terms of rule of law saw some deterioration during mid $2000s$. Regulatory control and control of corruption remains two areas where BRIC nations have to improve, though we do see some improvement over the last decade. The exceptions are Brazil - the leader in regulatory control - that saw a dip in $2000s$ and Russia, which shows an increase in corruption and ranks below the other BRIC nations. The final measure - voice and accountability - is related to political affiliation and countries with more democratically inclined political systems - India and Brazil - outperform Russia and China.

7 Conclusion

The growth of the BRIC nations - Brazil, Russia, India and China, has garnered much attention in the last decade. Though studies exist discussing some potential forces that aided growth, mostly focusing on countries in isolation, literature is sparse regarding a cohesive study of all BRIC nations to compare unique as well as common forces that accounted for the economic development.

In this paper, we use the Business Cycle Accounting methodology to examine the mechanisms of growth in all BRIC nations- avenues through which policy changes and reforms might have worked to spur growth. Our hope was to identify some unique as well as common forces underlying economic development of this block. Our results, which are robust to methodological alternations, as well as model modifications, show that while each nations' experience was unique, Brazil and Russia, nations that came off a crisis period in the 1990s to register impressive growth in the 2000s, benefitted mostly from improved efficiency. India and China, both on a relatively stable growth

path since 1990s, saw a growth spurt in 2000s that can be largely accounted for by improvements in investment wedges, particularly in the latter half.

Relating the observed improvement in efficiency and investment wedges to policy measures, we study financial liberalization and institutional and governance reforms in the BRIC nations using time series evidence. Both private sector access to domestic credit as well as net FDI inflows show improvements since early 2000s. Accordingly, financial indicators such as the country credit rating, credit availability, and capital affordability have improved, reflecting the domestic financial development which explains the recent improvement in investment wedges in all countries. One remaining question is why in Brazil and Russia financial development was accompanied by an improvement in efficiency while in India and China it was not. While we document that it relates to the development stage- Brazil and Russia coming out of a crisis to play catch-up and India and China already on a stable path-we leave further analysis of this topic for future research. According to institutional and governance indicators, BRIC nations have a long way to go before they catch up with the more developed Western nations. BRIC countries have taken steps in this direction by signing an accord to boost credit for trade transactions and authorizing establishment of a multilateral bank for funding projects in the developing world in the latest BRIC summit on March 29, 2012 with hopes of further such initiatives in the 2013 annual meeting of the BRICS.

References

[1] Aguiar, M. and G. Gopinath (2007), "Emerging Market Business Cycles: The Cycle is the Trend," *Journal of Political Economy*, Vol. 115 (1), pages 69–102.

[2] Alfaro, L., S. Kalemli-Ozcan and S. Sayek (2009), "FDI, productivity and financial development," *The World Economy*, Vol. 32 (1), pages 111–135.

[3] Bajona, C. and T. Chu (2010), "Reforming State-Owned Enterprises in China: Effects of WTO Accession," *Review of Economic Dynamics*, Vol. 13 (4), pages 800–823.

[4] Beekart, G., C. R. Harvey and C. Lundblad (2011), "Financial Openness and Productivity," *World Development*, Vol. 39 (1), pages 1-19.

[5] Bollard, A., P. Klenow and G. Sharma (2012), "India's Mysterious Manufacturing Miracle," *Review of Economic Dynamics*, forthcoming.

[6] Bosworth, B. and S. Collins (2008), "Accounting for growth: comparing China and India," *Journal of Economic Perspectives*, Vol. 22(1), pages 45–66.

[7] Braguinsky, S. and R. Myerson (2007), "A Macroeconomic Model of Russian Transition- The Role of Oligarchic Property Rights," *Economics of Transition*, Vol. 15(1), pages 77–107.

[8] Cardoso, E. and V. Teles (2010), "A Brief History of Brazil's Growth," Escola de Economia de Sao Paolo Working Paper.

[9] Chakraborty, S. (2009), "The boom and the bust of the Japanese economy: A quantitative look at the period 1980–2000," *Japan and the World Economy*, Vol. 21 (1), pages 116–131.

[10] Chakraborty, S. (2010), "Indian Economic Growth: Lessons for the Emerging Economies," in A.U. Santos-Paulino and G. Wan eds., *The Rise of China and India: Impacts, Prospects and Implications*, Palgrave Macmillan.

[11] Chari, V.V., E.R. McGrattan and P.J. Kehoe (2005), "Sudden Stops and Output Drops," *American Economic Review*, Vol. 95(2), pages 381–387.

[12] Chari, V.V., E.R. McGrattan and P.J. Kehoe (2007), "Business Cycle Accounting," *Econometrica*, Vol. 75 (3), pages 781–836.

[13] China Daily Newspaper Issue on April 14, 2011: http://www.chinadaily.com.cn/photo/2011-04/14/content_12324955.htm.

[14] Christiano, L.J. and J. Davis (2006), "Two Flaws in Business Cycle Accounting," Federal Reserve Bank of Cleveland Working Paper.

[15] Cho, D. and A. Doblas-Madrid (2012), "Business Cycle Accounting for International Financial Crises: The Link between Banks and the Investment Wedge," Michigan State University Working Paper.

[16] Cole, H. and L. Ohanian (2004), "New Deal Policies and the Persistence of the Great Depression: A General Equilibrium Analysis," *Journal of Political Economy*, Vol. 112 (4), pages 779–816.

[17] Cooley T. F. and G. D. Hansen (1995), "Money and the business cycle," in T. F. Cooley eds., *Frontiers of Business Cycle Research*, Princeton University Press.

[18] de Paula, L.F.R.(2007), "Financial Liberalization, Exchange Rate Regime and Economic Performance in BRICs Countries," Proceedings of the 35th Brazilian Economics Meeting, 98.

[19] Dekle, R. and G. Vandenbroucke (2012), "A Quantitative Analysis of China's Structural Transformation," *Journal of Economic Dynamics and Control*, Vol. 36 (1), pages 119–135.

[20] Findlay, R. (1978), "Relative backwardness, direct foreign investment, and the transfer of technology: a simple dynamic model," *Quarterly Journal of Economics*, Vol. 92 (1), pages 1–16.

[21] Fujiwara, I., K. Otsu and M. Saito (2010), "The Global Impact of Chinese Growth," University of Kent, School of Economics Discussion Paper Series, KDPE-1115.

[22] Gente, K., C. Nourry and M. Leon-Ledesma (2012), "External Constraints and Endogenous Growth: Why didn't Some Countries Benefit from Capital Inflows?," mimeo, University of Kent.

[23] Goldman Sachs Economic Research Group (2001), "Building Better Global Economic BRICs," Global Economics Paper No. 66, http://www.goldmansachs.com/our-thinking/brics/brics-reports-pdfs/build-better-brics.pdf.

[24] Gourinchas, P. and O. Jeanne (2006), "The elusive gains from international financial integration," *Review of Economic Studies*, Vol. 73 (3), pages 715–741.

[25] Graminho, F. (2006), "A neoclassical analysis of the Brazilian lost-decades," Bank of Brazil Working Paper Series 123.

[26] He, Q., T.T. Chong and K. Shi (2009), "What accounts for Chinese Business Cycle?," *China Economic Review*, Vol. 20 (4), pages 650–661.

[27] Hsieh, C. and P. J. Klenow (2009), "Misallocation and Manufacturing TFP in China and India," *Quarterly Journal of Economics*, Vol. 124 (4), pages 1403–1448.

[28] Hsu, M. and M. Zhao (2009), "China's Business Cycles between 1954 – 2004: Productivity and Fiscal Policy Changes," MRPA Paper 21283, University Library of Munich, Germany.

[29] Hong, E. and L. Sun (2011), "Foreign direct investment and total factor productivity in China: A spatial dynamic panel analysis," *Oxford Bulletin of Economics and Statistics*, Vol. 73 (6), pages 771–791.

[30] Izyumov, A. and J. Vahaly (2008) "Old Capital vs. New Investment in Post-Soviet Economies: Conceptual Issues and Estimates," *Comparative Economic Studies*, Vol. 50 (1), pp.79–110.

[31] Jones, J. and S. Sahu (2008), "Transition Accounting for India in a Multi-Sector Dynamic General Equilibrium Model," Discussion Papers 08-03, University at Albany, SUNY, Department of Economics.

[32] Kanczuk, F. (2004), "Real interest rate and Brazilian business cycles," *Review of Economic Dynamics*, Vol. 7(2), pages 436–455

[33] Kersting, E. (2008), "The 1980s recession in the UK: A Business Cycle Accounting Perspective," *Review of Economic Dynamics*, Vol.11 (1), pages 179–191

[34] Kobayashi, K. and M. Inaba (2006), "Business cycle accounting for the Japanese economy," *Japan and the World Economy*, Vol. 18 (4), pages 418–440

[35] Kose, M.A., E. Prasad, K. Rogoff and S. Wei (2009), "Financial globalization: A reappraisal," *IMF Staff Papers*, Vol. 56 (1), pages 8–62

[36] Kose, M.A., E. Prasad and M. Terrones (2009), "Does openness to international financial flows raise productivity growth?," *Journal of International Money and Finance*, Vol. 28 (4), pages 554–580.

[37] La Porta, R., F. Lopez-de-Silanes, A. Shleifer and R.W. Vishny (1997), "Legal determinants of external finance," *Journal of Finance*, Vol. 52 (3), 1131–1150.

[38] La Porta, R., F. Lopez-de-Silanes, A. Shleifer and R.W. Vishny (1998), "Law and finance," *Journal of Political Economy*, Vol. 106 (6), 1113–1155.

[39] La Porta, R., F. Lopez-de-Silanes, A. Shleifer and R.W. Vishny (1999), "The quality of government," *Journal of Law, Economics, and Organization*, Vol. 15 (1), 222–279.

[40] Lahiri, A. and K. Yi (2009), "A Tale of Two States: Maharashtra and West Bengal," *Review of Economic Dynamics*, Vol. 12 (3), pages 523–542

[41] Lama, R. (2011), "Accounting for Output Drops in Latin America," *Review of Economic Dynamics*, Vol. 14 (2), pages 295–316

[42] Ljungwall, C. and X. Gao (2009), "Sources of Business Cycle Fluctuations: Comparing China and India," CERC Working Paper 7

[43] Lu, S. (2012), "East Asian growth experience revisited from the perspective of a neoclassical model," *Review of Economic Dynamics*, Vol. 14 (2), pages 295–316

[44] Maddison, A. (2005), "World Development and Outlook 1820-2030: Evidence submitted to The House of Lords," http://www.ggdc.net/MADDISON/oriindex.htm

[45] Merlevede B., K. Schoors and B. Van Aarle (2009), "Russia from Bust to Boom and Back: Oil Price, Dutch Disease and Stabilisation Fund," *Comparative Economic Studies*, Vol. 51(2), pages 213–241

[46] Obstfeld, M. (1994), "Risk-taking, global diversification and growth," *American Economic Review*, Vol. 84 (5), pages 1310–1329.

[47] Otsu, K. (2010a), "A neoclassical analysis of the Asian crisis: Business cycle accounting for a small open economy," *B.E. Journal of Macroeconomics, Topics*, Vol.10 (1), Article 17.

[48] Otsu, K. (2010b), "International Business Cycle Accounting," University of Kent, School of Economics Discussion Paper Series, KDPE-1010.

[49] Rajan, R.J. and L. Zingales (2006), "The great reversals: the politics of financial development in the twentieth century," *Journal of Financial Economics*, Vol. 69 (1), pages 5–50.

[50] Rodrik, D. and A. Subramanian (2008), "From "Hindu Growth" to Productivity Surge: The Mystery of the Indian Growth Transition," *IMF Staff Papers*, Vol. 52 (2), pages 193–228.

[51] Schmitz, J. and A. Teixeira (2008), "Privatization's Impact on Private Productivity: The Case of Brazilian Iron Ore," *Review of Economic Dynamics*, Vol. 11(4), pages 745–760.

[52] Song, Z., K. Storesletten and F. Zilibotti (2011), "Growing Like China," *American Economic Review*, Vol. 101 (1), pages 196–233.

A Linearization Appendix

Define the log linearization of each detrended variables from their steady states as

$$\widetilde{v}_t = \ln \widehat{v}_t - \ln \overline{v}$$

Then the linearized equilibrium conditions are

$$0 = \frac{\beta}{na}\theta\frac{y}{k}\widetilde{k_{t+1}} - \frac{\beta}{na}\theta\frac{y}{k}\widetilde{y_{t+1}} + \widetilde{c_{t+1}} - \widetilde{c}_t - \frac{\beta}{na}\theta\frac{y}{k}\widetilde{\omega_{k,t+1}}$$

$$0 = \widetilde{y}_t - \widetilde{c}_t - \frac{1}{1-l}\widetilde{l}_t + \widetilde{\omega_{l,t}}$$

$$0 = \widetilde{y}_t - \frac{c}{y}\widetilde{c}_t - \frac{x}{y}\widetilde{x}_t - \frac{g}{y}\widetilde{\omega_{g,t}}$$

$$0 = na\widetilde{k_{t+1}} - \frac{x}{k}\widetilde{x}_t - (1-\delta)\widetilde{k}_t$$

$$0 = \widetilde{y}_t - \theta\widetilde{k}_t - (1-\theta)\widetilde{\gamma}_t - (1-\theta)\widetilde{l}_t$$

Finally, we consider three cases regarding the definition of $\widetilde{\omega_{e,t}}$. The first case follows Chari, Kehoe and McGrattan (2007) where efficiency wedges $\omega_{e,t}$ directly affect the level of productivity:

$$\widetilde{\omega_{e,t}} = \widetilde{\gamma}_t. \qquad \text{(Model I)}$$

In the second case, we define efficiency wedges as the growth of productivity between the previous period and the current period:

$$\widetilde{\omega_{e,t}} = \widetilde{\gamma}_t - \widetilde{\gamma_{t-1}}. \qquad \text{(Model II)}$$

Finally, in the third case, we define efficiency wedges as the growth of productivity between the current period and the next period:

$$\widetilde{\omega_{e,t}} = \widetilde{\gamma_{t-1}} - \widetilde{\gamma}_t. \qquad \text{(Model III)}$$

B Additional Tables Appendix- Parameters of the Vector AR (1) Stochastic Process of the Wedges

Table A: The Bayesian Priors for structural estimation of wedges

	Prior Distribution	**Prior Mean**	**Prior Variance**
P Diagonal	Beta	0.8	0.2
P Off-Diagonal	Normal	0	0.2
V Standard Deviation	Inverse Gamma	0.05	inf
V Correlation	Uniform	0	$-1, 1$

Table B: Parameters of the Vector AR(1) Stochastic Process driving the wedges -Benchmark Model

P				**V**			
			Brazil				
0.7930	0.1990	−0.3160	−0.1370	0.0010	0.0000	0.0000	0.0000
−0.3500	0.7940	0.3260	−0.2630	0.0000	0.0020	0.0000	0.0000
−0.0790	0.0200	0.7940	−0.0350	0.0000	0.0000	0.0010	0.0000
−0.0070	−0.0510	0.6710	0.8040	0.0000	0.0000	0.0000	0.0000
			Russia				
0.9330	0.1890	0.2230	0.6110	0.0080	−0.0140	0.0000	0.0000
−0.3470	0.8690	−0.5420	−0.1030	−0.0140	0.1490	0.0000	−0.0030
0.0390	−0.0410	0.9760	−0.1290	0.0000	0.0000	0.0000	0.0000
0.0220	−0.0470	−0.1000	0.8090	0.0000	−0.0030	0.0000	0.0010
			India				
0.8440	0.0110	−0.2890	0.2360	0.0090	0.0000	0.0000	−0.0020
0.2390	0.7790	0.3890	−0.0110	0.0000	0.0240	−0.0010	0.0000
−0.0050	0.0050	0.9400	−0.2730	0.0000	−0.0010	0.0000	0.0000
−0.0080	0.0610	−0.0110	0.7310	−0.0020	0.0000	0.0000	0.0010
			China				
0.8250	0.0280	0.0900	0.0860	0.0020	0.0010	0.0000	0.0000
−0.0150	0.8690	0.3800	−0.0490	0.0010	0.0100	0.0000	0.0000
−0.0110	0.0050	0.7860	−0.1410	0.0000	0.0000	0.0000	0.0000
0.1070	0.0330	−0.3730	0.8220	0.0000	0.0000	0.0000	0.0000

Table C: Parameters of the Vector AR(1) Stochastic Process driving the wedges -Model II

P				V			
Brazil							
0.5490	0.0047	0.0429	−0.0217	0.0010	0.0001	0.0003	0.0000
0.0266	0.8200	−0.0707	0.0221	0.0001	0.0024	0.000	0.0000
0.1770	0.0167	0.6164	0.0723	0.0003	0.0000	0.0046	0.0000
−0.0975	0.0753	0.2248	0.8709	0.0000	0.0000	0.0000	0.0002
Russia							
0.5668	0.0464	0.054	0.1516	0.0026	−0.0024	−0.0121	−0.0008
−0.3264	0.7534	−0.0127	0.3876	−0.0024	0.8214	1.6147	−0.0113
0.0796	−0.3596	0.5894	−0.1432	−0.0121	1.6147	3.1985	−0.0235
−0.6895	0.2033	−0.0584	0.8550	−0.0008	−0.0113	−0.0235	0.0050
India							
0.5906	−0.0294	−0.0112	0.5543	0.0122	−0.0017	−0.0001	−0.0024
0.2724	0.8427	0.2137	−0.0676	−0.0017	0.0268	−0.0005	−0.0007
−0.0013	−0.0005	0.9449	−0.2645	−0.0001	−0.0005	0.0001	−0.0001
−0.1240	0.0566	−0.0563	0.7311	−0.0024	−0.0007	−0.0001	0.0008
China							
0.4931	−0.0009	0.0624	0.0832	0.0022	0.0006	−0.0071	−0.0003
0.6399	0.8373	0.2618	−0.3045	0.0006	0.0106	−0.0024	0.0008
0.7828	0.0157	0.6470	−0.5072	−0.0071	−0.0024	0.0456	0.0036
−0.2634	0.0195	0.0378	0.9684	−0.0003	0.0008	0.0036	0.0008

Table D: Parameters of the Vector AR(1) Stochastic Process driving the wedges -Model III

P				V			
Brazil							
0.6078	0.1327	−0.4426	0.0945	0.0009	0.0000	0.0002	−0.0001
0.1489	0.7636	0.3575	−0.0446	0.0000	0.0019	0.0000	−0.0002
0.2001	−0.0175	0.7729	0.0463	0.0002	0.0000	0.0006	0.0000
−0.3876	0.0148	0.5559	0.8092	−0.0001	−0.0002	0.0000	0.0002
Russia							
0.7895	0.0180	0.0654	0.2833	0.0085	0.0195	−0.0001	−0.0010
−0.1659	0.8373	−0.2054	0.2147	0.0195	0.0984	0.000	−0.0041
0.3150	−0.0646	0.9177	−0.1507	−0.0001	0.0000	0.0002	−0.0001
−0.2272	−0.0203	−0.1627	0.8610	−0.0010	−0.0041	−0.0001	0.0010
India							
0.5858	0.0152	−0.2131	0.2100	0.0150	0.000	0.0003	0.0007
−0.0100	0.8537	0.1355	−0.1041	0.0000	0.0272	−0.0009	−0.0007
0.0170	−0.0003	0.9489	−0.2441	0.0003	−0.0009	0.0001	−0.0001
−0.1805	0.0476	−0.0699	0.8130	0.0007	−0.0007	−0.0001	0.001
China							
0.7457	0.0259	−0.0299	0.0999	0.0020	0.0004	0.0084	−0.0002
1.1285	0.8002	−0.1127	−0.1722	0.0004	0.0110	−0.0022	0.0003
−0.7322	0.1422	0.8069	0.2940	0.0084	−0.0022	0.0370	−0.0011
0.3301	−0.0192	−0.1401	0.8972	−0.0002	0.0003	−0.0011	0.0004

C Data Appendix

C.1 Data Sources

Table A1 presents the original sources of the data. PWT stands for Penn World Tables edition 7.1 and the extensions made by Duncan Foley. EM stands for the Eurominotor Global Market Information Database. ILO stands for the International Labor Organization LABORSTA database. The details of data construction follows.

Table A1. Original Sources of the Data

GDP	PWT
Consumption share	PWT
Investment share	PWT
Employment	PWT
Hours worked per worker	EM
Population	PWT
Adult Share in Total Population	ILO
Household Expenditure on Durables	EM
Net fixed Capital Stock	PWT[33]
Depreciation	PWT[34]
Household Income Share of Capital	EM

Employment E is computed from the PWT data of GDP per capita ($rgdpl2$) and GDP per person counted in total employment ($rgdpl2te$) and population (POP):

$$E = \frac{rgdpl2}{rgdpl2te} \times POP.$$

Labor L, which is defined as total hours worked, is the product of hours worked per worker h and employment. The adult population is computed using the data from ILO of the adult share in total population and the population data from PWT.

In order to compute the household expenditure on durables X_d, we use the consumer expenditure data of EM and the data of PWT for consumption share of GDP (kc), GDP per capita ($rgdpch$) and population (POP):

$$X_d = \frac{\text{consumer expenditure on durables}}{\text{consumer expenditure}} \times kc \times rgdpl2 \times POP.$$

The household income share of capital θ_h is derived from EM data on household income:

$$\theta_h = 1 - \frac{\text{gross income from employment}}{\text{gross income}},$$

[33]For Russian capital stock and depreciation we refer to Izyumov and Vahaly (2008) because the Foley database reports capital stock data only for the 2004-2008 period.

[34]Izyumov and Vahaly (2008) assume a constant 5% annual depreciation.

C.2 Imputing Service Flow from Consumer Durables

Consumption expenditure C_x in the data is defined as

$$C_x = C_{nd} + C_s + X_d,$$

where C_{nd}, C_s and X_d stand for the household expenditures on non-durables, services and durables. However, consumption in the model C is defined as

$$C = C_{nd} + C_s + C_d,$$

where C_d stands for the services flow generated from durable stocks. Investment X is defined as the sum of gross domestic capital formation X_f and X_d. Output Y is defined as the sum of GDP and C_d. Total capital stock K is the sum of net fixed capital stock K_f and the stock of consumer durables K_d.

The service flow from consumer durables C_d is imputed as

$$C_d = K_d(R_k + \delta_d).$$

where R_k is the net return on capital stock and δ_d is the depreciation rate of consumer durables assumed to be equal to 0.2. The stock of consumer durables follows a law of motion:

$$K_{d,t+1} = (1 - \delta_d)K_{d,t} + X_{d,t},$$

where the stock of consumer durables in 1990 is assumed to be equal to

$$K_{d,1990} = \frac{X_{d,1990}}{\delta_d}.$$

The net return on capital R_k is defined as

$$R_k = \theta_f \frac{GDP}{K_f} - \delta_f,$$

where θ_f is the income share of net fixed capital stock and δ_f is the depreciation rate of net fixed capital stock. The income share of net fixed capital stock is derived as

$$\theta_f = \frac{\theta_h \times NNP + \Delta}{GDP},$$

where θ_h is the household income share of capital which is directly obtained from data, Δ stands for the depreciation of net fixed capital stock and $NNP = GDP - \Delta$. The depreciation rate of net fixed capital stock is computed as

$$\delta_f = \frac{\Delta}{K_f}.$$

Finally, total capital share θ is defined as

$$\theta = \frac{\theta_f \times GDP + C_d}{Y}.$$

D Institutional and Governance Indicators - Definitions and measurement details

World Bank collects data on a set of institutional and governance indicators from 212 nations and we have the time series since 1996. In each instance, measures range from -2.5 to $+2.5$ with standard errors reflecting variability around the point estimate. The indicators are based on 30 aggregate data sources, survey and expert assessments. The details can be found in:

Daniel Kaufmann, Aart Kraay and Massimo Mastruzzi (2010). "The Worldwide Governance Indicators : A Summary of Methodology, Data and Analytical Issues", World Bank Policy Research Working Paper No. 5430:

http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1682130

(1) Voice and Accountability - reflects perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media

(2) Political Stability and Absence of Violence/Terrorism - reflects perceptions of the likelihood that the government will be destabilized or overthrown by unconstitutional or violent means, including politically-motivated violence and terrorism

(3) Government Effectiveness - reflects perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies

(4) Regulatory Quality - reflects perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development

(5) Rule of Law - reflects perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence

(6) Control of Corruption - reflects perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests.

Table 1: GDP ranking by PPP methodology (% share in world GDP)

Source: International Monetary Fund Statistics

	World Ranking									
Year	**1st**	**2nd**	**3rd**	**4th**	**5th**	**6th**	**7th**	**8th**	**9th**	**10th**
2011	U.S.	China	India	Japan	Germany	Russia	Brazil	U.K.	France	Italy
	(19.11)	(14.36)	(5.67)	(5.58)	(3.92)	(3.02)	(2.93)	(2.86)	(2.81)	(2.32)
2010	U.S.	China	Japan	India	Germany	Russia	U.K.	Brazil	France	Italy
	(19.53)	(13.61)	(5.81)	(5.46)	(3.96)	(3.00)	(2.93)	(2.93)	(2.87)	(2.39)
2005	U.S.	China	Japan	Germany	India	U.K.	France	Russia	Italy	Brazil
	(22.26)	(9.46)	(6.83)	(4.40)	(4.29)	(3.41)	(3.28)	(2.99)	(2.88)	(2.80)
2000	U.S.	Japan	China	Germany	India	France	U.K.	Italy	Brazil	Russia
	(23.55)	(7.61)	(7.14)	(5.07)	(3.72)	(3.63)	(3.59)	(3.31)	(2.92)	(2.65)
1995	U.S.	Japan	China	Germany	France	U.K.	Italy	India	Brazil	Russia
	(22.89)	(8.71)	(5.67)	(5.55)	(3.81)	(3.64)	(3.61)	(3.31)	(3.17)	(2.94)
1990	U.S.	Japan	Germany	France	Italy	U.K.	China	Brazil	India	Mexico
	(24.70)	(9.91)	(6.16)	(4.39)	(4.14)	(4.09)	(3.88)	(3.33)	(3.17)	(2.61)
1985	U.S.	Japan	Germany	France	Italy	U.K.	Brazil	China	Mexico	India
	(25.19)	(9.29)	(6.22)	(4.47)	(4.25)	(4.16)	(3.61)	(3.18)	(2.85)	(2.84)
1980	U.S.	Japan	Germany	France	Italy	U.K.	Brazil	Mexico	India	Spain
	(24.64)	(8.65)	(6.74)	(4.74)	(4.48)	(4.28)	(3.92)	(2.97)	(2.53)	(2.41)

Table 2: Aggregate GDP and GDP per capita growth rates

Data Source: World Bank and Penn World Tables

Column (1) summarizes growth in Aggregate GDP while column (2) summarizes growth in GDP per capita

		1960s		**1970s**		**1980s**		**1990s**		**2000s**	
		(1)	**(2)**	**(1)**	**(2)**	**(1)**	**(2)**	**(1)**	**(2)**	**(1)**	**(2)**
U.S.	Mean	4.66%	3.33%	3.32%	2.24%	3.04%	2.09%	3.22%	1.96%	1.85%	0.90%
	St. Dev.	(1.68%)	(1.67%)	(2.58%)	2.56%	(2.55%)	2.56%	(1.55%)	(1.57%)	(2.12%)	(2.08%)
OECD	Mean	5.74%	4.42%	3.73%	2.67%	2.94%	2.13%	2.56%	1.74%	1.75%	1.04%
	St. Dev.	(0.74%)	(0.81%)	(1.89%)	(1.91%)	(1.44%)	(1.46%)	(0.80%)	(0.84%)	(2.20%)	(2.18%)
Brazil	Mean	5.90%	2.97%	8.47%	5.92%	2.99%	0.82%	1.70%	0.12%	3.67%	2.49%
	St. Dev.	(3.68%)	(3.68%)	(3.48%)	(3.39%)	(4.76%)	(4.67%)	(2.94%)	(2.94%)	(2.43%)	(2.48%)
Russia	Mean							−4.91%	−4.81%	5.35%	5.66%
	St. Dev.							(6.14%)	(6.24%)	(4.73%)	(4.81%)
India	Mean	6.67%	4.44%	2.93%	0.55%	5.69%	3.35%	5.63%	3.62%	7.36%	5.74%
	St. Dev.	(6.14%)	(6.01%)	(4.16%)	(4.06%)	(1.88%)	(1.86%)	(2.0%)	(2.03%)	(2.35%)	(2.38%)
China	Mean	3.02%	0.89%	7.44%	5.34%	9.75%	8.75%	9.99%	8.75%	10.30%	9.64%
	St. Dev.	(14.85%)	(13.74%)	(5.62%)	(5.37%)	(3.24%)	(3.23%)	(3.24%)	(3.23%)	(1.81%)	(1.86%)

Table 3. Parameters and Steady States

Source: Authors' calculations

		Brazil	**Russia**	**India**	**China**
Parameter	*Explanation*	*Values*			
a	Average growth rate of per capita output	1.010	1.018	1.041	1.074
n	Average growth rate of population	1.017	0.999	1.019	1.007
θ	Share of capital in output	0.521	0.526	0.713	0.293
δ	Rate of depreciation	0.120	0.094	0.121	0.117
β	Subjective discount factor	0.849	0.939	0.776	1.042
Ψ	Elasticity of substitution between consumption and leisure	0.273	0.177	0.381	0.154
y/k	Steady state output to capital ratio	0.633	0.338	0.683	0.526
l	Steady state labor	0.230	0.193	0.218	0.230
c/y	Consumption as a share of output in the steady state	0.604	0.426	0.634	0.432
x/y	Investment as a share of output in the steady state	0.218	0.424	0.292	0.417
g/y	Government expenditure as a share of output in the steady state	0.179	0.150	0.074	0.151
Benchmark model with Investment Adjustment Costs					
ϕ	Sensitivity of investment to marginal Q	7.252	6.965	5.015	4.558
$\varkappa$	Steady state investment to capital ratio	0.147	0.111	0.181	0.198

Table 4: Properties of the wedges

Source: Authors' calculations

	Benchmark Model					
	Standard Deviation with respect to output	**Cross Correlations of wedges with output at lag k=**				
		−2	−1	0	1	2
		BRAZIL				
Efficiency Wedges	2.43	0.24	0.41	0.33	0.09	−0.11
Government Consumption Wedges	2.99	0.72	0.37	0.14	−0.16	−0.44
Investment Wedges	1.36	0.25	0.63	0.68	0.12	−0.17
Labor Wedges	1.55	0.16	0.19	0.50	0.55	0.40
		RUSSIA				
Efficiency Wedges	7.61	0.87	0.70	0.42	0.21	−0.02
Government Consumption Wedges	3.50	−0.28	−0.61	−0.80	−0.82	−0.73
Investment Wedges	9.61	−0.12	0.26	0.60	0.78	0.91
Labor Wedges	0.61	0.63	0.63	0.59	0.76	0.71
		INDIA				
Efficiency Wedges	2.16	0.43	0.18	−0.06	−0.51	−0.68
Government Consumption Wedges	3.22	0.21	0.25	0.45	0.47	0.23
Investment Wedges	1.87	0.86	0.87	0.77	0.66	0.50
Labor Wedges	0.85	−0.55	−0.53	−0.37	−0.05	0.20
		CHINA				
Efficiency Wedges	1.34	0.53	0.73	0.84	0.71	0.51
Government Consumption Wedges	3.55	0.54	0.54	0.48	0.30	0.01
Investment Wedges	1.64	0.24	0.34	0.31	0.22	0.03
Labor Wedges	1.48	−0.04	−0.11	0.01	0.10	0.26

Table 5a: Decomposition of Output - Benchmark Model

Source: Authors' calculations

	Brazil	**Russia**	**India**	**China**
1990:2009				
Efficiency Wedges	0.293	1.826	0.039	0.726
Government Consumption Wedges	−0.151	−0.196	0.014	0.049
Investment Wedges	0.368	−0.570	0.874	0.218
Labor Wedges	0.490	−0.060	0.073	0.006
1990:1999				
Efficiency Wedges	−0.535	−0.746	0.796	0.991
Government Consumption Wedges	−0.047	0.037	−0.118	−0.005
Investment Wedges	0.609	1.619	0.265	−0.142
Labor Wedges	0.973	0.090	0.057	0.155
2000:2009				
Efficiency Wedges	0.932	1.559	−0.128	0.415
Government Consumption Wedges	−0.153	−0.041	0.005	0.131
Investment Wedges	0.143	−0.437	1.054	0.720
Labor Wedges	0.078	−0.082	0.068	−0.266

Table 5b: Decomposition of Investment to Output Ratio - Benchmark Model

Source: Authors' calculations

	Brazil	**Russia**	**India**	**China**
1990:2009				
Efficiency Wedges	0.041	−0.110	0.106	0.139
Government Consumption Wedges	0.147	0.485	−0.037	−0.113
Investment Wedges	0.694	0.676	0.802	0.698
Labor Wedges	0.119	−0.051	0.129	0.277
1990:1999				
Efficiency Wedges	0.147	0.204	0.374	0.018
Government Consumption Wedges	0.044	0.393	0.213	0.312
Investment Wedges	0.848	0.400	0.147	0.516
Labor Wedges	−0.039	0.002	0.265	0.277
2000:2009				
Efficiency Wedges	0.073	−1.051	0.001	0.072
Government Consumption Wedges	0.317	0.785	−0.002	−0.468
Investment Wedges	0.526	1.581	0.941	1.129
Labor Wedges	0.084	−0.314	0.061	0.266

Table 6: Decomposition of Output -Alternative Models

Source: Authors' calculations

	Model II				Model III			
					1990:2009			
	Brazil	**Russia**	**India**	**China**	**Brazil**	**Russia**	**India**	**China**
Efficiency Wedges	0.239	1.647	0.017	0.626	0.268	1.922	0.055	0.871
Government Consumption Wedges	−0.021	−0.117	0.016	0.133	−0.102	−0.231	0.017	0.305
Investment Wedges	0.265	−0.603	0.812	0.249	0.356	−0.767	0.859	−0.187
Labor Wedges	0.516	0.072	0.155	−0.008	0.477	0.076	0.069	0.012
					1990:1999			
Efficiency Wedges	−0.54	−0.812	0.631	0.881	−0.512	−0.091	0.676	0.879
Government Consumption Wedges	0.057	0.574	−0.086	0.028	−0.008	−0.203	−0.079	0.094
Investment Wedges	0.463	1.277	0.373	0.106	0.570	1.336	0.347	−0.193
Labor Wedges	1.022	−0.038	0.081	−0.015	0.949	−0.042	0.056	0.220
					2000:2009			
Efficiency Wedges	0.854	1.297	−0.121	0.370	0.891	1.801	−0.084	0.606
Government Consumption Wedges	−0.004	0.263	0.005	0.271	−0.097	−0.177	0.005	0.556
Investment Wedges	0.073	−0.710	0.967	0.358	0.126	−0.780	1.015	0.206
Labor Wedges	0.076	0.149	0.149	0.000	0.079	0.157	0.064	−0.367

Table 7: Decomposition of Output - Benchmark Model with Investment Adjustment Costs

Source: Authors' calculations

	Brazil	Russia	India	China
1990:2009				
Efficiency Wedges	0.273	2.322	−0.166	0.636
Government Consumption Wedges	−0.052	−0.367	0.214	0.075
Investment Wedges	0.399	−0.941	0.579	0.288
Labor Wedges	0.380	−0.014	0.374	0.001
1990:1999				
Efficiency Wedges	−0.651	−0.746	0.723	0.893
Government Consumption Wedges	0.030	−0.082	−0.283	−0.013
Investment Wedges	0.749	1.807	0.396	0.067
Labor Wedges	0.871	0.020	0.165	0.052
2000:2009				
Efficiency Wedges	1.123	2.234	−0.331	0.298
Government Consumption Wedges	−0.015	−0.295	0.232	0.209
Investment Wedges	−0.002	−0.958	0.715	0.590
Labor Wedges	−0.106	0.018	0.384	−0.096

Figure 1: Real Macroeconomic Aggregates

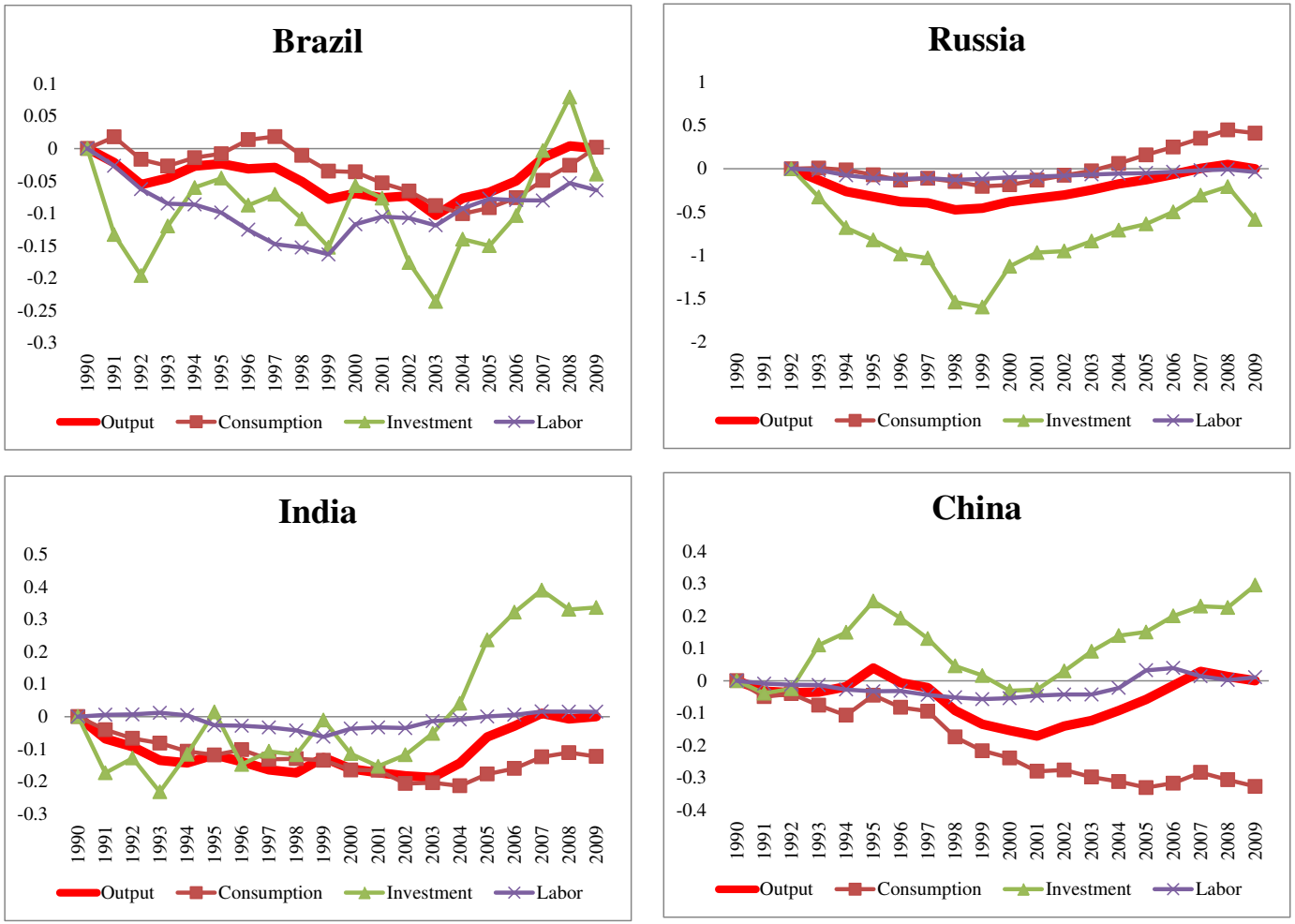
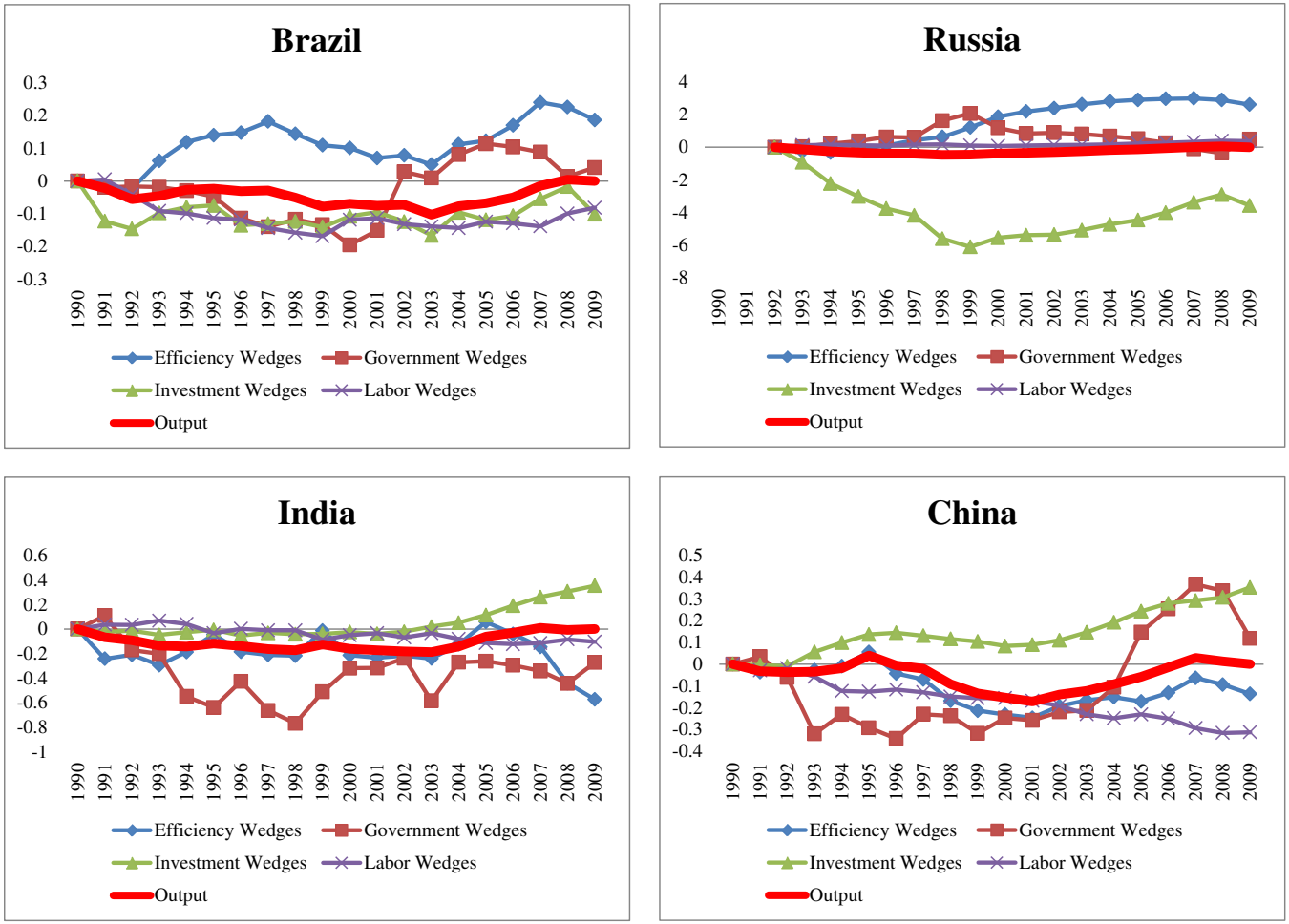
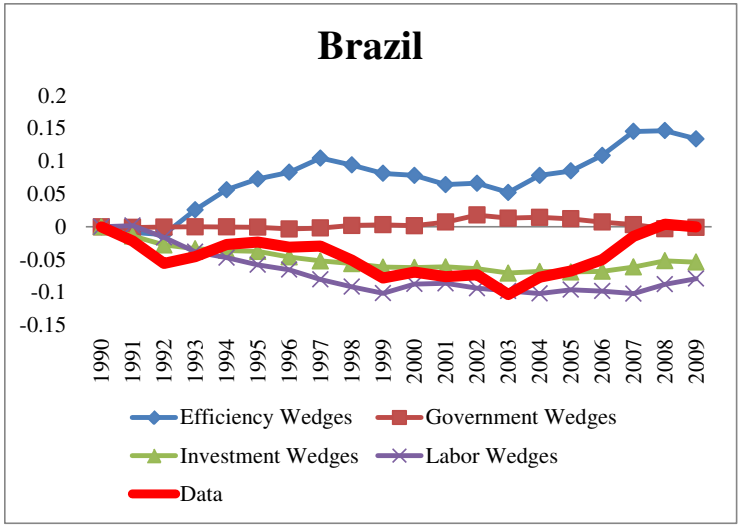


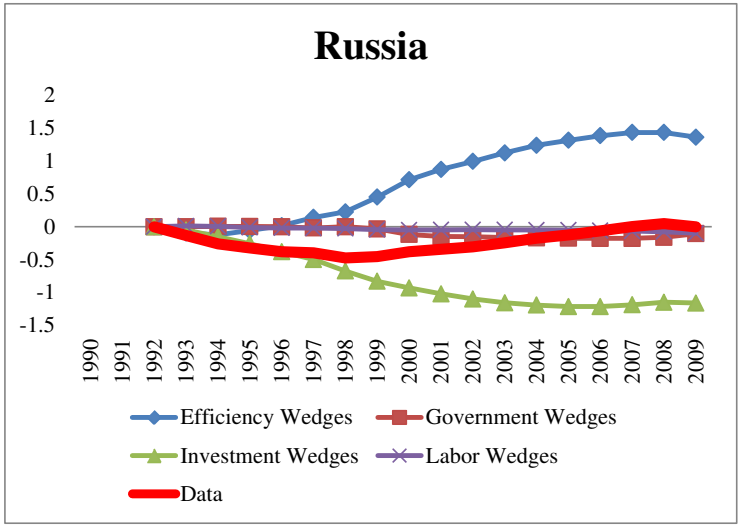
Figure 2: Wedges – Model I (Benchmark)

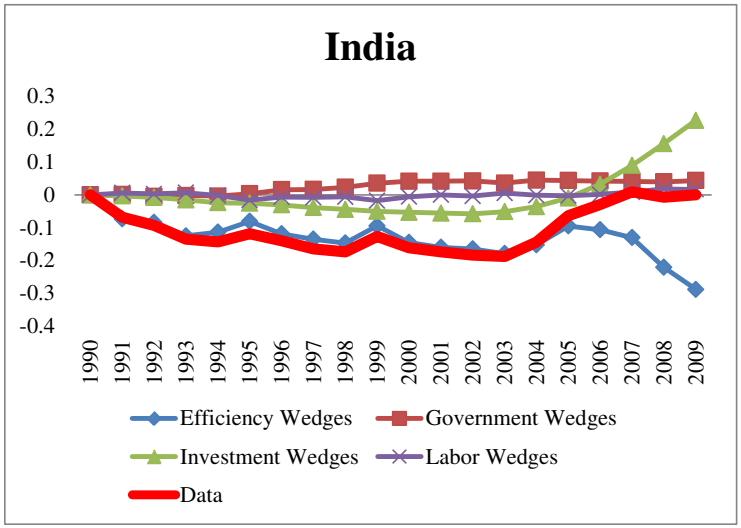


Note: In our benchmark model, efficiency wedge is modeled as shocks to the level of productivity

Figure 3a: Simulated Output - Model I (Benchmark)







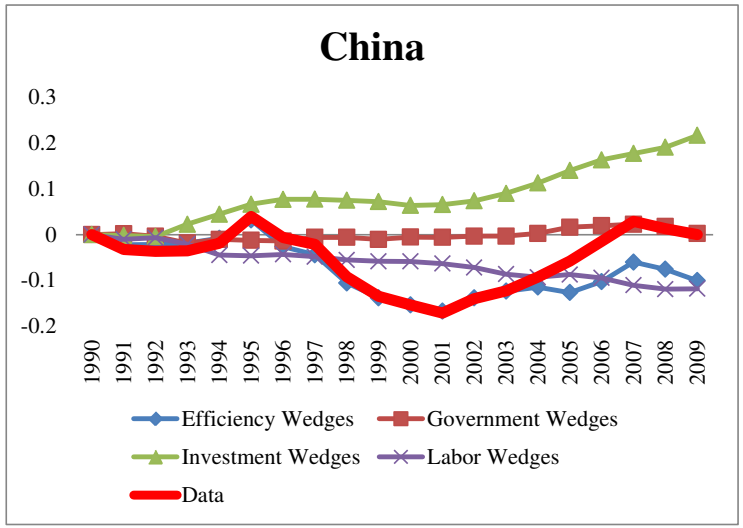


Figure 3b: Simulated Investment to Output Ratio - Model I (Benchmark)

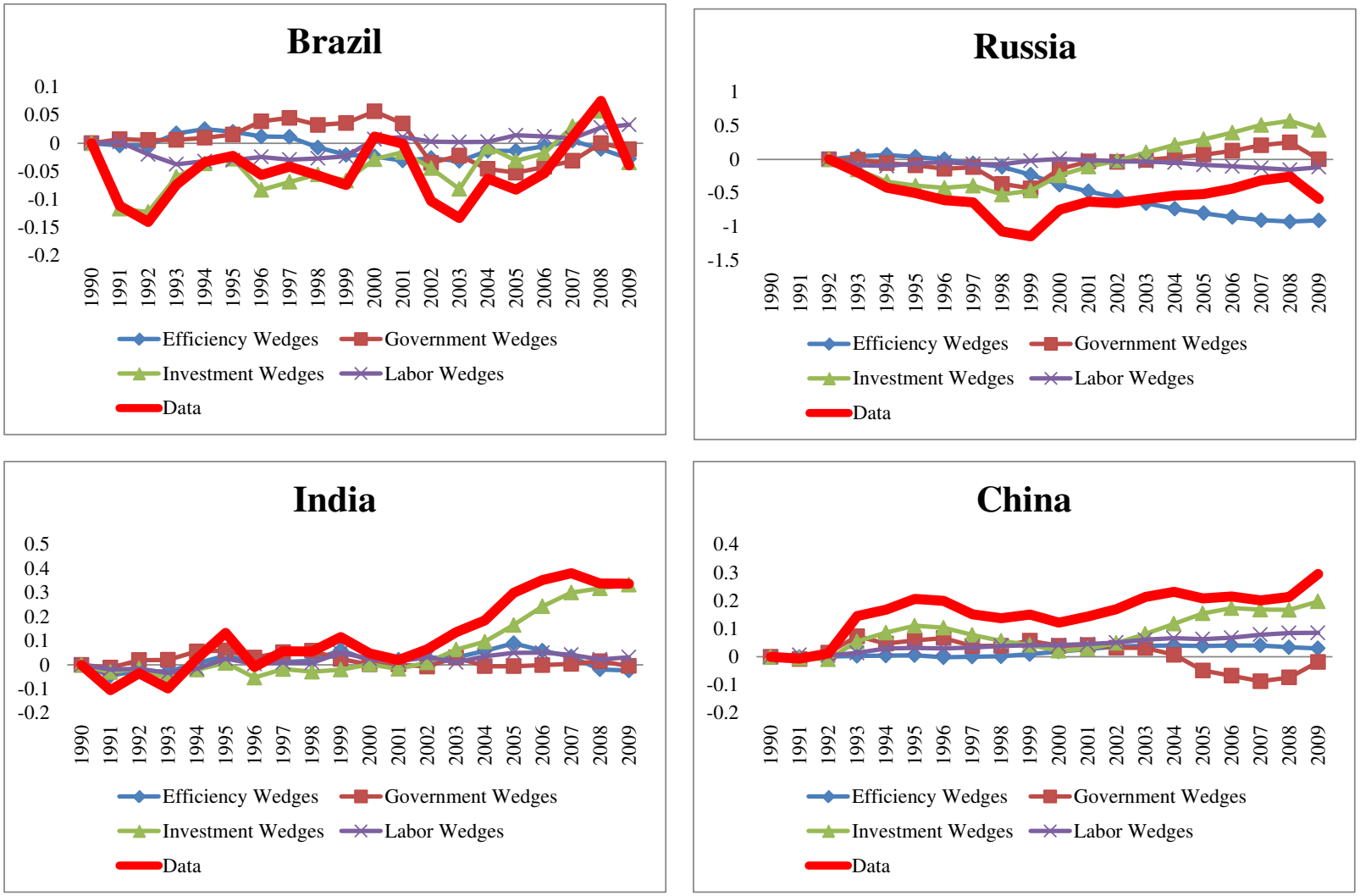
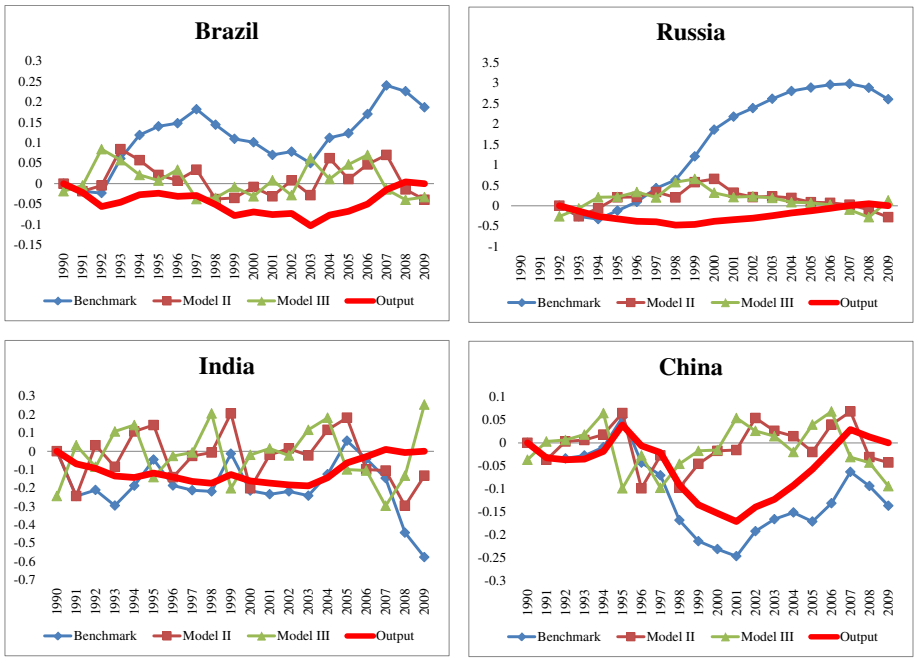


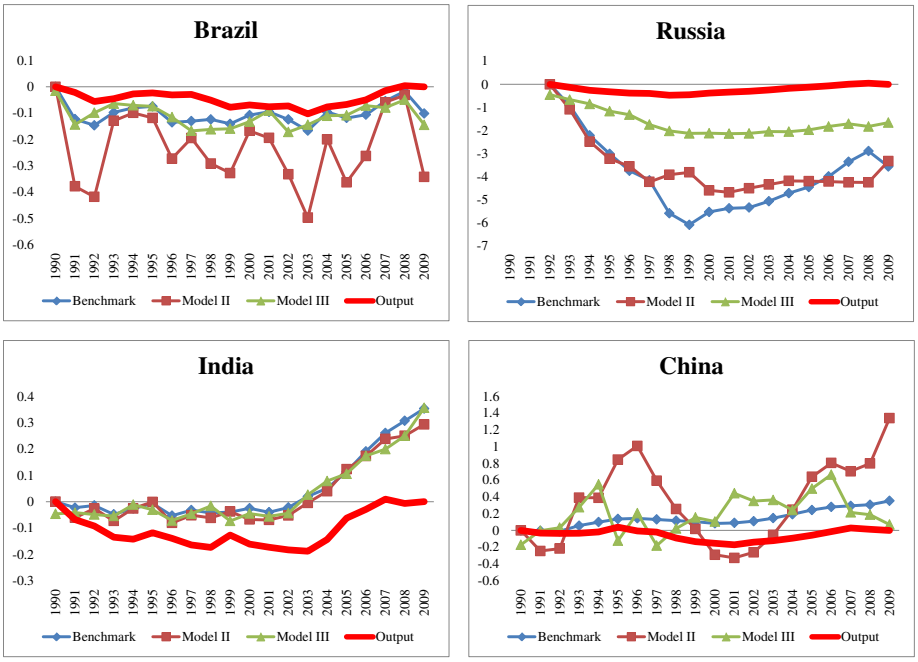
Figure 4: Efficiency and Investment Wedges-

Benchmark Model, Model II and Model III

Panel A: Efficiency Wedge



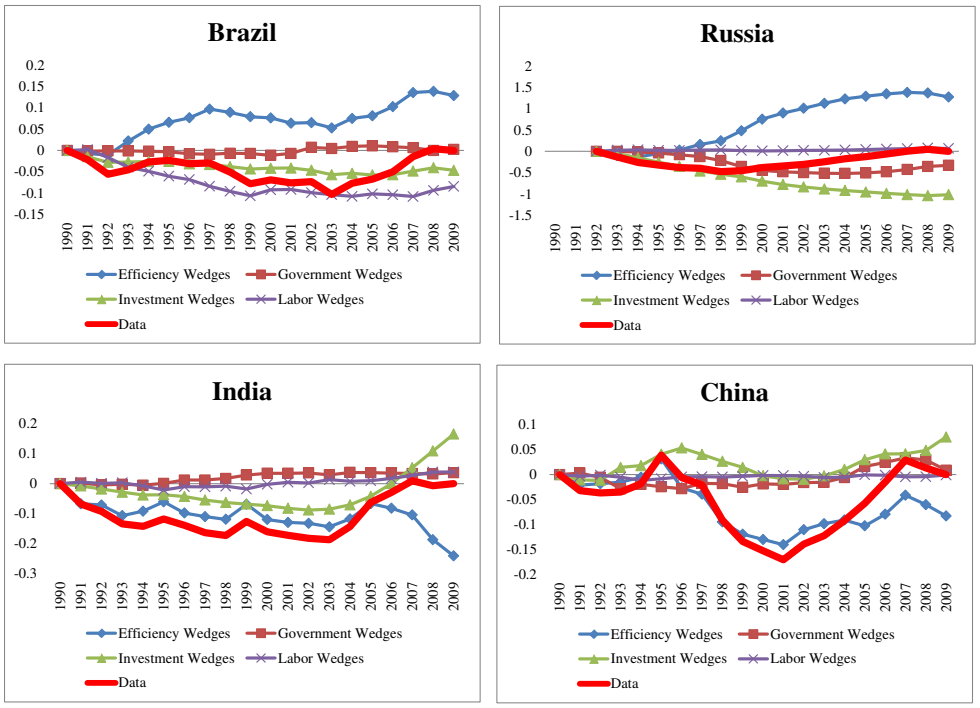
Panel B: Investment Wedge



Note: In models II and III, efficiency wedge is modeled as shocks to productivity growth

Figure 5: Simulated Output

Panel A: Model II



Panel B: Model III

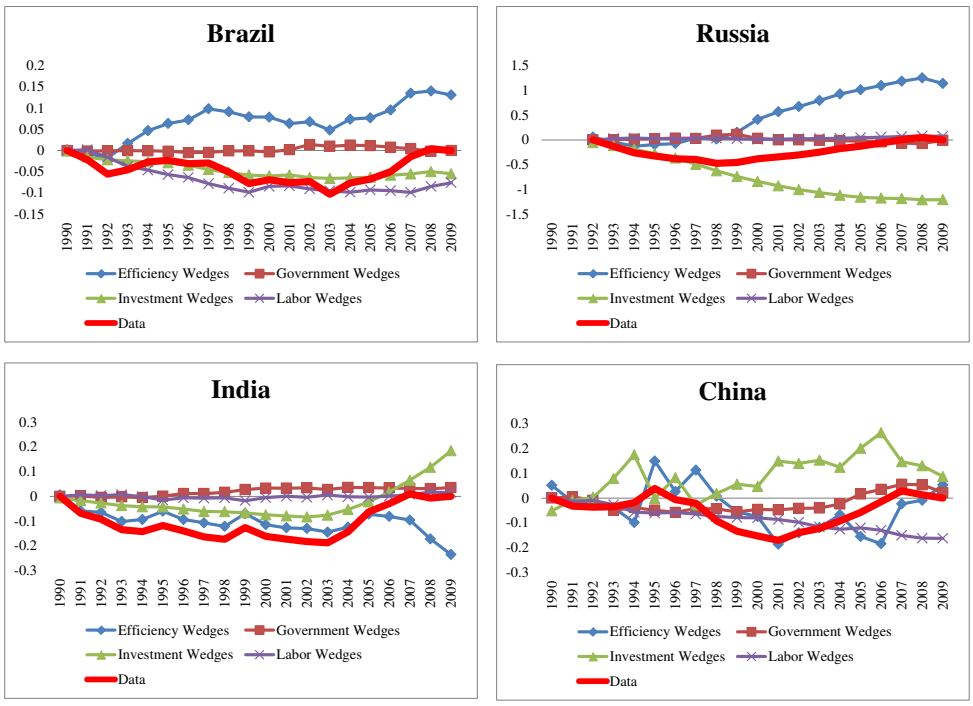
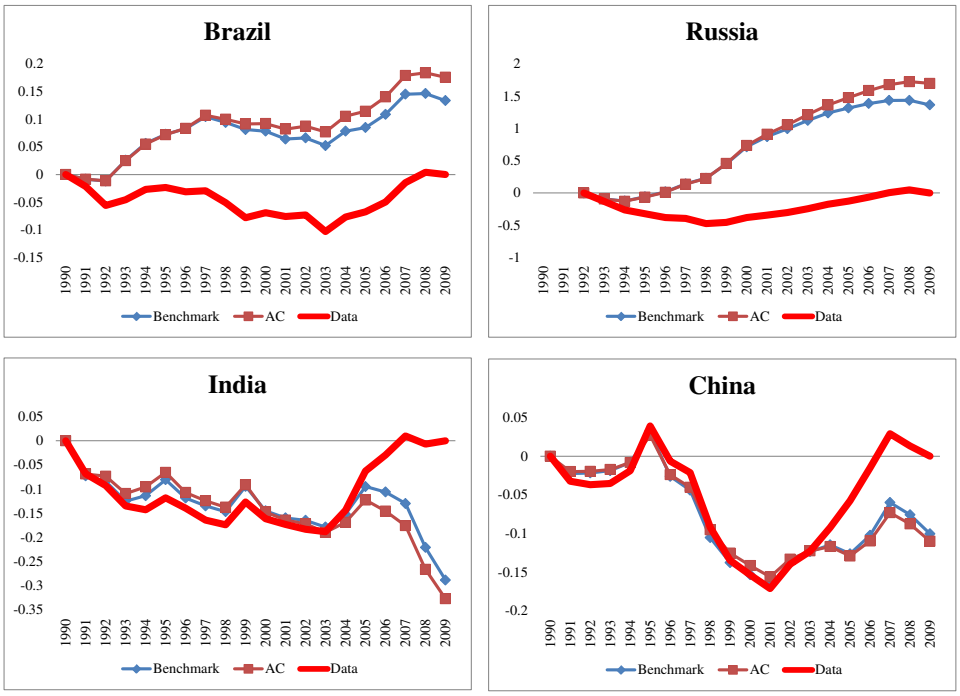


Figure 6: Benchmark Model Simulations with Investment Adjustment Cost

A. Simulated Output with only Efficiency Wedges



B. Simulated Output with only Labor Wedges

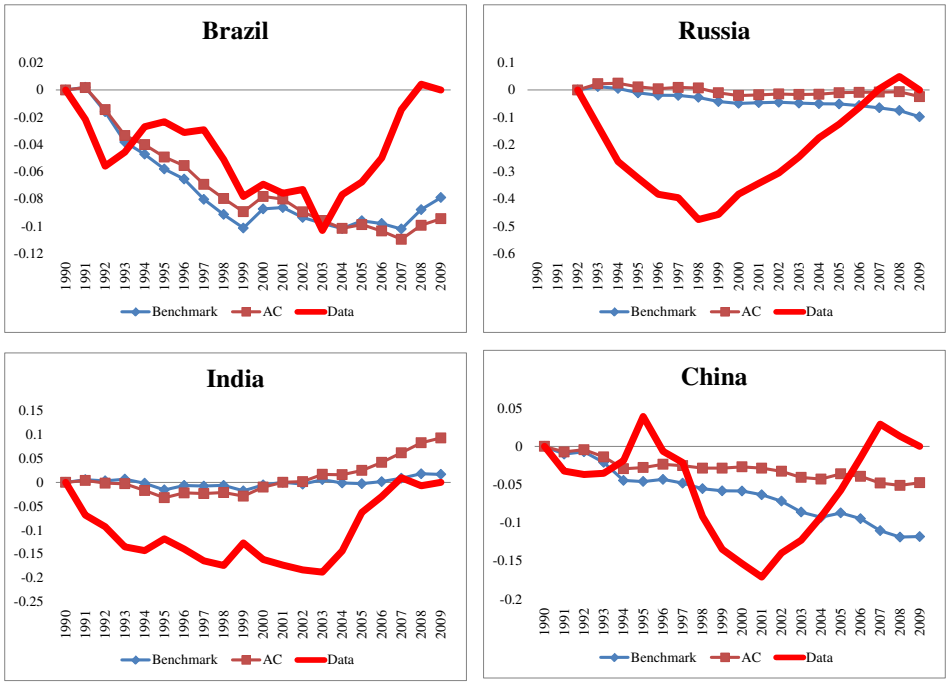
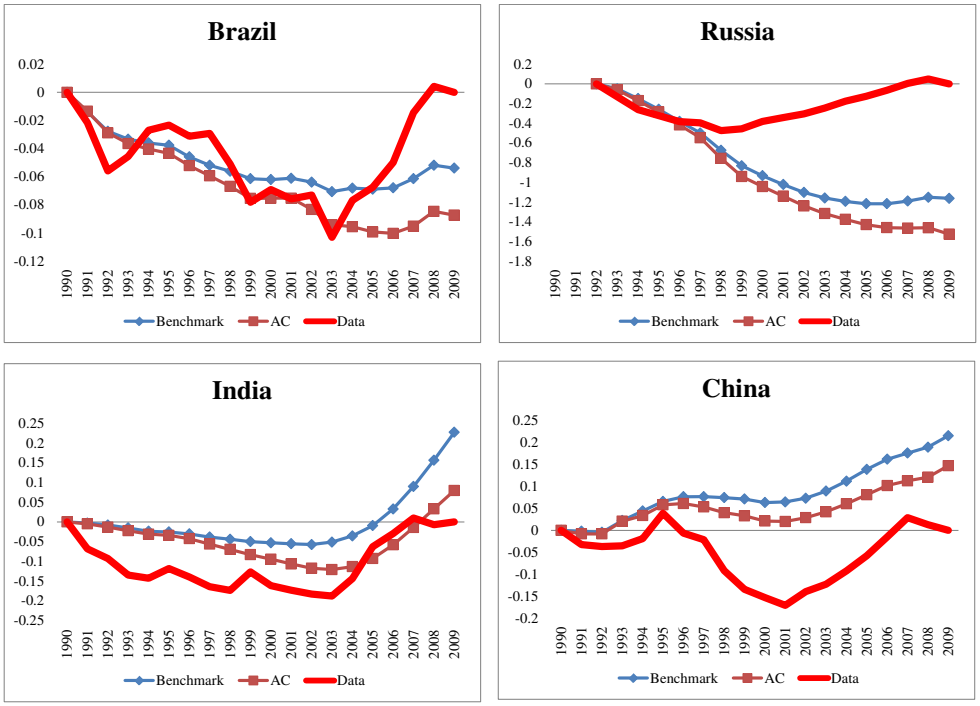


Figure 6: Benchmark Model Simulations with Investment Adjustment Cost continued:

C. Simulated Output with only Investment Wedges



D. Simulated Output with only Government Consumption Wedges

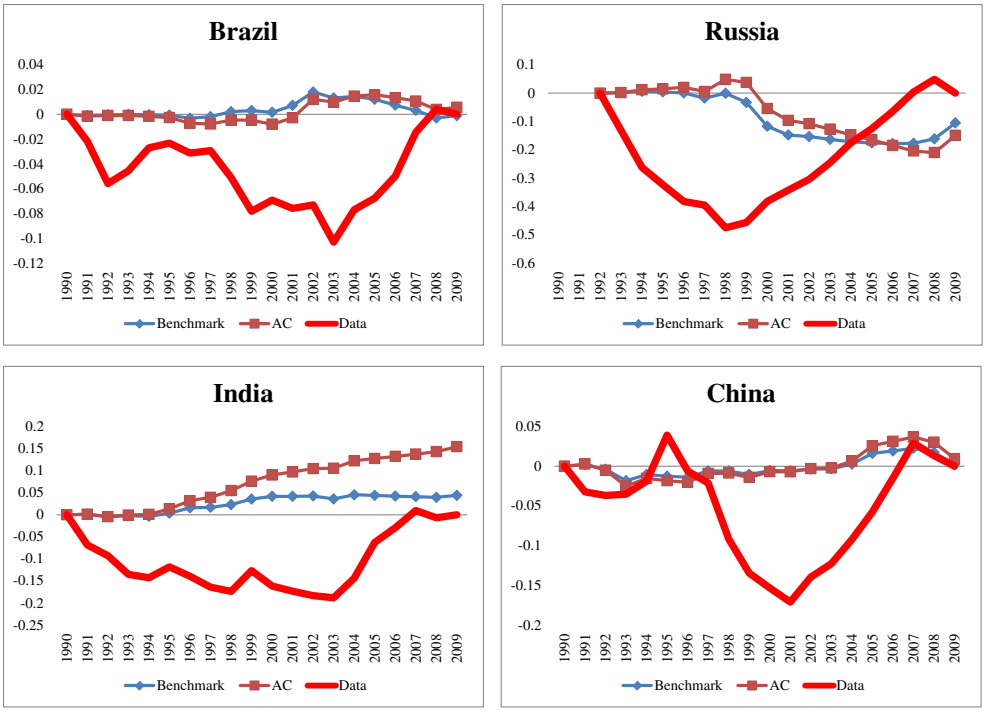
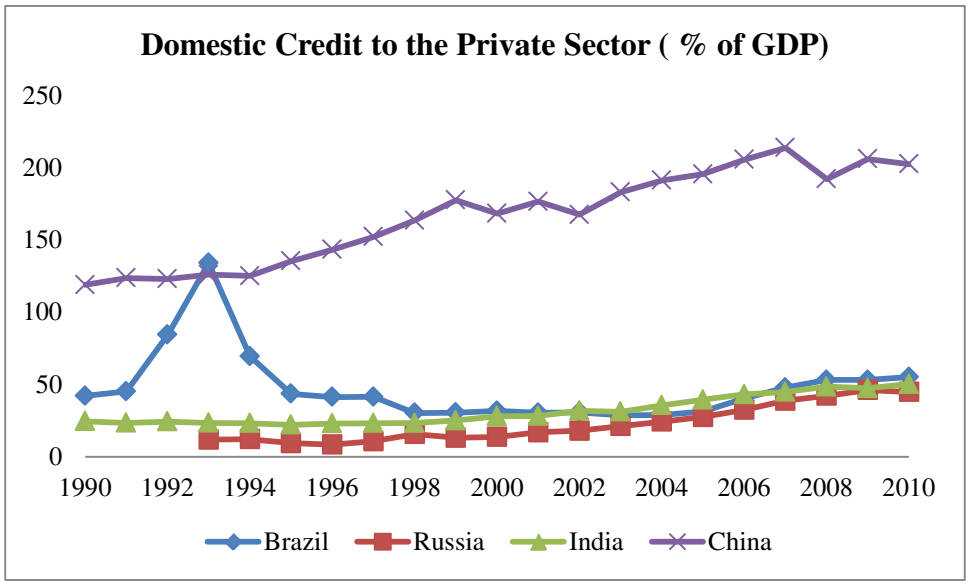


Figure 7A: Flow of Domestic Credit to Private Sector and Inflows of FDI



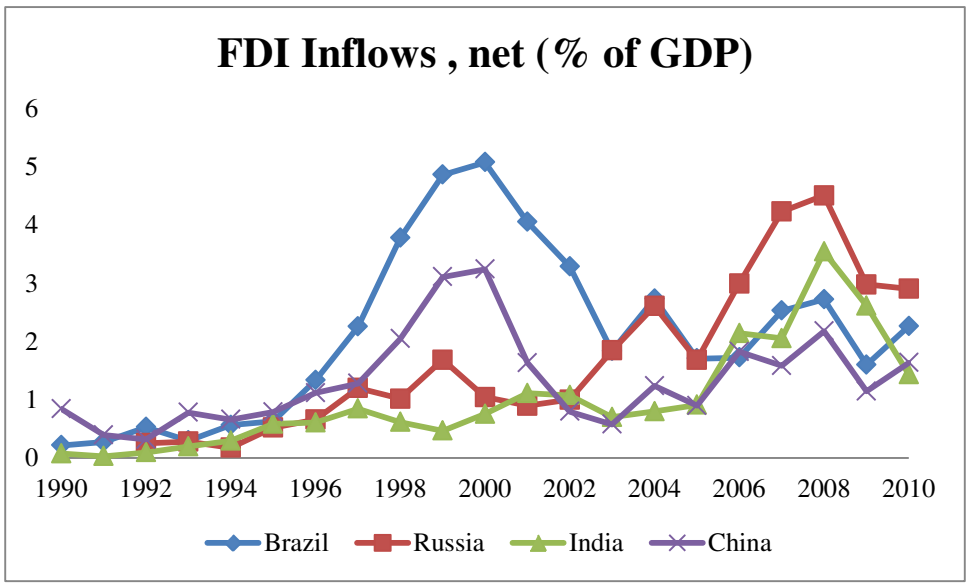
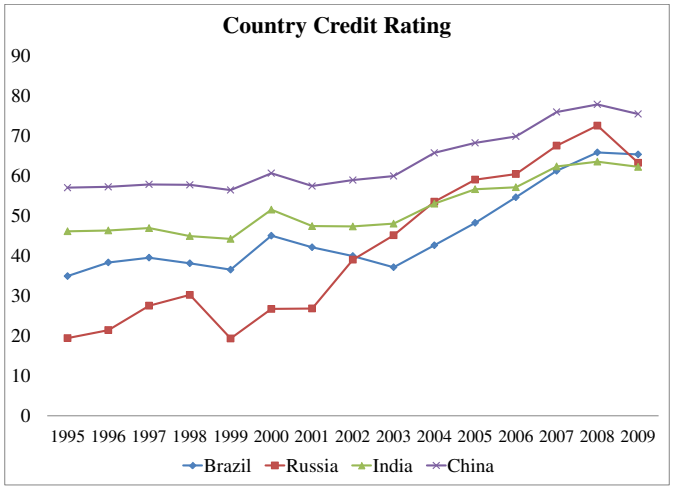
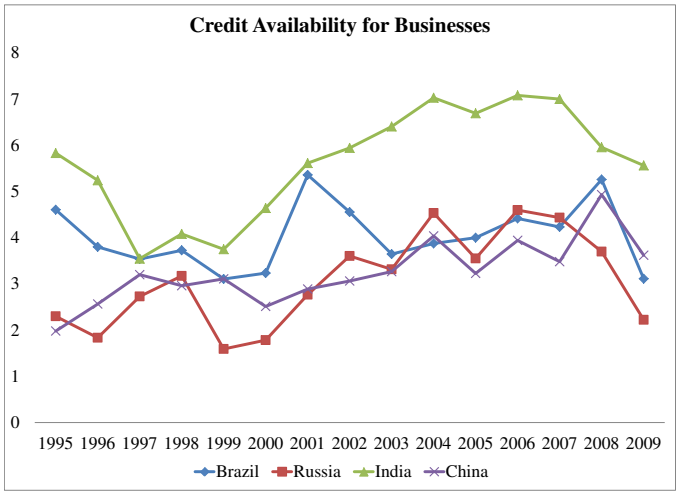


Figure 7B: Financial Market Indicators





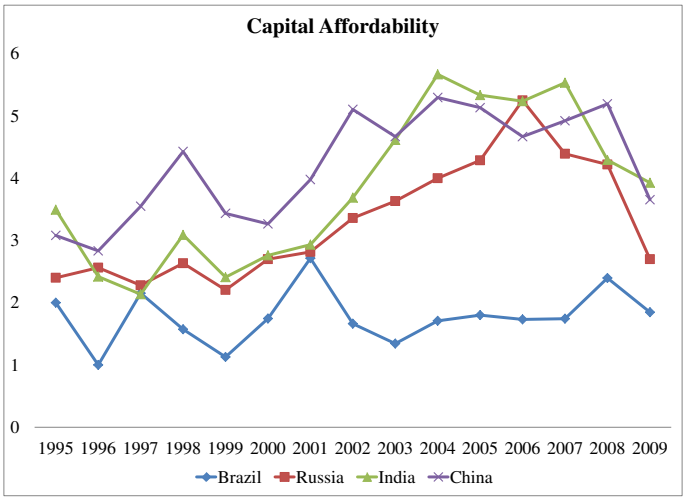


Figure 7c: Measures of Institutional and Policy Reforms