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Deconstructing the BRICs:
Structural Transformation and Aggregate Productivity Growth

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RESEARCH MEMORANDUM

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Abstract

This paper studies structural transformation and its implications for productivity growth in the BRIC countries based on a new database that provides trends in value added and employment at a detailed 35-sector level. We find that for China, India and Russia reallocation of labour across sectors is contributing to aggregate productivity growth, whereas in Brazil it is not. However, this result is overturned when a distinction is made between formal and informal activities. Increasing formalization of the Brazilian economy since 2000 appears to be growth-enhancing, while in India the increase in informality after the reforms is growth-reducing.

Keywords: Economic growth, New structural economics, Structural change, BRIC countries

JEL: C80; N10; O10

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1. INTRODUCTION

A central insight in development economics is that development entails structural change. Structural change, narrowly defined as the reallocation of labour across sectors, featured prominently in the early literature on economic development by Kuznets (1966). As labour and other resources move from traditional into modern economic activities, overall productivity rises and incomes expand. The nature and speed with which structural transformation takes place is considered one of the key factors that differentiate successful countries from unsuccessful ones (McMillan and Rodrik, 2011). Therefore, new structural economists argue that production structures should be the starting point for economic analysis and the design of appropriate policies (Lin, 2011).[1]

Technological change typically takes place at the level of industries and induces differential patterns of sectoral productivity growth. At the same time, changes in domestic demand and international trade patterns drive a process of structural transformation in which labour, capital and intermediate inputs are continuously relocated between firms, sectors and countries (Kuznets, 1966; Chenery et al., 1986; Harberger, 1998, Hsieh and Klenow, 2009). One of the best documented patterns of structural change is the shift of labour and capital from production of primary goods to manufacturing and later to services. This featured prominently in explanations of divergent growth patterns across Europe, Japan and the U.S. in the post-WW-II period (Denison, 1967; Maddison, 1987; Jorgenson and Timmer, 2011). Another finding is that in low-income countries the level and growth rate of labour productivity in agriculture is considerably lower than in the rest of the economy, reflecting differences in the nature of the production function, in investment opportunities, and in the rate of technical change (Syrquin, 1984; Crafts, 1984, Gollin et al. 2011). Together these findings suggest a potentially important role for resource allocation from lower to higher productive activities to boost aggregate productivity growth. Based on the sector database of Timmer and de Vries (2009), the IADB (2010) and McMillan and Rodrik (2011) found that structural change was contributing to productivity growth in Asia; whereas it was absent or even reducing growth in Africa and Latin America. Also Bosworth and Collins (2008) found strong growth-enhancing structural change in China and India.

So far, however, analyses of structural change in developing countries are constrained by the availability of detailed sector data, obscuring a proper assessment of the role of structural transformation in driving aggregate productivity growth. Typically, data is only available for broad sectors such as agriculture, industry and services, hiding important reallocations that can take place, for example from low-productive garment making to high-productive transport equipment manufacturing. Also a distinction between formal and informal activities within a sector, say informal and formal textile manufacturing may have important consequences for our understanding of the effects of structural change on aggregate growth. Productivity growth in the formal sector could go hand-in-hand with a substitution of capital for labour and thereby a push of employment into low-productive informality, but such reallocation effects would not be picked up in an aggregate analysis.

This paper addresses these issues by studying the role of structural change for growth in four large developing countries, the BRIC countries: Brazil, China, India and Russia. The acronym BRIC was invented by Jim O'Neill in 2001 to group these four developing countries because of their recent growth spurts and potential for future domination of the world economy due to their population and economic size. Economic growth in China and India in particular has been well above world average, and provides a foundation for the growth of world GDP. Figure 1 shows that the share of the BRICs in world GDP increased from about 15 per cent in 1980 to 27 per cent in 2008.

[Figure 1 here]

To analyse the role of structural change in BRICs' growth, we present a harmonized time-series database of value added and persons engaged with a common detailed 35 sector classification (ISIC revision 3). The dataset builds upon the time-series of broad sectors for China and India by Bosworth and Collins (2008) and for Asian and Latin American countries by Timmer and de Vries (2009). It adds further detail and harmonizes the measurement of output and employment across countries, which is important for a comparative and more fine-grained analysis of economic growth and production. Data on number of workers is based on the broadest employment concept, including self-employment, family-workers and other informal workers. The dataset is based on a critical assessment of the coverage and consistency of concepts and definitions used in various primary data sources. The sector database is publicly available.[2]

Using the canonical shift-share method we find strong growth-enhancing effects of structural change in China, India, and Russia, but not in Brazil. This confirms the findings of McMillan and Rodrik (2011) and Bosworth and Collins (2008). However, we show that these results are sensitive to the level of aggregation by performing the same decomposition at various levels of aggregation such as 3, 10 and 35 industries. This is true in particular, when a distinction is made between formal and informal activities within sectors. To this end, we use detailed national accounts data for India, and nationally representative surveys of the informal sector in Brazil. For example, in India the informal sector accounts for up to 30 per cent of manufacturing's value added, compared with an 80 per cent share in employment, indicating large differences in productivity between formal and informal activities. Our analysis suggests that in India the expansion of informal activities after the reforms is associated with a reduction in aggregate growth. In contrast, employment reallocation towards formal activities in Brazil is increasing aggregate growth after 2000.

This shows the importance of using detailed industry data to analyse structural change as the standard decomposition method is quite sensitive to the level of aggregation. We extend the decomposition method to show formally that by relying on aggregate sector data only, reallocation effects can be substantially over- or underestimated. The remainder of the paper is organized as follows. Section 2 discusses the main issues in constructing the harmonized BRIC dataset, relegating a detailed description of sources and methods by country to a data appendix. The decomposition method to measure the contribution of sectors to growth is presented in section 3. Section 4 discusses trends in production structures and presents decomposition results by country. In section 5, we account for employment reallocation across formal and informal activities in decomposing growth for Brazil and India. Section 6 provides concluding remarks.

2. SECTOR DATABASE FOR THE BRIC COUNTRIES

In this section we discuss the general approach in constructing a database that provides time-series on value added, price deflators, and employment by sector, following the methodology developed by Timmer and de Vries (2009), also used by McMillan and Rodrik (2011). The database is constructed on the basis of an in-depth study of available statistical sources. National data is harmonized in terms of industry classifications. The classification list has 35 sectors based on the International Standard Industrial Classification (ISIC) revision 3 shown in table 1. Data series are annual and run from 1980 to 2008 for Brazil, from 1995 to 2008 for Russia, from 1981 to 2008 for India, and from 1987 to 2008 for China.

Gross value added in current and constant prices is taken from the national accounts of the various countries. In recent years, value added series have been compiled according to the 1993 United Nations System of National Accounts (UN SNA, see UN (1993)). Therefore, international comparability is high, in principle. However, the national statistical office of China only proceeded to change its statistical procedures from a Material Product System (MPS) to the UN SNA in 1992. And although in Russia the statistical office adopted the UN SNA in the early 1990s, a UN SNA consistent set of industry data is only presented from 2002 onwards. The shift from the MPS to the UN SNA has been gradual in China and Russia. Some elements of the MPS are still visible, such as the grouping and treatment of services into material product and non-material product services in the China Statistical Yearbook. Beside these major shifts in the statistical system of Russia and China, national statistical institutes frequently change methodologies as well. In the national accounts, GDP series are periodically revised which includes changes in the coverage of activities (for example after a full economic census has been carried out and "new" activities have been discovered), changes in the methods of calculation, and changes in base year of the prices used for calculating volume growth rates.

[Table 1 here]

Changes in the methodology and statistical system introduce breaks in the time series. Our general approach to solve this issue, is to start with GDP levels for the most recently available benchmark year, expressed in that year's prices, from the national accounts provided by the national statistical institute or central bank. Historical national accounts series are subsequently linked to this benchmark year using an overlapping year between the old and the new series. This linking procedure ensures that growth rates of individual series are retained although absolute levels are adjusted according to the most recent information and methods.

Employment series are typically not part of the core set of national account statistics put out by national statistical institutes. Usually, only total employment is available from the national accounts. To arrive at sector-level data, additional material has been collected from population censuses, and employment and labour force statistics. For each country, a choice was made of the best statistical source for consistent employment data at the industry level.

For Brazil, employment series are an integral part of the input-output framework and these series include own-account workers. Therefore, we use the detailed employment data from the input-output tables as the main source. The main source for employment series in Russia is the system of national accounts employment statistics, which provides full-time equivalent jobs by one-digit sectors for the period from 2003 to 2008. For disaggregation and backward extrapolation of employment series to 1995, we used the Balance of Labour Force, the Full Circle Employment Survey, and the Labour Force Survey for particular industries.

Employment data for India is based on the Employment and Unemployment Surveys from the National Sample Survey Organization. The employment definition used is the 'usual principal and subsidiary status'. This definition is to a large extent comparable over the various rounds of the survey, and has a wide acceptance as a measure of employment (Bosworth and Collins, 2008). In addition, this employment definition is used in the national account statistics for India. In our opinion, the employment data that we use for India is the best available, but it should be noted that the quality and reliability of employment data for India is intensively discussed and subject to great scrutiny (see the data appendix for an extensive discussion). Finally, employment series by three broad sectors for China are from various issues of the China Statistical Yearbook. Detailed industrial employment series for 35 industries are based on various issues of the China Industrial Economic Statistics Yearbook and the China Labour Statistical Yearbook. The more detailed industry data is made consistent with the aggregate three-sector data by taking into account the discrepancies between employment statistics in regular reports and population censuses. Therefore, the three sector employment data for China and India match with those used by Bosworth and Collins (2008).

Employment in our data set is defined as 'all persons employed', including all paid employees, but also informal workers such as own-account workers and employers of informal firms. The inclusion of own-account workers is crucial for the measurement of productivity levels in developing countries (McMillan and Rodrik, 2011).[3] It is especially important for industries which have a large share of self-employed workers, such as agriculture, low-skilled manufacturing, trade, business and personal services. In section 5, we specifically aim to distinguish between formal and informal activities within sectors. A detailed description of the sources and methods on a country-by-country basis is provided in the data appendix.

3. STRUCTURAL DECOMPOSITION METHOD

To measure the contribution of structural change to growth, we start with the canonical decomposition originating from Fabricant (1942). The change in aggregate labour productivity levels (ΔP) can be written as:

$$\Delta P = \sum_i \Delta P_i \overline{L}_i + R, \tag{1}$$

with $\overline{L_{\mathrm{i}}}$ the average share of sector *i* in overall employment, and R the reallocation term. In equation (1), the change in aggregate productivity is decomposed into within-sector productivity changes (the first term on the right-hand side which we call the "within-effect" (also known as "intra-effect"), and the effect of changes in the sectoral allocation of labour which we call the "reallocation -effect", (the second term, also known as the "shift-effect" or "structural-change effect"). The within-effect is positive (negative) when the weighted change in labour productivity levels in sectors is positive (negative). The reallocation-effect is a residual term, which measures the contribution of labour reallocation across sectors, being positive (negative) when labour moves from less (more) to more (less) productive sectors. One advantage of this approach above partial analyses of productivity performance within individual sectors is that it accounts for aggregate effects. For example, a high rate of productivity growth within say manufacturing can have ambiguous implications for overall economic performance if manufacturing's share of employment shrinks rather than expands. If the displaced labour ends up in activities with lower productivity, economy-wide growth will suffer. It should be noted that this reallocation term is only a static measure of the allocation effect as it depends on differences in productivity levels across sectors, not growth rates. Growth and levels are often, but not necessarily, correlated.[4] The reallocation term is often used as an indicator for the success of structural transformation (e.g. Bosworth and Collins, 2008; IADB, 2010; McMillan and Rodrik, 2011).[5]

One aim of this paper is to investigate whether the reallocation term is affected by a change in the level of aggregation used in the decomposition. Typically, decompositions are carried out at the level of broad sectors. This paper uses a more detailed dataset finding different decomposition results. For example, aggregate trends in manufacturing might hide considerable variation at a lower level. Aggregate manufacturing productivity growth might be the result of a shrinking formal sector, outsourcing labour-intensive activities to small informal firms. This effect is picked up as a negative reallocation effect in our more detailed decomposition analysis, but not by an analysis based on aggregate manufacturing data. Structural change will be growth-reducing when the shift of labour from formal to informal activities is properly accounted for. In Section 5 we will show that this is indeed the case for India after the reforms.

More formally, let each sector *i* consists of a number of subsectors *j*. As before, for each sector *i* the change in labour productivity is given by a weighted growth of subsectors *j*, with share of *j* in *i* employment as weights, and a residual term measuring the reallocation across industries in a sector *i* (R_i):

$$\Delta P_i = \sum_{j \in i} \Delta P_j \, \overline{L_{\mathrm{i,j}}} + R_i \ , \qquad (2)$$

where $\overline{L_{\mathrm{i,j}}}$ is the average share of subsector *j* in sector *i* employment Substituting equation (2) in equation (1), it is easily shown that the change in aggregate productivity can be decomposed in an employment weighted change of productivity levels in all subsectors *j* plus a new reallocation term:

$$\Delta P = \sum_j \left(\Delta P_j \overline{L_{\mathrm{j}}}\right) + \left(\sum_i R_i \, \overline{L_{\mathrm{i}}} + R\right), \qquad (3)$$

where $\overline{L_j}$ is the average share of subsector *j* in overall employment. Formula (3) shows that the new overall reallocation effect consists of the reallocation of labour between sectors *i* (the old R*)*, and the reallocation effects between subsectors *j* within each sector *i* (R_i summed over all sectors). In the example above, R_i is negative for manufacturing bringing down the overall reallocation effect. This indicates the importance of having a detailed sector database to analyse the role of structural change in economic growth, not only in theory but also empirically as we will argue in the next sections.

4. STRUCTURAL TRANSFORMATION IN THE BRIC COUNTRIES

We combine the sector database with the decomposition method to examine the contribution of structural change to productivity growth. We first aggregate the data to 3 broad sectors (agriculture, industry, and services; see last column in table 1 for classification) and apply formula (3), and do the same for the full 35 sector detail. In section 5 we additionally distinguish between formal and informal activities within sectors before applying the decomposition. Descriptive statistics on production and employment structures, as well as decomposition results are presented by country. We follow the BRIC acronym in chronological order and observe that productivity growth rates steadily rise as we move from Brazil (1.1 per cent average annual since 1995) via Russia (4.4 per cent since 1995) and India (4.7 per cent since 1991) to China (8.7 per cent annually since 1997).

(a) Brazil

Table 2 shows a drop in agricultural employment shares in Brazil, falling from about 38 per cent of total employment in 1980 to 18 per cent in 2008. Declining agricultural employment shares are a common feature across growing economies. In Brazil, labour moves to services industries, which contrasts with the experience of China (see below) and past developments in US, Europe and Japan where agricultural workers moved mainly to manufacturing (Kuznets, 1966). More industry detail can be found in Appendix table 1. It indicates notable increases in employment shares in retail trade (from 6 to 12 per cent of total employment), business services (from 6 to 9 per cent), education (from 3 to 6 per cent), and public administration (from 3 to 5 per cent).

[Table 2 here]

At the same time, productivity levels differ sharply across sectors (see last three columns in table 2, as well as the last three columns in appendix table 1). In 1980, the agricultural productivity level was 13 per cent of total economy level, whereas services were at 167 per cent of the average productivity level. Over time, productivity growth in agriculture was fast, which can be observed from the increase in the relative productivity level of agriculture, rising from 13 to 36 per cent, whereas services productivity growth was slow. High productivity growth in agriculture is partly related to advancements in farm yields as well as a reduction in surplus labour (disguised unemployment) from the movement of workers to services (Baer, 2008).

In table 3, we show the decomposition results from applying equation (3) to the 3 broad sector database, and the 35 detailed sector database. Note that we first aggregate data to a particular level (e.g. 3 or 35 sectors) before applying the decomposition.[6] As argued in section 3, a decomposition analysis with more detailed data may result in a different contribution of structural change to growth. Decomposition results are shown for the period from 1980 to 1995 and from 1995 to 2008.[7]

[Table 3 here]

For the period from 1980 to 1995, average annual productivity growth was -0.9 per cent. The 'lost decade' of Latin America actually lasted one and a half decade in Brazil, which is particularly reflected in negative productivity growth rates in services (-2.0 and -1.6 percentage points contributions at the 3-sector and 35-sector level respectively). Nevertheless, the movement of workers towards services which had an above-average productivity level is associated with a positive reallocation effect, amounting to 1.1 percentage points at the 3-sector level. After 1995, when the government managed to control inflation in its Plano Real (see also footnote 9), productivity growth became positive in all sectors. Appendix table 1 suggests that productivity growth was particularly high in agriculture and mining, which is related with the commodity boom, but also in chemical manufacturing and financial services. For the period from 1995 to 2008 we again find a large contribution from employment reallocation to services (0.6 percentage points), explaining about halve of aggregate growth.

However, in the latter period, sector trends obscure subsector trends. The reallocation term drops to 0.1 percentage points when decomposing growth at the 35-sector level rather than the 3-sector level. Although the productivity level in overall services is above average (see Table 2), this is not true for all services sub-sectors. In particular, within the services sector labour moves to subsectors such as retail trade and renting of machinery and equipment and other business activities which have below-average productivity levels (see Appendix Table 1). Hence the reallocation effect becomes much smaller in the analysis of detailed sub-sectors. At first sight, this result confirms and strengthens the findings by IADB (2010) and McMillan and Rodrik (2011) that structural change was not conducive to growth in Brazil since 1995. However, in section 5 we show that once making also a distinction between formal and informal activities this no longer holds true for the most recent period after 2000.

(b) Russia

Any analysis of Russian structural change requires detailed knowledge of the treatment of oil and gas activities in the national accounts. Exports of oil and gas are about 20 per cent of GDP during the past decade, but in the national accounts the oil and gas sector accounts only for about 10 per cent of GDP.

This puzzling observation is due to transfer pricing where large Russian oil companies use trading companies to bring their output to market (Gurvich, 2004; Kuboniwa et al., 2005). Because of transfer pricing schemes, the value added in wholesale trade is overestimated, while underestimated in mining. We therefore introduce a new sector consisting of mining and wholesaling, alongside agriculture, industry (excl. mining), and services (excluding wholesaling).

In table 4, production structures of Russia's economy in 1995 and 2008 are shown. Russia is the only BRIC country where the employment share in manufacturing declines after 1995. Workers move from agriculture and manufacturing towards mining and services. In appendix table 2, we find a large decline in the employment share in heavy manufacturing such as machinery equipment, whereas large gains are observed in retail and wholesale trade, as well as public administration.

[Table 4 here]

To measure the contribution of sectors to growth, we decompose aggregate productivity growth from 1995 to 2008. Results are shown in table 5. Applying the decomposition formula to the dataset with 4 or 35 sectors hardly affects the reallocation term. In both cases, employment reallocation contributes about 1 percentage point to growth, which is due to the above-average productivity levels in the expanding services sectors.

Perhaps surprisingly, productivity improvements in mining and wholesale are not the main driver of economic growth, accounting for 0.3-0.4 percentage points of growth.[8] Given that mining activities and wholesale trade services encompass more than those related to oil and gas only, we consider this an upper bound for the contribution of oil and gas to Russia's economic growth. Rather, productivity improvements within industrial sectors (notably food, beverages, and tobacco manufacturing, and basic metals and fabricated metal manufacturing) and services sectors (renting of machinery and equipment and other business services) mainly account for aggregate productivity growth.

[Table 5 here]

(c) India

Scholars of Indian economic development typically analyse growth rates before and after the reforms in the early 1990s as we will do here (Rodrik and Subramanian, 2005). The underlying political and institutional forces of India's GDP growth and its acceleration after the reforms are well documented in the literature (see e.g. Bhagwati, 1993; Rodrik and Subramanian, 2005). From 1981 to 1991, annual productivity growth averaged about 3 per cent. In the post-reform period, growth accelerated to 4.7 per cent annually. Table 6 shows employment shares and relative productivity levels. Since 1981, the agricultural employment share steadily declined from 70 per cent in 1981 to 54 per cent in 2008. Workers moved to both industrial and services sectors (see also Kochar et al., 2006).

After the reforms, we observe fast increase in employment shares in construction, telecommunications and business services, driven by privatization, foreign investment and global outsourcing trends (Kochar et al., 2006). In contrast, manufacturing employment is rather constant with little structural change within; except for the increase in textile manufacturing employment shares (see appendix table 3 and Dougherty (2008) for a discussion).

[Table 6 here]

In table 7, decomposition results are presented using the sector database at the 3 and 31 sector level.[9] Indian productivity growth after the reforms is mainly driven by the expansion in the services sector which is characterized by above-average productivity levels. In both periods, structural change accounts for about 1 percentage point of aggregate productivity change. If we decompose growth using the 31 sector detail, the contribution of reallocation increases almost another halve percentage point. These findings are consistent with Bosworth and Collins (2008), and confirm the findings of McMillan and Rodrik (2011): the contribution of structural change in Asian countries such as India (and China, see below) is much higher than in Latin American countries such as Brazil.

[Table 7 here]

(d) China

China is the paragon of Asia's pattern of structural change, where agricultural workers move towards manufacturing (McMillan and Rodrik, 2011). In table 8, we distinguish the period from 1997 to 2008, which broadly corresponds with the public enterprise reforms in 1997 and China's exchange rate policy after its ascension to the WTO in 2001 (Rodrik, 2011).

[Table 8 here]

Data on China's production structure is shown in table 8, with subsector detail in appendix table 4. Decomposition results are shown in table 9. While broad sectoral trends in China are well understood (see e.g. Bosworth and Collins, 2008), detailed sector trends have not been analysed in a comparative perspective before, due to a lack of data. First of all, the industrial employment share is much higher in China compared to Brazil, Russia, or India, mainly due to manufacturing. In China we observe employment share gains in many manufacturing subsectors: electrical and optical equipment tops the list, but manufacturing activities related to wood, pulp, paper, rubber, and plastics increased as well. In services, on the other hand, structural change is much slower than in the other countries. The overall employment share of services is increasing, but this is highly concentrated in below-average productive sectors such as retail trade and other community and personal services. As a result, the reallocation effect is not higher than in India or Russia, accounting for about a full percentage point of aggregate growth, in line with Bosworth and Collins (2008) and McMillan and Rodrik (2011). Clearly, manufacturing is the main contributor to aggregate productivity growth, driven by increasing employment shares of high-productive industries such as machinery manufacturing. It is in these industries that China stands out from the other BRIC nations.

[Table 9]

5. STRUCTURAL TRANSFORMATION AND THE INFORMAL SECTOR IN BRAZIL AND INDIA

In many developing countries, the informal sector accounts for the majority of employment and a substantial share of value added (Schneider, 2000). In the extended decomposition method in section 3, we have argued that if formal and informal activities within sectors are not distinguished, the role of structural change for growth may not be accurately measured. In this section, we explore the role of employment allocation across formal and informal activities for growth in Brazil and India.[10]

The sector database that we presented in section 2 should be distinguished from the informal sector data that we use in this section. Although the term 'informal sector' is widely used and studied since the first report on informal employment in Kenya by the ILO in 1972 (ILO, 1972), its precise meaning and measurement remains subject to controversy (Henley et al. 2009). We take a pragmatic approach and rely on the definition of informality used in the country itself for collecting statistics. The common definition of the informal sector for India is based on an employment size threshold, where the so-called "organized sector" consists of firms employing 10 or more workers using power, and 20 or more workers without using power (see the data appendix for further discussion). While formal and informal activities in India are classified according to employment size, the activities face a different legal and institutional environment. For Brazil, mostly legal definitions of the informal sector are used, and the overlap between different definitions is imperfect (Henley et al. 2009). We follow the literature and define informal employment according to contract status: a worker is classified as informal if he/she does not have a signed labour card (Perry et al. 2007). Also, autonomous workers, comprising own-account workers and employers of unregistered firms are considered part of the informal sector. Clearly, definitions of the informal sector vary between Brazil and India and absolute sizes should not be compared. But we can use them to analyse trends, which is what we will do here. We find that in India informality is increasing after the reforms reducing aggregate productivity growth, while the opposite is true for Brazil since 2000.

(a) Brazil

For Brazil, consistent time series of formal and informal employment from the national accounts are available since 2000. Value added of informal sectors is estimated using income per worker ratios from surveys of the urban informal economy (Economia Informal Urbana) and household surveys (Pesquisa Nacional por Amostra de Domicílios), which is explained in detail in the data appendix. Employment shares of informal activities in the overall economy decreased substantially from 62 per cent to 55 per cent during the past decade (see table 10). This contrasts with the 1990s for which most researchers find that informal employment increased rather than decreased (Schneider, 2000; Menezes-Filho and Muendler, 2011).[11] Recent formalization of Brazil's economy might be due to a decline in the interest rate and improvements in access to credit, which make it easier and cheaper for firms to borrow (Catão et al. 2009). In addition, Brazil has simplified registration procedures and lowered tax rates for small firms in the SIMPLES program (Perry et al., 2007).[12] Also government-directed industrial policies provide an incentive for firms to formalize in order to be able to win government contracts. As a result, the costs of formalizing a firm are increasingly offset by the benefits.

[Table 10]

Within sectors for which we are able to split formal and informal activities, informal employment is largest in agriculture and lowest in public utilities and financial and business services as expected. In all sectors, informal employment is going down between 2000 and 2008. In fact, the change in overall informal employment is for 77 per cent explained by reallocation towards formal activities within sectors.[13] Therefore, we expect positive reallocation effects as formal activities have much higher productivity levels as compared to informal activities. This is indicated in the last two columns in table 10 which show the productivity level of informal activities relative to the formal activities within a sector. These values are all well below half. It is noteworthy that these ratios are declining over time in most sectors, in particular in manufacturing, suggesting an increasing gap in productivity between informal and formal activities.

Decomposition results in table 11 based on equation (3) suggest that after allowing for employment reallocation towards formal activities, the positive effects of structural change are much higher. Without making the formal/informal split structural change appeared to contribute only a little to aggregate productivity growth, as we found before. After taking account of the increasing formalisation, structural change contributed more than 1.2 percentage points, effectively explaining all of Brazil's growth since 2000. These findings qualify the view by the IADB (2010), and McMillan and Rodrik (2011) that structural change has not been growth-enhancing in Brazil. Clearly, employment reallocation towards formal activities, in particular in distributive trade and in manufacturing, is contributing to growth.[14]

It remains to be seen whether this process of structural change has long-lasting dynamic effects. So far, the trends suggest that only static reallocation gains have been realized as productivity levels in both the formal and the informal sector are stagnant or even go down. This suggests a process in which the most productive informal entrepreneurs choose to formalize (de Paula and Scheinkman, 2011), with the result that productivity levels in both the formal and the informal sector go down. This is reflected in the small or even negative contributions of productivity growth within industry and services (see last two columns in Table 11). In contrast to China, growth-enhancing structural change in Brazil is not accompanied by dynamic productivity growth in industry. This shows that growth-enhancing structural change is necessary but not sufficient for aggregate productivity growth.

[Table 11]

(b) India

For India, we have two different data sources that allow us to distinguish between formal and informal activities and explore the role of structural change for growth. The national accounts provide time series of net domestic product by formal and informal activity for 9 broad sectors. Also, it presents data for organized sector by detailed manufacturing industry based on the Annual Survey of Industries (ASI). We combine both datasets covering 21 sectors of the economy, including 13 manufacturing industries, with for each sector a split between formal and informal activities. Informal employment is derived by subtracting organized employment from total employment obtained in labour force surveys. This residual approach is carried out by sector. Therefore, we use the employment estimates of the national sample survey organization only for survey years (hence our period begins in 1993 and ends in 2004, see the data appendix for further information).

In Table 12, we provide the employment shares and relative productivity levels of informal activities in India by broad sector. The first two columns in Table 12 show that in contrast to Brazil, the share of informal employment in India increased. Also, within almost all manufacturing industries the share of informal employment was rising (Kulshreshtha, 2011), which is partly related to labour market rigidities that prevented modern manufacturing from expanding employment opportunities (Pieters et al., 2011). At the same time, the last two columns show productivity levels of the unorganized sector in India are lagging behind the organized sector and the gap is widening over time, as in Brazil. This might lead to an overestimation of the growth effects of structural change in an analysis which does not account for increasing informality.

[Table 12]

Using the 21-sector data without a formal-informal split, we find that between 1993 and 2004, structural change was growth-enhancing, contributing 1.1 percentage points to aggregate productivity growth (see Table 13), reflecting our earlier findings in Table 7. However, when splitting each sector into a formal and informal part, the contribution of structural change drops to zero. This suggests increasing dualism in the Indian economy with high productivity levels and growth rates in the formal sector, partly achieved by economizing on the use of labour through outsourcing labour-intensive activities to small informal firms (Pieters et al., 2011). And while informal employment is increasing, productivity growth in that sector is stagnating, leading to growth-reducing structural change. In this case, the sectoral productivity growth is less than the weighted sum of formal and informal productivity growth rates. This effect is picked up as a negative reallocation effect in our more detailed decomposition analysis, but not by an analysis based on aggregate data. Also within manufacturing a similar growth-reducing structural change is to be seen (results available upon request), in particular in transport manufacturing, where informality is growing rapidly.

At the very least the results in this section suggest that decompositions of growth should carefully consider the role of employment reallocation across formal and informal activities. Aggregate productivity growth trends hide the growth-enhancing effects of a shift away from informal low-productive activities as in Brazil, and the growth-reducing role of reallocation of employment to informality in India.

[Table 13 here]

6. CONCLUDING REMARKS

New structural economists reinvigorate the argument that the nature and speed of structural transformation is a key factor in explaining economic growth (Lin, 2011). Rodrik and McMillan (2011) argue that structural change is growth-enhancing in Asia, whereas it is growth-reducing in Africa and Latin America. However, empirical analysis of structural change in developing countries has been based on aggregated sector data (e.g. Bosworth and Collins, 2008; IADB, 2010; McMillan and Rodrik, 2011), which may hide diverging trends at a more detailed level and thereby obscure a proper assessment of the role of structural transformation for aggregate productivity growth.

This paper studied patterns of structural change and productivity growth in four major developing countries since the 1980s, the BRIC countries, using a newly constructed detailed sector database. Based on a structural decomposition, we find that for China, India and Russia reallocation of labour across sectors is contributing to aggregate productivity growth, whereas in Brazil it is not. This strengthens the findings of McMillan and Rodrik (2011). However, this result is overturned when a distinction is made between formal and informal activities within sectors. Increasing formalization of the Brazilian economy since 2000 appears to be growth-enhancing, while in India the increase in informality after the reforms is growth-reducing.

The case of Brazil shows that growth-enhancing structural change is necessary but not sufficient for aggregate productivity growth. The shift of employment from informal to formal activities coincided with slow or even negative productivity improvements in formal industry and services. On the other hand, in India, informal activities expanded after the reforms, creating more dualism. The expansion of the low-productive informal activities was accompanied by dynamic formal activities, especially in the manufacturing and business services sector (Eichengreen and Gupta, 2011). India shows that growth-reducing structural change can go hand-in-hand with productivity improvements within particular industries generating high aggregate productivity growth. These divergent growth paths between India and Brazil indicate that within- and reallocation-effects have to be considered in combination in any analyses of structural change. . Clearly, these analyses also depend critically on the level of sector detail used and should be interpreted with care.

The new sector database provides a more fine-grained analysis of economic growth and production in the BRIC countries. As such, the level of detail in this paper is in between micro (firm-level) analysis and macro analysis of growth. A drawback of this approach is that we may still miss out on important dynamics within sectors. For example, Hsieh and Klenow (2009) explore the productivity distribution of firms within detailed manufacturing sectors within India and China and find that resource reallocation towards the most productive firms within narrowly defined industries may double productivity. In the end though, one is interested in the economy-wide effects of structural change and future empirical analysis should aim to analyse the role of resource reallocation for aggregate growth building up from the micro-level. The increasing availability of micro data that allow tracking employees across firms (e.g. McCaig and Pavcnik (2011) for Vietnam, and Menezes-Filho and Muendler (2011) for Brazil), opens up a promising research agenda.

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FIGURES AND TABLES

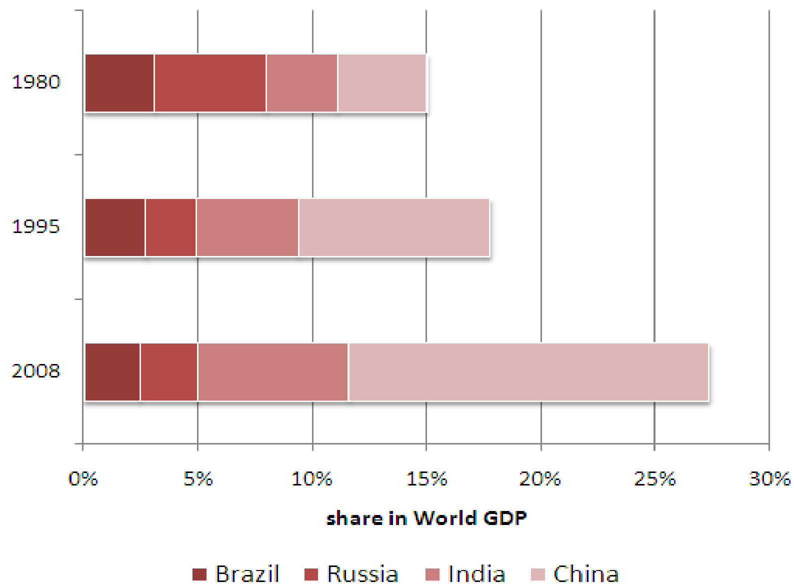

Figure 1. Share of the BRIC countries in world GDP

Note: Total GDP, in millions of 1990 US$ (converted at Geary Khamis PPPs). *Source*: The Conference Board total economy database, September 2011.

Table 1. Industries that are distinguished in the BRIC sector database

number	ISIC rev. 3	Description	3-sector
1	AtB	Agriculture, Hunting, Forestry and Fishing	Agriculture
2	C	Mining and Quarrying	Industry
3	15t16	Food, Beverages and Tobacco	Industry
4	17t18	Textiles and Textile Products	Industry
5	19	Leather, Leather and Footwear	Industry
6	20	Wood and Products of Wood and Cork	Industry
7	21t22	Pulp, Paper, Paper , Printing and Publishing	Industry
8	23	Coke, Refined Petroleum and Nuclear Fuel	Industry
9	24	Chemicals and Chemical Products	Industry
10	25	Rubber and Plastics	Industry
11	26	Other Non-Metallic Mineral	Industry
12	27t28	Basic Metals and Fabricated Metal	Industry
13	29	Machinery, not elsewhere classified	Industry
14	30t33	Electrical and Optical Equipment	Industry
15	34t35	Transport Equipment	Industry
16	36t37	Manufacturing not elsewhere classified; Recycling	Industry
17	E	Electricity, Gas and Water Supply	Industry
18	F	Construction	Industry
19	50	Sale, Maintenance and Repair of Motor Vehicles and Motorcycles; Retail Sale of Fuel	Services
20	51	Wholesale Trade and Commission Trade, Except of Motor Vehicles and Motorcycles	Services
21	52	Retail Trade, Except of Motor Vehicles and Motorcycles; Repair of Household Goods	Services
22	H	Hotels and Restaurants	Services
23	60	Inland Transport	Services
24	61	Water Transport	Services
25	62	Air Transport	Services
26	63	Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies	Services
27	64	Post and Telecommunications	Services
28	J	Financial Intermediation	Services
29	70	Real Estate Activities	Services
30	71t74	Renting of Machinery and Equipment and Other Business Activities	Services
31	L	Public Admin and Defence; Compulsory Social Security	Services
32	M	Education	Services
33	N	Health and Social Work	Services
34	O	Other Community, Social and Personal Services	Services
35	P	Private Households with Employed Persons	Services

Table 2. Employment shares and relative productivity levels in Brazil

	1980	1995	2008	1980	1995	2008
	L_i	L_i	L_i	RP_i	RP_i	RP_i
Agriculture	38%	26%	18%	0.13	0.22	0.36
Industry	23%	20%	21%	1.33	1.39	1.32
Services	39%	54%	61%	1.67	1.23	1.07
All sectors	100%	100%	100%	1.00	1.00	1.00

Note: L_i refers to the employment share of sector *i*. Numbers may not sum due to rounding. RP_i refers to the productivity level of sector *i* relative to the total economy productivity level. *Source*: authors calculations using the sector database. Full 35-sector detail is shown in appendix table 1.

Table 3. Structural transformation and Aggregate Productivity Growth in Brazil

	1995-2008	1995-2008	1980-95	1980-95
	3-sector	35-sector	3-sector	35-sector
Contribution of productivity growth in:				
Agriculture	0.3%	0.3%	0.2%	0.2%
Industry	0.2%	0.2%	-0.2%	-0.2%
Services	0.1%	0.5%	-2.0%	-1.6%
All sectors (1)	0.6%	1.0%	-2.0%	-1.6%
Reallocation (2)	0.6%	0.1%	1.1%	0.8%
Aggregate productivity growth (3) = (1) +(2)	1.1%	1.1%	-0.9%	-0.9%

Note: Aggregate productivity growth is the average annual logarithmic growth rate. Numbers may not sum due to rounding. *Source*: authors calculations using the sector database and equation (3).

Table 4. Employment shares and relative productivity levels in Russia

	1995	2008	1995	2008
	L_i	L_i	RP_i	RP_i
Agriculture	28%	21%	0.26	0.20
Mining and Wholesale trade	6%	9%	3.54	2.47
Industry	27%	23%	1.13	1.13
Services	40%	46%	1.06	1.02
All sectors	100%	100%	1.00	1.00

Note: L_i refers to the employment share of sector *i*. Numbers may not sum due to rounding. RP_i refers to the productivity level of sector *i* relative to the total economy productivity level. *Source*: authors calculations using the sector database. Full 35-sector detail is shown in appendix table 2.

Table 5. Structural transformation and Aggregate Productivity Growth in Russia

	1995-2008	1995-2008
	4-sector	**35-sector**
Contribution of productivity growth in:		
Agriculture	0.1%	0.1%
Mining and Wholesale trade	0.3%	0.4%
Industry	1.2%	1.1%
Services	1.8%	1.7%
All sectors (1)	3.5%	3.4%
Reallocation (2)	0.9%	1.0%
Aggregate productivity growth (3) = (1) +(2)	4.4%	4.4%

Note: Aggregate productivity growth is the average annual logarithmic growth rate. Numbers may not sum due to rounding. *Source*: authors calculations using the sector database and equation (3).

Table 6. Employment shares and relative productivity levels in India

	1981	1991	2008	1981	1991	2008
	L_i	L_i	L_i	RP_i	RP_i	RP_i
Agriculture	70%	64%	54%	0.52	0.46	0.30
Industry	13%	16%	20%	1.87	1.69	1.33
Services	17%	21%	26%	2.20	2.13	2.20
All sectors	100%	100%	100%	1.00	1.00	1.00

Note: L_i refers to the employment share of sector *i*. Numbers may not sum due to rounding. RP_i refers to the productivity level of sector *i* relative to the total economy productivity level. *Source*: authors calculations using the sector database. Full 31-sector detail is shown in appendix table 3.

Table 7. Structural transformation and Aggregate Productivity Growth in India

	1991-2008	1991-2008	1981-1991	1981-1991
	3-sector	**31-sector**	**3-sector**	**31-sector**
Contribution of productivity growth in:				
Agriculture	0.5%	0.5%	0.5%	0.5%
Industry	0.9%	1.0%	0.5%	0.2%
Services	2.5%	1.9%	1.1%	0.8%
All sectors (1)	3.8%	3.4%	2.1%	1.5%
Reallocation (2)	0.9%	1.3%	0.9%	1.4%
Aggregate productivity growth (3) = (1) +(2)	4.7%	4.7%	3.0%	3.0%

Note: Aggregate productivity growth is the average annual logarithmic growth rate. Numbers may not sum due to rounding. *Source*: authors calculations using the sector database and equation (3).

Table 8. Employment shares and relative productivity levels in China

	1987	1997	2008	1987	1997	2008
	L_i	L_i	L_i	RP_i	RP_i	RP_i
Agriculture	59%	51%	40%	0.51	0.35	0.23
Industry	23%	23%	27%	1.59	2.14	2.06
Services	18%	26%	33%	1.88	1.24	1.07
All sectors	100%	100%	100%	1.00	1.00	1.00

Note: L_i refers to the employment share of sector *i*. Numbers may not sum due to rounding. RP_i refers to the productivity level of sector *i* relative to the total economy productivity level. *Source*: authors calculations using the sector database. Full 35-sector detail is shown in appendix table 4.

Table 9. Structural transformation and Aggregate Productivity Growth in China

	1997-2008	1997-2008	1987-1997	1987-1997
	3-sector	**35-sector**	**3-sector**	**35-sector**
Contribution of productivity growth in:				
Agriculture	0.6%	0.6%	0.9%	0.9%
Industry	4.4%	4.6%	4.6%	4.5%
Services	2.5%	2.6%	1.2%	1.5%
All sectors (1)	7.5%	7.9%	6.7%	6.8%
Reallocation (2)	1.2%	0.8%	1.0%	0.9%
Aggregate productivity growth (3) = (1) +(2)	8.7%	8.7%	7.7%	7.7%

Note: Aggregate productivity growth is the average annual logarithmic growth rate. Numbers may not sum due to rounding. *Source*: authors calculations using the sector database and equation (3).

Table 10. Employment shares and relative productivity levels of informal activities within sectors in Brazil

	2000	2008	2000	2008
	IL_i	IL_i	$RPIF_i$	$RPIF_i$
Agriculture	90%	86%	0.09	0.11
Mining	51%	34%	0.32	0.18
Manufacturing	48%	40%	0.33	0.27
Public utilities	29%	18%	0.58	0.39
Construction	82%	74%	0.14	0.16
Trade, hotels, and restaurants	58%	49%	0.29	0.26
Transport services	58%	52%	0.28	0.26
Communication services	68%	66%	0.22	0.22
Financial and business services	23%	20%	0.40	0.34
Other services	63%	59%	0.27	0.26
All sectors	62%	55%	0.27	0.25

Note: IL_i refers to the employment share of informal activities in sector *i*. $RPIF_i$ refers to the productivity level of informal activities relative to the formal activities within sector *i*. *Source*: authors calculations, see data appendix.

Table 11. Structural Change, Formal and Informal Activities, and Aggregate Productivity Growth in Brazil

	2000-2008	**2000-2008**
	10-sector	**informal split**
Contribution of productivity growth in:		
Agriculture	0.33	0.19
Industry	-0.10	-0.50
Services	0.59	0.07
All sectors (1)	0.83	-0.24
Reallocation (2)	0.17	1.24
Aggregate productivity growth (3) = (1) +(2)	1.00	1.00

Note: Aggregate productivity growth is the average annual logarithmic growth rate. Numbers may not sum due to rounding. *Source*: authors calculations, see data appendix.

Table 12. Employment shares and relative productivity levels of informal activities in India

	1993	2004	1993	2004
	L_i	L_i	$RPIF_i$	$RPIF_i$
Agriculture	99%	99%	0.06	0.05
Mining	57%	58%	0.06	0.07
15t16	83%	88%	0.14	0.10
17t19	87%	92%	0.12	0.09
20	98%	99%	0.32	0.10
21t22	72%	88%	0.15	0.09
23	58%	49%	0.01	0.01
24	64%	73%	0.05	0.03
25	70%	73%	0.28	0.47
26	88%	92%	0.09	0.06
27t28	71%	83%	0.13	0.05
29	73%	77%	0.26	0.20
30t33	54%	74%	0.37	0.15
34t35	22%	72%	0.43	0.05
36t37	98%	97%	0.03	0.03
Public utilities	29%	36%	0.08	0.09
Construction	90%	96%	0.12	0.07
Trade, hotels, and restaurants	99%	99%	0.16	0.05
Transport and communication services	69%	83%	0.33	0.32
Financial and business services	55%	74%	1.22	0.28
Other services	64%	72%	0.21	0.15
All sectors	92%	94%	0.12	0.08

Note: IL_i refers to the employment share of informal activities in sector *i*. $RPIF_i$ refers to the productivity level of informal activities relative to the formal activities within sector *i*. Leather and footwear products (19) is included in textile and textile products (17t18). *Source*: authors calculations, see data appendix.

Table 13. Structural Change, Formal and Informal Activities, and Aggregate Productivity Growth in India

	1993-2004	1993-2004
	21-sector	**informal split**
Contribution of productivity growth in:		
Agriculture	0.3%	0.3%
Industry	0.8%	1.4%
Services	1.6%	2.1%
All sectors (1)	2.7%	3.8%
Reallocation (2)	1.1%	0.0%
Aggregate productivity growth (3) = (1) +(2)	3.8%	3.8%

Note: Aggregate productivity growth is the average annual logarithmic growth rate. Numbers may not sum due to rounding. *Source*: authors calculations, see data appendix.

DATA APPENDIX. SOURCES AND METHODS BY COUNTRY

Each BRIC country has a long history in collecting statistics, and while the system of national accounts provides a unifying framework, approaches vary across countries and over time. Therefore, we discuss sources and methods used to construct the sector database by country. We also discuss the estimation of formal and informal employment and value added, which is not part of the sector database.

(a) Brazil

For Brazil, recent time-series data of value added in current and constant prices are obtained from the national accounts at IBGE. These series have the 2000 population census as the reference year.[15] The industry classification of Brazil (CNAE 1.0) matches closely with the 35 industries distinguished in this paper, except for several services industries. For splitting up these services industries we use value added shares from annual firm-level surveys from the statistical office. We split up distributive trade industries using the pesquisa anual de comércio. To separate transportation services from business services and personal and community services, we use the value added shares from the pesquisa anual de serviços.[16] Because for current prices extra detail was added, aggregate price deflators are assumed to be identical for more disaggregated industries.

The national accounts provide employment by industry as well. These occupational employment series are an integral part of the supply and use table framework used by the statistical office, and the series include informal and own-account workers (IBGE, 2008). The integration of value added and employment ensures internal consistency in the time series for Brazil. Similar to value added series, we split up distributive trade industries using employment shares from the pesquisa anual de comércio, and separate transportation services from business services and personal and community services using shares from the pesquisa anual de serviços.

Additional detailed employment data is available from the national account statistics, which allows a distinction between formal and informal employment, for the period from 2000 to 2008. We follow most of the literature on informality in Brazil, and define informal employment according to contract status: a worker is classified as informal if he/she does not have a signed labour card (Perry et al. 2007). Also, autonomous workers, comprising own-account workers and employers of unregistered firms are considered part of the informal sector.[17] Next, we multiply the number of employees without a labour card with an estimate of the average yearly income from the annual household survey (Pesquisa Nacional por Amostra de Domicílios, PNAD) for 2003. Profits of autonomous workers are obtained from the 2003 survey of the urban informal sector (Economia Informal Urbana, ECINF). These profits are a weighted average of the monthly profits for own-account workers and employers of unregistered firms.[18] Combining the income of workers without a signed labour card with the profits of own-account workers and employers of registered firms provides an estimate of informal sector GDP. For other years, we assume the ratio of nominal income per worker is fixed. The imputation is similar to that of India's statistical office, where for various sectors (but not all sectors) ratios of value added per worker are used to estimate domestic product (Kulshreshtha, 2011). To provide some indication of our estimates: for

2003 the share of the informal sector in total GDP is estimated at 28.2 per cent, which is comparable to the 28.4 per cent estimate of informal sector's GDP share in Brazil for the early 2000s by Vuletin (2009), but lower compared to the 39.8 per cent share for 1999/2000 by Schneider (2000).

(b) Russia

Value added series for Russia, following the UN SNA industry classification up to the level of four digits, are available from 2002 onwards at the Federal State Statistics Service of the Russian Federation (Rosstat). Before 2002, official output series are available in the Soviet classification (the All-Union Classification of the Industries of the National Economy, OKONKh). However, Rosstat collected the primary data for 2003-2004 using both the old and new industry classification.[19] This facilitates the transition from one system to the other as it allows linking the value added series. A detailed discussion of the matching procedure due to the change in industry classification is provided in Timmer and Voskoboynikov (2011). Value added series are deflated using physical volume series.

The main source for employment series in Russia is the system of national accounts employment statistics, which provides full-time equivalent jobs by one-digit sectors for the period from 2003-2008. Importantly, this source includes households that produce goods and services for own consumption. In Russia, the share of hours worked from these activities by households is estimated at about 12-15 per cent of total hours worked, and 57.8 per cent of total hours worked in agriculture (Rosstat, 2009). For disaggregation and backward extrapolation of employment series to 1995, we used the balance of labour force, the full circle employment survey, and the labour force survey for particular industries.

(c) India

Value added series for India are obtained from the national account statistics available at the central statistical organization. The most recent version of national accounts 'back-series', which provides long time-series data consistent with the latest vintage of GDP, are used. However, this requires splitting some industries as the national accounts classification is not fully consistent with ISIC rev. 3.1. To split up some of the manufacturing industries, information from the annual survey of industries (for the formal sector), and the national sample survey organizations' survey on unorganized manufacturing (for the informal sector) are used.[20] The approach assures that aggregate values are consistent with those reported in the national accounts. National account statistics provides output net of financial intermediation services indirectly measured for some sectors at a more aggregate level. For consistency of the value added series with the other BRIC countries, we allocated these intermediation services across sectors proportional to their shares in GDP.

Comprehensive statistics on employment in India are relatively less frequent compared to other economic variables such as output or value added. In addition, the quality of available employment data in India is widely discussed among Indian researchers (see Himanshu, 2011; Unni and Raveendran 2007; Sundaram and Tendulkar 2004 among others) and consequently there has been an improvement in the quality of employment statistics over time. Nevertheless, by now, it is widely acknowledged that the quality of the data is still inadequate (Srinivasan, 2010).[21] In this paper, we try to estimate employment by industries in a more consistent way, making use of several available sources on employment in India. Two major sources of employment data by industries covering the entire economy are the decennial population censuses and the Employment and Unemployment Surveys of the National Sample Survey Organization (NSSO). Recently, India also brings out an economic census which also provides employment data during successive economic censuses. Other sources, which cover only selected segments of the economy, includes the Directorate General of Employment and Training (DGET), NSSO surveys on unregistered manufacturing, and the Annual Survey of Industries (ASI). The existence of multiple sources of data, nevertheless, hardly helps make a meaningful comparison across sources or over time, as they differ in coverage, sectors and more importantly worker definitions and frequency of availability (see Srinivasan, 2010). For instance the population census conducted once in ten years, provides employment numbers by industries, while the NSSO surveys conducted once in 5 years provides work participation rates under different definitions, which are not strictly comparable with the census definition. While the DGET and ASI estimates are available annually only for the organized segments of the economy, which constitutes only a minor part of the aggregate economic activity, the Census and NSSO covers all segments of economic activity.

While questions are raised about the methodology and often the observed trends in employment in the data, most researchers implicitly acknowledge the fact that the NSSO "quinquennial surveys provide perhaps the only comprehensive database on employment in the country" (Rangarajan et al., 2011). Given the absence of a better alternative, we also largely depend upon the NSSO employment surveys in the employment series for India. Fortunately, the concepts used in the consecutive NSSO surveys since the 1970s has remained almost the same, making inter-temporal comparison relatively feasible. NSSO provides the share of workers in different segments of the economy in total population. This information, along with population figures from decennial population census is used to derive the number of workers in any given industry.

NSSO defines work as any activity perused for income (pay, profit or family gain), thus including any economic activity that results in the production of goods and services. It provides employment data under three major definitions; 1) Usual Principal Status (UPS); 2) Current Weekly Status (CWS); and 3) Current Daily Status (CDS). While the UPS considers a person as employed depending on the activity pursued by him/her for the major part of the previous year, the CWS considers her employed if she has worked even for one hour during the previous week Under the CDS approach each day of the seven days preceding date of survey is considered as the reference period. A person is considered to be working for the entire day, if she had worked at least for four hours during the day. Among these concepts the Usual Status is the most liberal and widely used concepts (Aggarwal, 2004). We take the employment under the 'usual principal and subsidiary status' (UPSS) definition. This includes all persons who worked for at least 30 days during the past year. The employment definition is to a large extent comparable over the various rounds of the survey, and has a wider acceptance as a measure of employment (Bosworth and Collins, 2008). In addition, this employment definition is used in the national account statistics for India. We use the various quinquennial major rounds of the EUS from the 38th (1983) to the 61st (2004/05) to generate employment for these years. This series of employment is comprehensive in that it is inclusive of casual workers, regular and salaried workers and self-employed workers.

As is evident from the discussion above, there is no time-series data on employment in India, except for the organized segments of the economy. ASI provides annual employment data for registered manufacturing, and DGET provides the same for all registered segments of the economy, in particular at a very detailed level for the recent years. In addition NSSO also provides annual employment data derived from a smaller sample of households (see Srivivasan, 2010 for a discussion of these surveys). We have explored the possibility of using all these information, whenever appropriate, to derive a time-series of employment. For instance, we observe that the thin round based annual employment numbers are quite volatile, particularly at industry level. It has been often suggested that the use of thin rounds may pose little problem if one uses for national aggregate, despite a small sample size resulting in an increase in the variance. But this may not be advised at the detailed industry level.

We obtain time-series of employment for the organized segment of the economy from DGET, and calculate the unorganized employment for survey years as a residual (see Sakthivel and Joddar, 2006). Subsequently, we linearly interpolate the ratio of unorganized to organized employment, which is used to generate time-series of employment in the unorganized sector. The sum of the two for the years in between the survey years is the total employment. Here we make an assumption that the ratio of unorganized to organized grows linearly between two consecutive survey years. In order to examine how sensitive our final results to this assumption, we also generated time-series employment using alternative approaches. NSSO also provides wage rates by workers in its employment surveys. Assuming that wage rate grows linearly between two consecutive survey years, which is a sensible assumption, we imputed annual wage rate. National Accounts provide information on total labour compensation, which is divided by the imputed wage rate to obtain implicit employment. Growth rate of these are used to interpolate time series of employment for non-survey years. The results are quite comparable. A caveat may be added however. The wage rate based calculation excludes self-employed workers, as NAS compensation data does not provide self-employed wages separately. Self-employed workers constitute a major chunk of India's labour force (Srinivasan, 2010). We also explored the possibility of using growth rates of annual thin round surveys of NSSO to generate a time-series of employment at the aggregate level, and for broad sectors. To accommodate the annual fluctuations from the thin sample, but at the same time retain the levels in the major round years, we employ a procedure which uses the movement of the thin sample minus the average annual growth rate of the major rounds over the five year periods. We observed that the annual fluctuations in the thin round data is remarkably high, even at aggregate level, posing doubts about the reliability of this data. We also tried linear interpolation of employment to arrive at time-series for years in between successive NSSO rounds. From National Accounts, one can obtain industry output, and assuming that labour productivity grows linearly, one can impute employment series. Nevertheless, we do not follow this route, as it harms the purpose of conducting a proper productivity analysis.

Estimates of value added for the organized and unorganized sector of India are presented in detailed tables underlying the national accounts. We use the official definition of organized (registered) and unorganized (unregistered) firms, in order to distinguish between formal and informal sectors. The organized sector consists of firms employing 10 or more workers using power, and 20 or more workers without using power. In the national accounts of India, the informal sector is denoted the unorganized sector, because of the non-availability of regular accounts (Kulshreshtha, 2011). Time series of net domestic product (gross domestic product minus consumption of fixed capital) by broad sectors are available from 1980 onwards.[22] These estimates are obtained directly from surveys on organized and unorganized manufacturing and lately also from surveys of distributive trade firms. For other sectors, value added is estimated by multiplying the unorganized labour force by ratios of value added per worker, which were obtained from various surveys (Kulshreshtha, 2011). The informal sector employment data we use for India are based on a residual approach. We subtract the organized sector employment from total employment by sector, itself obtained from NSSO surveys, in order to obtain an estimate of unorganized employment. Organized employment estimates are based on the employment market information program of the DGET, the ministry of labour.

(d) China

The value added series by main sector for China are from the China Statistical Yearbook (CSY) (NBS, various issues). The CSY provides longitudinal series for five broad sectors of the economy, namely agriculture, industry, construction, transportation and commerce, and other services. In addition, the CSY provides more detailed information for services industries, but the sum of these industries is not consistent with the total. Also, an earlier version of the statistical yearbook (NBS CSY, 2001) shows more sectoral detail for services sectors (including employment as well). We adjusted shares, if possible in combination with additional information, such that more detailed sectoral series are consistent with the totals for services. For detail in manufacturing industries, nominal gross value added by sector is obtained from the industrial statistics published in the China Industrial Economic Statistics Yearbook (*CIESY*) by the Department of Industrial and Transportation Statistics, which is part of the National Bureau of Statistics (NBS).

In 1992, the NBS switched from the material product system to the system of national accounts. As a result, no value added data by sector is available before 1993. However, for the pre-1993 period, estimates are available for net value of output. These estimates are compiled following the concepts of the material product system. Wu et al. (2008) adjusts net output values by adding back estimated capital consumption. Linking the series before 1993 results in intertemporally consistent time series of sectoral value added, which is subsequently matched with the total manufacturing sector reported in the statistical yearbook. Value added deflators are the implicit deflators reported in the statistical yearbook by broad economic sectors. For industrial sectors, producer price indices (PPI) are used to deflate the nominal value added.

Similar to value added, basic employment series by main sectors for China are from various issues of the *CSY* and detailed industrial employment series are from various issues of the *CIESY* and the *China Labour Statistical Yearbook* (*CLSY*). These series are not always consistent or reconcilable and contain serious breaks. The three broad-sector series based on population censuses are considered the most consistent estimates and used by other scholars such as Bosworth and Collins (2008). But they contain a serious break in 1990. As shown in Wu (2011), in 1990, 80.1 million additional employees were reported in the 1990 Population Census as compared to the annual estimation with the 16-sector breakdown. This break has never been officially explained or adjusted and the 16-sector employment series stopped after 2002. Wu (2011) found that this break could have emerged in the early 1980s if the 1982 Population Census data are used. He argued that the break by nature could have begun in the early 1970s when there was a change of the employment policy aiming at relaxing regulations on rural enterprises and informal activities. Therefore, his adjustment to the total numbers employed revises the series between 1982 and 1990 by interpolating the 1982 and 1990 census-based additional employment. The additional employment is allocated to major sectors. Based on the existing structure of the five broad sectors, we first assume that one-third are engaged in agriculture, none are engaged in non-material/non-market services, and the rest are allocated into industry, construction and material services. At detailed industry levels in the industrial sector, the *CIESY* data provide employment data for enterprises at or above the "designated size" and the *CLSY* data provide less detailed data for total employment (including all below the "designated size"). The industry data construction follows Wu and Yue (2010) in principle but using the above broad-sector estimates in Wu (2011) as control totals. Wu and Yue (2010) use all industry level census data, namely, China's 1985 and 1995 Industrial Censuses and the 2004 and 2008 Economic Censuses, to make industry level estimates consistent and then allocate the additional employment (below the "size" and outside the "system" or self-employed) into labour-intensive industries only. The industry level estimates are reconciled with the national totals.

Appendix table 1. Employment shares and relative productivity levels for Brazil

	1980	1995	2008	1980	1995	2008
	L_i	L_i	L_i	RP_i	RP_i	RP_i
AtB	38%	26%	18%	0.13	0.22	0.36
C	1%	0%	0%	0.99	2.30	3.14
15t16	2%	2%	2%	1.47	1.28	1.03
17t18	3%	3%	3%	0.76	0.67	0.50
19	1%	1%	1%	0.59	0.51	0.27
20	1%	1%	0%	0.92	0.80	0.61
21t22	1%	1%	1%	2.00	1.74	2.06
23	0%	0%	0%	7.63	6.66	6.10
24	1%	1%	1%	3.87	3.37	5.95
25	0%	0%	0%	2.22	1.94	1.10
26	1%	1%	1%	1.35	1.18	1.05
27t28	1%	1%	1%	2.36	2.06	1.93
29	1%	1%	1%	2.42	2.11	2.33
30t33	0%	0%	1%	3.38	2.95	2.49
34t35	0%	0%	1%	3.47	3.03	3.59
36t37	1%	1%	1%	1.00	0.88	0.91
E	1%	0%	0%	1.88	5.29	5.98
F	9%	6%	7%	0.85	0.92	0.68
50	1%	2%	2%	1.55	0.91	0.80
51	1%	2%	2%	2.73	1.61	1.65
52	6%	11%	12%	1.00	0.59	0.48
H	2%	4%	4%	0.84	0.49	0.98
60	2%	3%	3%	1.00	0.97	0.57
61	0%	0%	0%	5.19	5.07	1.72
62	0%	0%	0%	3.56	3.47	1.65
63	1%	1%	1%	1.75	1.70	0.93
64	0%	0%	0%	2.03	1.98	2.24
J	1%	1%	1%	9.60	7.32	9.65
70	1%	1%	1%	9.80	10.70	13.38
71t74	6%	7%	9%	1.37	1.05	0.85
L	3%	5%	5%	2.44	2.10	1.67
M	3%	5%	6%	1.31	1.13	0.77
N	2%	3%	3%	1.61	1.38	1.14
O	8%	11%	12%	0.47	0.40	0.35
P	-	-	-	-	-	-
All sectors	100%	100%	100%	1.00	1.00	1.00

Note: L_i refers to the employment share of sector *i*. Numbers may not sum due to rounding. RP_i refers to the productivity level of sector *i* relative to the total economy productivity level. P included in O. *Source*: authors calculations using the sector database.

Appendix table 2. Employment shares and relative productivity levels for Russia				
	1995	**2008**	**1995**	**2008**
	L_i	L_i	RP_i	RP_i
AtB	28%	21%	0.26	0.20
C	1%	1%	4.49	4.08
15t16	2%	2%	1.67	1.51
17t18	2%	1%	0.33	0.33
19	0%	0%	0.30	0.43
20	1%	1%	0.80	0.61
21t22	0%	1%	1.72	1.65
23	0%	0%	3.62	3.48
24	1%	1%	1.47	1.66
25	0%	0%	1.27	1.53
26	1%	1%	1.04	1.17
27t28	2%	2%	2.04	1.95
29	3%	2%	0.49	0.65
30t33	2%	1%	0.63	0.99
34t35	2%	2%	1.03	0.77
36t37	1%	1%	2.81	1.68
E	2%	2%	2.17	1.11
F	8%	7%	0.86	0.98
50	1%	2%	0.53	0.66
51	4%	8%	3.24	2.23
52	4%	6%	1.91	1.20
H	1%	2%	1.40	0.83
60	4%	4%	1.92	1.54
61	0%	0%	1.35	1.74
62	0%	0%	3.05	3.76
63	1%	1%	3.05	2.01
64	1%	1%	1.47	1.98
J	1%	1%	1.89	2.86
70	2%	1%	0.91	2.38
71t74	4%	4%	1.23	2.51
L	3%	5%	1.57	0.59
M	9%	8%	0.28	0.17
N	6%	6%	0.48	0.27
O	3%	3%	0.56	0.38
P	-	-	-	-
All sectors	100%	100%	1.00	1.00

Note: L_i refers to the employment share of sector *i*. Numbers may not sum due to rounding. RP_i refers to the productivity level of sector *i* relative to the total economy productivity level. P included in O. *Source*: authors calculations using the sector database.

Appendix table 3. Employment shares and relative productivity levels for India

	1981	1991	2008	1981	1991	2008
	L_i	L_i	L_i	RP_i	RP_i	RP_i
AtB	69.8%	64.0%	54.0%	0.5	0.5	0.3
C	0.5%	0.7%	0.6%	3.9	3.5	2.8
15t16	2.2%	2.3%	2.1%	0.9	0.9	0.8
17t18	3.4%	3.2%	4.0%	0.9	0.8	0.6
19	-	-	-	-	-	-
20	1.3%	1.1%	1.2%	0.9	0.5	0.2
21t22	0.2%	0.3%	0.4%	2.4	2.7	1.1
23	0.0%	0.0%	0.0%	11.7	11.6	29.4
24	0.3%	0.4%	0.5%	3.9	4.4	5.7
25	0.1%	0.1%	0.1%	5.0	4.0	1.9
26	0.9%	0.9%	1.1%	0.7	1.1	0.8
27t28	0.7%	0.8%	0.9%	3.3	3.1	3.1
29	0.2%	0.3%	0.3%	5.0	3.0	2.5
30t33	0.2%	0.2%	0.2%	6.9	5.6	7.7
34t35	0.2%	0.2%	0.3%	4.7	3.9	3.4
36t37	0.6%	0.9%	1.2%	0.7	0.4	0.6
E	0.3%	0.4%	0.3%	6.5	6.8	7.1
F	1.9%	3.5%	6.7%	2.9	1.5	0.9
50	0.2%	0.4%	0.6%	2.5	1.6	1.1
51	0.7%	0.9%	1.4%	4.9	3.8	4.0
52	4.9%	6.2%	7.8%	1.4	1.2	1.1
H	0.8%	0.9%	1.4%	0.9	1.0	1.1
60	2.1%	2.7%	3.9%	2.3	2.0	1.5
61	-	-	-	-	-	-
62	-	-	-	-	-	-
63	-	-	-	-	-	-
64	0.2%	0.2%	0.5%	5.7	5.4	16.1
J	0.4%	0.5%	0.7%	7.5	9.6	10.8
70	0.0%	0.0%	0.1%	187.1	155.5	25.8
71t74	0.2%	0.3%	1.1%	2.6	2.7	3.6
L	2.5%	2.9%	1.6%	2.1	2.1	2.8
M	1.6%	1.7%	2.5%	1.6	1.8	1.4
N	0.6%	0.6%	0.8%	1.7	2.3	2.3
O	2.1%	2.6%	2.3%	1.4	1.0	0.8
P	0.8%	0.6%	1.2%	0.5	0.4	0.2
All sectors	100%	100%	100%	1.0	1.0	1.0

Note: L_i refers to the employment share of sector *i*. Numbers may not sum due to rounding. RP_i refers to the productivity level of sector *i* relative to the total economy productivity level. 19 included in 17t18. 61t63 included in 60. *Source*: authors calculations using the sector database.

Appendix table 4. Employment shares and relative productivity levels for China

	1987	1997	2008	1987	1997	2008
	L_i	L_i	L_i	RP_i	RP_i	RP_i
AtB	59.2%	50.5%	40.2%	0.5	0.3	0.2
C	1.8%	1.8%	1.3%	2.5	2.3	2.5
15t16	1.7%	1.8%	1.9%	2.0	3.0	2.5
17t18	2.4%	2.1%	2.8%	1.3	2.0	1.3
19	0.3%	0.4%	0.8%	0.7	2.0	0.8
20	0.5%	0.6%	1.3%	0.5	1.6	0.9
21t22	0.8%	0.7%	1.5%	1.0	2.3	1.1
23	0.1%	0.1%	0.1%	17.8	7.1	4.8
24	0.9%	1.1%	1.0%	3.0	3.5	4.4
25	0.8%	0.9%	1.5%	0.9	2.0	1.0
26	2.2%	1.9%	1.1%	0.8	2.1	3.0
27t28	1.3%	1.4%	1.3%	2.5	3.4	4.7
29	1.9%	1.4%	1.5%	1.1	2.5	3.3
30t33	0.9%	1.1%	2.0%	1.5	3.5	3.8
34t35	0.5%	0.7%	0.8%	1.1	3.0	4.7
36t37	1.6%	1.2%	1.0%	0.3	0.5	0.9
E	0.3%	0.4%	0.5%	9.2	5.0	5.4
F	4.5%	5.7%	6.7%	1.4	1.0	0.7
50	-	-	-	-	-	-
51	1.2%	1.7%	1.8%	8.3	3.7	3.3
52	3.2%	4.5%	4.9%	0.6	0.3	0.3
H	1.2%	1.7%	2.5%	1.7	1.1	0.8
60	1.9%	2.0%	2.4%	1.6	1.8	1.6
61	0.2%	0.3%	0.2%	2.0	1.9	1.7
62	0.1%	0.1%	0.1%	2.0	1.9	1.7
63	0.3%	0.3%	0.3%	2.0	1.9	1.7
64	0.6%	0.7%	0.9%	0.6	1.7	2.3
J	0.3%	0.5%	0.6%	13.8	9.4	8.9
70	0.1%	0.1%	0.2%	51.1	26.9	19.2
71t74	0.6%	0.5%	0.5%	3.1	4.4	6.2
L	1.7%	1.7%	1.9%	1.0	1.4	1.1
M	2.5%	2.5%	2.7%	0.9	0.8	0.7
N	0.9%	0.7%	0.9%	1.0	1.3	1.2
O	3.6%	9.0%	12.8%	0.4	0.2	0.1
P	-	-	-	-	-	-
All sectors	100%	100%	100%	1.0	1.0	1.0

Note: L_i refers to the employment share of sector *i*. Numbers may not sum due to rounding. RP_i refers to the productivity level of sector *i* relative to the total economy productivity level. 50 partly included in 51 and partly in 52. P included in O. *Source*: authors calculations using the sector database.

ENDNOTES TEXT

[1] For a discussion of policies to promote diversification, see Cimoli et al. (2009) and the symposium around Lin's paper (Lin, 2011) in the World Bank Research Observer.

[2] The sector database is available to the referees from the authors upon request. The sector database will be published online [website not disclosed].

[3] To provide some indication on the size of the informal sector, we find in section 5 that the informal share in total manufacturing employment is about 48 percent in Brazil in 2000, and 85 percent in India in 2004.

[4] The decomposition is based on average labor productivity, but ideally should be based on marginal productivity. If a production function is Cobb Douglas, the marginal productivity of labor is average productivity times the labor share in value added. If labor shares differ across sectors, an analysis based on average productivity may be misleading. For example, high average productivity in capital-intensive industries such as petroleum refining (ISIC rev. 3, sector 23) and public utilities (ISIC rev. 3, sector E) may simply reflect a low labor share (see appendix table 1 to 4 for data). We assume that marginal and average productivities have a strong correlation. Mundlak et al. (2008) and Gollin et al. (2011) found that differences in average productivity in agriculture and manufacturing are related to large gaps in marginal productivity). Similarly, controlling for capital, productivity is higher in formal as compared to informal activities (de Vries, 2010) .

[5] Various decomposition methods have been proposed in the literature. Initial-year, mid-year, or end-year shares can be used, with the former typically giving a greater weight to the reallocation-effect as compared to the latter. To minimize this index number problem, we use mid-year average employment shares (see Balk (2001) for an overview). Alternatively, one can use value added shares as weights instead of employment, as in Bosworth and Collins (2008). This approach is less appealing as it does not focus on a reallocation of inputs but of outputs.

[6] The within-effects by sector and the reallocation effect are multiplied with the period-average annual productivity growth rate after the decomposition.

[7] In the literature on economic growth in Latin America, it is common to analyze growth rates before and after 1990 since most reforms were implemented around that year (e.g. IADB, 2010; McMillan and Rodrik, 2011). For

Brazil, however, we prefer to consider the period before and after 1995. Brazil faced a prolonged period of (hyper-) inflation from 1986 to 1994, which crippled productivity growth. Only after the successful introduction of the Plano Real in 1994 did hyperinflation cede and did productivity growth resume (see Baer (2008) for a discussion of the Plano Real). If we consider the same period from 1990 to 2005 at the 35-sector level, as in McMillan and Rodrik (2011), we also find that structural change was not conducive for growth in Brazil.

[8] The 0.4 percentage points contribution in the decomposition with 35 sectors is equally split between mining activities (0.20 percentage points) and wholesale trade services (0.24 percentage points).

[9] For India, industry 19 (Leather and footwear) cannot be separated from 17t18 (Textile and textile products). Also, transport services are grouped as 60t63. Therefore, the sector database distinguishes 31 sectors for India.

[10] Data to split informal and formal activities within sectors is much harder to come by for Russia and China, and we therefore restrict our analysis in this section to Brazil and Russia.

[11] The lack of comparable data on informal employment and value added does not allow us to distinguish between formal and informal activities for the 1990s. We expect structural change would lower growth during this period, as workers moved towards low-productive informal activities (Menezes-Filho and Muendler, 2011).

[12] The SIMPLES program was introduced in the mid-1990s and gradually expanded across the Federal states of Brazil thereafter. After 2007, a unified tax regime for small firms was introduced, which is known as 'Super Simples'.

[13] We decomposed the change in the share of informal workers in total employment between 2000 and 2008 to explore the effect of within and between industry shifts. Consider:

$$\Delta IL = IL_t - IL_{t-1} = \sum_i \Delta IL_i \overline{L_i} + \sum_i \Delta L_i \overline{IL_i},$$

where IL_i refers to the employment share of informal activities in sector *i*, and $\overline{L_i}$ refers to the average share of sector *i*'s employment in total employment. The change in overall informal employment is for 77 percent explained by the first term.

[14] Detailed results (not shown) are available from the authors upon request.

[15] Previously, time-series in Brazil had 1985 as the reference year. Brazil revised its GDP upward following the shift to 2000 as the reference year. New activities were discovered in the 2000 population census and the value added of several sectors was higher than previously estimated (IBGE, 2006). The statistical office released new time series

by industry back to 1995. Employment and value added series for years before 1995 were linked using an overlapping year.

[16] A limitation of using shares from these firm surveys for disaggregation is that informal firms are not included, which may bias the more detailed estimates. The surveys have an employment threshold for including firms (e.g. 20 employees in the case of the pesquisa anual de comércio). Ideally, we would have used information from economic censuses that include informal activities. However, Brazil's latest economic census dates back to 1985 after which the statistical office started the annual surveys.

[17] Henley et al. (2009) examine three definitions of the informal sector in Brazil: whether a worker has a signed labor card, whether a worker contributes to social security, and whether a worker is employed in a firm with five or less employees. We find that informal employment decreased using the first and the second definition. Informal employment patterns might be different for the third definition as the SIMPLES program, which simplified and lowered taxes for small firms, created the perverse incentive for firms to remain small in order to pay a lower tax rate (Perry et al. 2007).

[18] Profits of autonomous workers are included in Gross Operating Surplus (GOS). If we subtract the income of autonomous workers from GOS, the share of GOS in value added drops from 53 percent to 30 percent. A common assumption of the capital share in income is 0.3 in macroeconomic models (Jorgenson and Timmer, 2011), thus our imputation gains some credibility.

[19] The Soviet industry classification OKONKh (Obshchesoi͡uznai͡a klassifikat͡sii͡a otrasleĭ narodnogo khozi͡aĭstva) was developed for the planned economy in line with the concept of material products. The last revision of this Soviet classification was introduced in 1976, and is difficult to reconcile with international counterparts. For a detailed discussion of the classification, see Masakova (2006).

[20] The following manufacturing industries were split up: rubber and petroleum products, basic metals and metal products and electrical machinery. In addition, some of the service sectors (distributive trade industries, and real estate and business services) were split up. The latter was accomplished by using information from recent surveys in the case of real estate and business services and additional information underlying Kolli (2009) on the retail trade sector.

[21] Srinivasan (2010) argues that it is the complexity of Indian labor market such as shifting from self-employment to wage employment in off seasons and frequent entry to and exit from the work force that causes much of the conceptual, measurement and data gathering problems.

[22] Excluding consumption of fixed capital from GDP might distort value added shares in favor of informal firms, which are usually less capital intensive. We have no data to explore this issue further, but a correction could imply that the reallocation effect towards informal manufacturing increases (see section 6).