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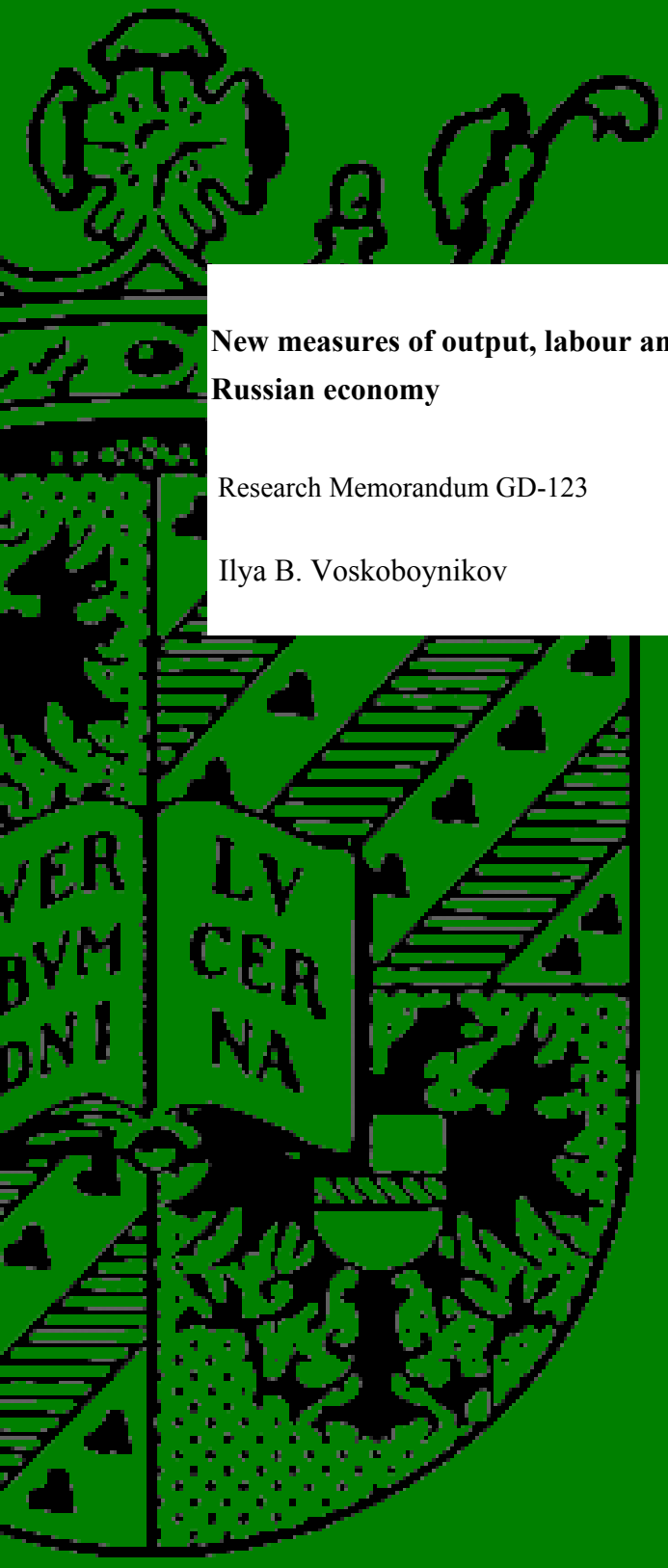

New measures of output, labour and capital in industries of the Russian economy

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RESEARCH MEMORANDUM

New measures of output, labour and capital in industries of the Russian economy

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Abstract

Russia is an important part of the world economy both now and in the past. Indeed, one would expect an abundance of studies on Russian economic development. In the past, growth and performance in planned economies vis-à-vis the Western world did attract much attention. These types of studies contributed to two revolutions of development thinking, which are the "big push" approach based on success of Soviet industrialization in 1930-s and the unexpected collapse of the Soviet Union in 1991. However, recent performance of the Russian economy is less considered while much could be learned from studying the post-Soviet economic development. The key obstacle to the research in case of Russia is data availability. Detailed industrial data of labour, capital and output from early 1990-s onwards is not available both in the official statistics and in the literature. The present paper addresses this gap, providing detailed description of the newly developed dataset, which covers 34 industries in NACE 1.0 classification in 1995-2009. The paper also reports results of output growth rates decomposition into contributions of labour, capital and productivity (industrial growth accounting). Using more detailed data and better theoretical foundation it shows that the contribution of capital to economic growth in Russia is much more substantial that it has previously been reported in the literature until recently.

Keywords: economic growth, Industrial growth accounting, the Russian economy, economies in transition

JEL: O47, P27

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1. Introduction

Recently researchers have shown a renewed interest in issues of economic growth, structural change and productivity on the basis of cross-countries comparisons. The industry-level perspective is promising for a deeper understanding of development patterns because growth can originate in a wide range of industries such as agriculture, mining, manufacturing or financial services. Growth in these industries will be of a fundamentally different nature. Moreover, growth can be explained not only by changes in productivity within industries, but also by reallocation of labour and capital inputs among them. This reallocation is found to be a defining characteristic for growth in successful countries (van Ark, O'Mahony, and Timmer 2008; Lin 2010; McMillan and Rodrik 2011).

Russia is an important part of the world economy both now and in the past. Indeed, one would expect an abundance of studies on Russian economic development. In the past, growth and performance in planned economies vis-à-vis the Western world did attract much attention (Ofer 1987). These type of studies, also known as Sovietology, contributed to two revolutions of development thinking, which are the “big push” approach based on success of Soviet industrialization in 1930-s and the unexpected collapse of the Soviet Union in 1991 (Lin 2010). Ellman (2009) highlighted other influences of the enormous Sovietology literature on economics on issues such as the Gerschenkron effect in growth statistics, the role of national institutions in determining growth, the ratchet effect in economic administration, economics of property rights, the informal sector and famines.

However, recent performance of the Russian economy is much less considered while much could be learned from studying the post-Soviet economic development. The present paper addresses this gap.

The case of Russia is important for an understanding of many issues common for economies in transition, such as disorganization introduced by Blanchard and Kremer (1997) and search friction described by Roland and Verdier (1999). The Soviet Russia was the largest and the oldest planned economy, so specifics of the command pattern of development both on

micro and macro levels should appear in Russia much better than in other former Socialist economies. Equally important, the process of transition was documented in Russian primary statistics better than in statistics of many other former Socialist countries. Indeed, Russian national statistics has been enriched with the long Soviet tradition of thorough primary data collecting[1] and the post-transition attention to such issues as measurement of the shadow economy and bridging of the old Soviet and the up-to-date international statistical standards[2]. It could generate important insights for theories of long-run economic growth on the basis of data available.

In contrast with relatively smooth transformation of the Russian statistics, statistical offices of many former socialist countries substituted Soviet-like elements of the statistical system for an international system all-at-once, breaking long time series of output, labour and capital[3]. Consequently, Russia is one of a few economies in transition, where the transformation path was registered completely and in detail.

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[1] Blades and Harrison (1992) highlighted the requirement, which existed for statistical offices of the Central and East European countries, to keep detailed track on the production plan of each firm. They mention enormous piles of statistical forms to be filled. Although after transition the statistical offices lost their power and firms became more relaxed in submitting these forms, until now many statistical questionnaires in economies in transition are more detailed than their counterparts in developed economies. Bratanova (2003, Ch. 3) analyses one of such surveys inherited by former Soviet republics from the Soviet statistics, which is the survey of fixed assets *Form 11*.

[2] On the basis of its own unique experience the Russian statistical office contributed to the OECD Manual of measurement of the non-observed economy (OECD 2002) and implementation of National Accounts in economies in transition (UN 1996). Herrera (2010) provides detailed description of transformation of Russian official statistics from MPS to SNA, using it as the case of a successful integration of such a complicated international institution as SNA-based national statistics.

[3] For example, detailed and reliable statistics of fixed capital of East Germany was abandoned after the unification, because statisticians did not find an approach for conversion of value measures from Mark of former GDR to German Mark. Another reason was a fast and unobservable in statistics obsolescence of "communist" fixed capital in the East Germany (Ritter 1997). Bratanova (2003, Ch. 6) provided more examples of countries which terminated collecting detailed data of capital stocks. She mentioned Hungary, the Czech Republic, and the Slovak Republic. Because of high inflation in early transition and inability of the government to provide the revaluation of assets some former Soviet republics broke the series of capital stocks. Another problem was of the same nature as in Germany – they had to adapt the new national currency instead of the Soviet/Russian ruble.

One of the key questions that will be dealt with in this paper is the issue about the sustainability of the growth trajectory in Russia. Economic growth in most former socialist countries, including Soviet Russia, before transition was found to be driven mainly by growth in inputs, also known as *extensive* growth (Ofer 1987, p. 1786). Once transition happened, the growth path of many Eastern European countries became productivity-driven, known as *intensive* growth (Campos and Coricelli 2002, p. 795). This matches the story that elimination of price distortions that were abundant in the planned economy period improved efficiency through better allocation of production factors across activities. Efficiency was also improved as firms were motivated to diminish real production costs. In planned economy the only criteria of performance for the firm was fulfilling the production plan. The process of shifting to more efficient technologies and management practices after plan-market transition could explain the intensive growth path.

However, this transformation from extensive to intensive growth does not necessarily characterize Russian growth after transition. The Russian economy stands out in many ways from its Eastern European counterparts. Before transition it had an industrial sector that was already well-advanced and bigger than in most other countries. Next, it has an abundance of tradable natural resources; territory is large; the distance to the European Union (EU) is longer; and transport infrastructure is less developed. Because of the difference in industrial structure complexity of production should be different as well. Finally, taking into account that some former Socialist countries are members of EU now, the gap in the level of institutional development is substantial.

The current literature is divided on the question what is driving Russian growth. On the one hand, part of the literature explains Russia's growth by high oil and gas prices[4]. Associated investments financed by wind-fall profits could amplify development[5] and indirect evidence for this is the substantial contribution of oil and gas sector to GDP growth[6]. On the other hand, the

[4] (Ahrend 2006; Beutin, Veugelers, and de Souza 2007; Gaddy and Ickes 2010; Connolly 2011)

[5] (Ahrend 2006)

[6] (Gurvich 2004; Kuboniwa, Tabata, and Ustinova 2005; World Bank 2005)

growth accounting literature suggests that growth in Russia is driven by improvements in productivity[7]. If growth is indeed productivity driven, Russia would have managed somehow to escape the natural resource curse, transforming natural resources into productive assets[8].

This paper aims to contribute to this debate by linking long time-series on industrial output, inputs and productivity because a key obstacle to the research based on long run industrial time series in case of Russia is data availability. *Detailed* data of output for industries in an international industrial classification, which cover the total economy, has become available in official publications of the Russian statistical office (*Rosstat*)[9] only recently, whereas detailed series of labour and capital are not issued. These official publications cover the period from early 2000-s at best (Rosstat 2010b). For years before 2003 industrial data is available only in the old Soviet industrial classification[10], which is inconsistent with the new one[11], or any other international one. Conventional suppliers of industrial data for international comparisons such as the United Nations (*UN*), the Organization for Economic Co-operation and Development (*OECD*) and the International Labour Organization (*ILO*) do not provide additional information, because they are based on the official series and do not go beyond the publicly available official data of *Rosstat*.

Another key concern is the quality of the official data. Canonical prerequisites for industry growth accounting are a set of consistent data on labour and capital inputs and outputs within the System of National Accounts (*SNA*) framework[12]. *SNA* is the international

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[7] E.g. (World Bank 2008, Ch. 1)

[8] (van der Ploeg 2011)

[9] For convenience all sources published by the Russian statistical office are referenced as *Rosstat* in spite of the fact that the official name of the Russian/Soviet statistical office has been changing in time.

[10] Industrial classification of industries of the National Economy, OKONKh (*Otraslevaĭa klassifikatsiĭa narodnogo khoziaĭstva* (Rosstat 1976)). From now on the OKONKh classification will be mentioned as "the Old classification".

[11] The new industrial classification, OKVED (*Obshcherossiĭskiĭ klassifikator vidov ėkonomicheskoĭ deiatel'nosti*) coincides with NACE 1.0 to the four-digit level. OKVED/NACE 1.0 is mentioned as "the New industrial classification".

[12] (OECD 2001b; Jorgenson, Ho, and Stiroh 2005)

standard of measures of economic activity, which amounts to a coherent and consistent set of macroeconomic accounts of sources and use of national income. However, in case of Russia some of these elements are not consistent with each other, whereas others do not even exist in the official statistics for the whole period 1995-2009. SNA was introduced in Russia in early 1990-s, substituting for the old Soviet national income accounting called the Material Product System (*MPS*)[13]. But this process was slow and even nowadays some rudiments of *MPS* have survived in the system of national statistics. This coexistence creates conceptual inconsistencies between different blocks of the Russian statistical system[14].

Also the quality of official data is not consistent over the years of transition. In early 1990-s Russian statisticians had no experience in national accounting, conducting households and labour surveys, and preparing statistics of prices in a period characterized by high inflation[15], and mass reallocations of capital and labour force. This led to the low quality of data in this period[16] even in comparison with Russian statistics of the 2000-s. In addition, the industrial classification was changed in 2003 and national accounts methodologies were revised four times during 1990-2009. The old industrial classification was introduced in the period of planned economy. It was made up within *MPS*, and inconsistent with any international classification (Masakova 2006).The old industrial classification was substituted by the new one in 2003, resulting in a break in the series. *Rosstat* did not revise *the National Accounting System (NAS)*[17] back before 2002 in the new industrial classification. In other words,

[13] In Soviet and Russian literature this system is called the Balance of National Economy (*Balans narodnogo khoziaistva*). The first revision of it was published for 1923-1924 economic year (Popov 1926). I use term *the Material Product System* to provide consistency with the bulk of the literature in English.

[14] (Ivanov 1987; Ivanov, Rjabushkin, and Homenko 1993; Masakova 2006; Ivanov 2009)

[15] Bessonov (Bessonov 2005, pp. 23-34) pointed to the fact that under high inflation substantial errors in measurement of prices are inevitable even if experienced statisticians apply up-to-date methodology.

[16] Poor quality in years of early transition is common for transition economies (Campos and Coricelli 2002).

[17] Term *NAS* will be used to reference the data of the System of National Accounts for the Russian economy, whereas term *SNA* will mean the international standard of national statistics.

NAS at the level of industries in the new classification do not exist before 2002[18]. All these issues put severe limitations on any study of recent long-term growth in Russia and complicate the growth accounting exercise for industries of the Russian economy [19].

However, there is no complete absence of data. In contrast with *NAS*, such primary sources as regular firms and households surveys in many aspects are well developed and have been collected for decades. Detailed data of primary sources in many cases is published and may be used to fill gaps in *NAS* statistics, improving official data for the purpose of detailed industrial growth accounting.

The objective of this study is to compile a consistent dataset of labour, capital and value added time series for 34 industries of the Russian economy from 1995 to 2009, taking into account differences in *NAS* revisions, change of industrial classifications, measurement issues of labour and capital, and improving accuracy of estimates of factor shares in value added.

This dataset is more detailed and elaborated than data currently used in the literature. A few studies apply growth accounting techniques to infer the contributions of labour and capital input growth on Russian growth on the one hand, and improvements in efficiency in the use of inputs (multi-factor productivity) on the other. This is done at the level of the total economy or a few highly aggregated sectors[20], and mainly covers the period until early 2000s. In comparison, these types of analysis for developed economies and new *EU* members are exercised at the level of many dozens of industries[21] and have shown that a more detailed

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[18] It is interesting to note that the issue of consistency between the Soviet industrial classification and an international one is not new in the literature. It was intensively developed for the US- the USSR comparisons at the level of industries. For example, Revenko (1966; 1972) compiled the composition of labour, capital and labour compensation of the U.S. manufacturing in the Soviet industrial classification for a couple of years at a very detailed level.

[19] See more about different revisions of *NAS* in Appendix A.T1.

[20] (De Broeck and Koen 2000; Dolinskaya 2002; Voskoboynikov 2003; Bessonov 2004; Iradian 2007; Kvintradze 2010; Kuboniwa 2011)

[21] E.g. (van Ark, O'Mahony, and Timmer 2008; Timmer and others 2010; Havlik, Leitner, and Stehrer 2012).

analysis of industry growth paths reveals new patterns of growth which are hidden in more aggregate studies.

This paper has the following structure. Section two introduces the industrial growth accounting approach. It outlines what type of data is needed for the analysis. The following sections deal with an issue how the existing economic statistics on Russia should be transformed to make it consistent with the growth accounting methodology. Starting from section 3 I discuss sources of relevant data available with references on data published; the approach to provide consistency with the existing elements of *NAS* and growth accounting methodology, and then results and limitations[22] of the approach. Section 3 considers nominal and real value added, for which issues of consistency with *SNA* are relatively minor and mainly involve the link between the two industry classifications. In developing data of labour (section 4) and capital (section 5), in addition to the classification problem I consider the consistency issues between rudiments of *MPS* (*the Balance of Labour Force, the Balance of Fixed Assets*) and *SNA*. Another important issue, which appears in section 4, is the coverage of various survey samples, for which data is available (such as coverage of the total economy, all organizations, large and medium firms). Next, section 6 considers the approach for imputiation of factors' shares in value added which are needed to evaluate the marginal productivity of inputs. I compare various sources of labour and capital introduced in previous sections as well as new evidence based on micro data. Combining all results together I obtain the favorite dataset as well as alternative datasets, which are based on various simplified assumptions.

Finally, section 7 provides growth accounting decomposition of value added growth rates into contributions of factors and multifactor productivity on the basis of the newly developed data. Starting from the dataset which is commonly used in the literature I replicate the main finding of the extant literature that MFP is the main source of growth in Russia. Then shifting to the improved dataset (with better investment deflators; more accurate factors' shares and depreciation rates, which vary across industries; capital input on the basis of

[22] There are two types of limitations for this dataset. The limitations of the first type are general for industrial growth accounting datasets. They have been summarized in (O'Mahony and Timmer 2009). The limitations of the second type are specific in case of Russia. They are in the focus of this section.

services instead of stocks) I found that the contribution of MFP is much less mostly because of the increased role of capital. After all it is revealed that more than half of total output growth is explained by input growth.

2. Growth accounting approach

The growth accounting methodology allows a breakdown of output growth rates into a weighted average of growth in various inputs and productivity change. It is based on the neoclassical framework of Solow (1956; 1957) and developed further in the studies of Jorgenson and Griliches (1967) and Jorgenson, Gollop and Fraumeni (1987). Within this approach productivity growth represents disembodied technical change. Taking into account constant returns to scale multifactor productivity growth is necessary to increase standards of leaving.

This approach is used for building a consistent set of inputs, output and productivity measures for the Russian economy in 1995-2009. This section follows the representation of value added-based industrial growth accounting of Jorgenson, Ho and Stiroh (2005, Ch.8), and Timmer and others (2010, pp. 54-7).

The quantity of value added $\left(Z_j\right)$ in industry *j* may be represented as the function of capital services, labour services and technology as

(1) $$Z_j = g_j\left(K_j, L_j, T\right)$$

Under the assumptions of competitive factor markets, full input utilization and constant returns to scale the multifactor productivity (A) is defined as[23]

[23]Notation: $\Delta \ln X = \ln X_t - \ln X_{t-1}$.

(2) $$\Delta \ln A_j \equiv \Delta \ln Z_j - \bar{v}^Z_{K,j} \Delta \ln K_j - \bar{v}^Z_{L,j} \Delta \ln L_j$$

where $\bar{v}^Z_{\circ,j}$ is the period-average share of the input in nominal value added. The value shares of capital and labour are defined as follows

(3) $$v^Z_{K,j} = \frac{p^K_j K_j}{p^Z_j Z_j}; \quad v^Z_{L,j} = \frac{p^L_j L_j}{p^Z_j Z_j}$$

such that they sum to unity. The quantity of value added is defined implicitly from a Törnqvist expression for gross output:

(4) $$\Delta \ln Z_j = \frac{1}{\bar{v}^Y_{Z,j}} \left(\Delta \ln Y_j - \left(1 - \bar{v}^Y_{Z,j}\right) \cdot \Delta \ln X_j \right),$$

where Y - gross output, X - intermediate inputs, $\bar{v}^Y_{Z,j}$ is the period-average share of value added in gross output. The corresponding price index for value added is defined implicitly to make the following value identities hold:

(5) $$p^Z_j Z_j = p^K_j K_j + p^L_j L_j = p^Y_j Y_j - p^X_j X_j.$$

Rearranging equation (2), industry value added growth can be decomposed into the contribution of capital, labour and multifactor productivity:

(6) $$\Delta \ln Z_j = \bar{v}^Z_{K,j} \Delta \ln K_j + \bar{v}^Z_{L,j} \Delta \ln L_j + \Delta \ln A_j,$$

Where $\bar{v}^{Z}_{\circ,j}$ is the period average share of factor compensation in value added of industry *j*. According to Harberger (1998), positive growth rates of multifactor productivity mean diminishing of real costs of production.

The volume growth of GDP is defined as a Törnqvist weighted average of value added growth in industries as follows

$$(7) \qquad \Delta \ln Z \equiv \sum_j \bar{v}^{GDP}_{Z,j} \cdot \Delta \ln Z_j =$$

$$= \sum_j \bar{v}^{GDP}_{Z,j} \cdot \bar{v}^{Z}_{K,j} \cdot \Delta \ln K_j + \sum_j \bar{v}^{GDP}_{Z,j} \cdot \bar{v}^{Z}_{L,j} \cdot \Delta \ln L_j + \sum_j \bar{v}^{GDP}_{Z,j} \cdot \Delta \ln A_j,$$

where $\bar{v}^{GDP}_{Z,j}$ is the average share of value added of industry *j* in GDP.

Equation (7) shows that the GDP growth rates are based on *direct aggregation across industries*. Taking into account differences in prices on labour and capital, GDP may grow not only because of changes in total amounts of inputs involved, but also because of inputs reallocation. For various questions it makes sense to split these two effects. For this it is necessary to introduce a definition of aggregate MFP, which is an alternative to (2) and based on the aggregate production possibility frontier (APPF):

$$(8) \qquad \Delta \ln A^{APPF} \equiv \Delta \ln Z - \bar{v}^{Z}_{K} \cdot \Delta \ln K - \bar{v}^{Z}_{L} \cdot \Delta \ln L,$$

where $\bar{v}^{Z}_{\circ}$ is the period-average share of the input in nominal value added for the total economy and $\Delta \ln K$ and $\Delta \ln L$ are growth rates of capital and labour for the total economy as well.

The key difference of (8) from (2) and (7) is the assumption that in (8) input prices are the same across industries. If this prices the same, the aggregation of factors will be different from (7). For capital from $\sum P_{K,j} K_j = P_K K$ I have

(9) $\sum K_j = K$

and for labour from $\sum P_{L,j} L_j = P_L L$

(10) $\sum L_j = L.$

Substitution of (7) into (8) and rearranging the equation I obtain the new representation of $\Delta \ln A^{APPF}$

(11) $$\Delta \ln A^{APPF} = \sum_j \bar{v}_{Z,j}^{GDP} \cdot \Delta \ln A_j + \\ + \left(\sum_j \bar{v}_{Z,j}^{GDP} \cdot \bar{v}_{K,j}^{Z} \cdot \Delta \ln K_j - \bar{v}_K^Z \cdot \Delta \ln K\right) + \\ + \left(\sum_j \bar{v}_{Z,j}^{GDP} \cdot \bar{v}_{L,j}^{Z} \cdot \Delta \ln L_j - \bar{v}_L^Z \cdot \Delta \ln L\right)$$

so

(12) $$\Delta \ln A^{APPF} = \sum_j \bar{v}_{Z,j}^{GDP} \cdot \Delta \ln A_j + REALL_K + REALL_L,$$

where $\sum_j \bar{v}_{Z,j}^{GDP} \cdot \Delta \ln A_j$ is the weighted average of MFP growth in industries, and terms $REALL_K$ and $REALL_L$ reflect reallocation effects of inputs of capital and labour across industries. The reallocation effect is positive if prices of factors are not equal across industries and an industry with higher input price has higher growth rates of the input.

A number of important limitations need to be considered of the models outlined above. I only considered models of value added. Value-added - based growth accounting is more restrictive than the gross output-based model. In particular, in case of the value-added approach it is assumed that the gross output production function

(13) $$Y_j = f_j\left(X_j, K_j, L_j, T\right)$$

is separable in capital, labour and MFP, so there is no symmetry between primary inputs, capital and labour, and intermediate inputs X_j. It means that (13) may be represented by (1) as

(14) $$Y_j = f_j\left(X_j, g_j\left(K_j, L_j, T\right)\right)$$

It is based on the assumption that real diminishing costs take place because of better use of labour and capital, but not of intermediate input. This restrictive version of growth accounting is used in the analysis, because there are no detailed time series of intermediate inputs available for Russia, which are the essential prerequisite for the gross output based approach.

The second type of limitations is related to the assumptions of perfect competition and equilibrium in the neoclassical growth accounting framework. These might not hold for the Russian economy, in particular in earlier years of transition. However, there are arguments why this approach is useful. First, growth accounting is a standard framework for international comparison of productivity not only among developed economies, but also among developing economies and economies in transition. It has been implemented in the literature even for planned economies (Kaplan 1969; Ofer 1987; Krugman 1994). So, it may be used for comparisons with the existing analyses in the literature. Second, it could be considered as the benchmark for alternative calculations based on different set of assumptions such as non-constant economies of scale and mark-ups (Barro 1999; Basu and Fernald 2001).

The third type of limitations of doing growth accounting for the Russian economy has to do with the accuracy and drawbacks of data available in *NAS*. The following subsections of this chapter deal with this problem, transforming the official data of *NAS* to the form suitable for the growth accounting exercise.

3. Value added

National Accounts are a conventional source of output growth rates for industrial growth accounting. However, relevant official data for the Russian economy at detailed industrial level in the new industrial classification are available since 2003 only[24]. Series of gross output and value added in current and constant prices before 2003 should be bridged from the old to the new classification.

Nominal gross output values by industries in the new classification before 2003 were obtained from Rosstat within the Russia KLEMS feasibility study project[25]. This dataset is an unpublished backcast estimation, which is based on the detailed bridge between the old classification and the new one. The bridge was compiled by Rosstat in 2003-2004, when data were collected in the two classifications at the same time (Bessonov and others 2008)[26]. The gross output data covers 27 industries of the new classification instead of 34 industries, because for sub-industries of *Transport and Communications* (codes 60, 61, 62, 63 and 63)[27], *Trade* (50, 51, and 52) and *Real estate, renting and Business services* (70 and 71t74) data are available at the more aggregated level. For the sub-industries of these three industries I assume that the growth rates of gross output are equal to the growth rates of the parent industries.

To obtain nominal value added in industries I multiply the gross output of an industry to the corresponding value added – gross-output ratio. These ratios were calculated for the industries in the Old classification, which were the closest counterparts of the industries in the new classification with published data[28]. For example, for the new industry classified as *Mining*

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[24] Sources - (Rosstat 2010b; Rosstat 2011). Nominal gross output and value added – tables 2.3.2-2.3.16 (numbers of corresponding tables are the same in both statistical yearbooks); growth rates of gross output – tab. 2.5.3; growth rates of value added – tab. 2.5.7. Data is published at the level of 78 industries.

[25] (Bessonov and others 2008)

[26] Calculations have been updated by Aleksei Ponomarenko for the Russia KLEMS feasibility study.

[27] See the list of codes and industries in the new classification in A.T2.

[28] See A.T4. A choice of some counterparts seems odd, but it is explained with the data available. With the exception of the last release of *NAS*, *Rosstat* brought data into open at the level of 25 industries in

and Quarrying (C), the ratio was calculated using the sums of value added and gross output of three industries in the old classification, which are *Oil Extracting Industry* (11210)[29], the *Oil Refining Industry* (11220), and the *Natural Gas Industry* (11230). To cross check the validity of our data, I also use an alternative approach to impute value added time series data. Assuming that the bridges between the classifications for value added and investments were the same, I calculated value added in the new classification as a function of value added from the old classification and the bridge for investments. Results of the two approaches were consistent for most industries, indicating the robustness of our methodology[30].

The volume indices of gross output until 2002 are based on the detailed set of individual output volume indices with nominal gross output weights fixed in the new classification[31].The volume indices of value added until 2002 are assumed to be equal to the volume indices of output. This approach is justified by the fact that official volume indices of values added are calculated on the basis of the same set of physical volume indices of products as the indices of gross output. The difference between official gross output and value added volume indices is only in the system of product weights.

The basic dataset of real value added in industries[32] provides the closest link with the official data, which is also important for comparisons of our results with results in the literature based on the official statistics. However, the absence of double deflation for real value added is a limitation of the basic dataset, because value added growth rates are not consistent with the definition of real value added (4). I relax this assumption, introducing the double deflation

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the old classification and 15 industries in the new classification. In some cases it was impossible to split the industry, which is a real counterpart, from other industries in the publication grouping.

[29] See the list of codes and industries of the old classification in A.T3.

[30] The bridge for investments is discussed in detail in sub-section 5.2.2.

[31] This methodology was developed by Eduard Baranov and Vladimir Bessonov and implemented for backcast estimations of industrial output for the Ministry of Economic Development of the Russian Federation (Bessonov and others 2008). Detailed description of this methodology is available in (Bessonov 2005).

[32] The comprehensive information about the basic and the alternative datasets is presented in Appendix A.T5. The basic dataset is dataset V.

procedure on the basis of imputed SUTs. The time series of *SUT* is calculated with *SUT RAS* approach, suggested by Temurshoev and Timmer (2011) on the basis of official detailed benchmark SUT of 1995 and official final demand components and gross output series. Next, industrial volume indices of value added are aggregated, applying Törnqvist aggregation as in equation (7).

[Fig. F1 is here]

For the Russian economy double deflation procedure is important. If the volume growth rate of value added is calculated with single deflation or derived by the direct observation of volume output series, it will be unrelated to changes in relative prices of gross output and intermediate inputs. Studies of Griliches (1994); Triplett (1996); and Fremdling, De Jong and Timmer (2007) showed that real value added measures critically depend on a proper and separate estimation of gross output and intermediate inputs prices. In case of Russia, the corresponding bias could be substantial. For example, output prices of export-oriented sectors mainly on international markets, whereas intermediate inputs prices (e.g. prices on energy) are formed in the domestic market. These domestic prices might be heavily distorted due to explicit and implicit subsidies. Fig. F1 shows average annual growth rates of value added by industries of the market economy, both for single and double-deflation methods. Indeed, it can be seen that for energy intensive industries with a substantial share of energy, gas and fuel in gross output, such as *Fuel* (code 23), *Utilities* (E) and *Metal* (27t28), double deflated real value added growth rates are negative whereas single deflated are positive. Some value added growth rates even turn negative, which indicates that the growth in use of intermediate inputs is higher than the growth in output, signaling a wasteful use of intermediates. For example, if single-deflated value-added growth rates for *Metal* are equal to 2.0 per cent, the double deflated value is negative and equal to -0.8 per cent a year, for *Fuel* these values are 2.7 and -1.5 per cent, and for *Utilities* 0.5 and – 5.0 per cent. In the same time such domestically oriented industries as *Post and Telecommunications* (64), *Rubber and Plastics* (25), and

Construction (F) do not gain from growing world prices and use intermediate inputs more efficiently.

This finding has to be considered as preliminary and only indicative of the potential importance of this issue given that, they rely on a rough time series of *SUTs* with only one benchmark table in 1995. Having a more recent *SUT* would be very useful from this perspective. Moreover, the double deflation procedure for real value added in industries is known to be sensitive to measurement errors (Hill 1971).

4. Labour services

The best measure of labour input is hours worked within SNA borders of production. However, if primary statistics of jobs are more reliable than of hours worked, as is the case in Russia[33], a reasonable option is to use the number of jobs in the full-time equivalent (FTE jobs) instead.

Series of FTE jobs in one-digit industries of the Russian economy are available from 2003[34] in *the Balance of Labour Inputs* (*BLI*) and should be extended back to 1995 and broken down to the level of 34 industries. This subsection suggests an approach on the basis of the data of *the Balance of Labour Force* (*BLF*) and the survey of large, medium and small firms known as "*the Full Circle*" (*FC*). The core of the approach is the assumption that growth rates of FTE jobs are the same as growth rates of the average number of employees, which is the basic concept of employment in *BLF* and *FC*.

[33] Data on hours worked is available in Russian official statistics. It is originated from two primary sources, which are the survey of large and medium firms and *the Labour Force Survey* of households. Since the most popular form of labour compensation in Russia is monthly rather than hourly payment, primary statistics of hours worked in firms is of poor quality. Next, coverage of the survey of large and medium firms varies in different industries. While in *Manufacturing* its data is relatively representative, it is much less informative for *Agriculture*, *Trade* and *Services*. As to households' survey *LFS*, data of hours worked is not published at the level of industries and industrial disaggregation of *LFS* is traditionally of poor quality (Vishnevskaya and others 2002, Ch. 4).

[34] Data on FTE jobs in 2003-2010 is available in (Rosstat 2010c, tab. 5.6), whereas hours worked in 2005-2009. Availability of the *BLI* data in industries is summarized in table A.T6.

The average number of workers in the total economy or in an industry is calculated on the basis of reports of firms. A firm should keep formal records of daily attendance of each worker. The period average number of workers for the firm is calculated as the ratio of the number of working days of all workers in the period over the total number of working days. This ratio is adjusted in cases of part time contracts and such categories of workers as women on maternity or parental leave, some categories of students, and workers on payless vacations (Rosstat 2009c, p. 179). Until 2003 the average number of workers is the only available detailed and time-consistent indicator of labour input in industries.

4.1. Data sources

In addition to the data of *BLI*, which is consistent with *NAS*, there are two sources of data on labour input - *BLF* and *FC*. *BLF* is the oldest system of labour accounts used to be a part of *the Material Products System*[35]. It is compiled with reports of organizations of *the Full Circle* survey, data on self-employed entrepreneurs, and workers of market households[36]. It covers a period from 1995 onwards and starts from 1998 in the new classification. The employment concept of *BLF* is the average number of employees. Since data is available at the one-digit level, a further break down is necessary with the conceptually consistent dataset of *the Full circle*[37].

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[35] In Russian statistics *Balance of Labour Force* is called *Balans trudovykh resursov*. It has been developing by official statistics for many decades since 1930-s, being the part of the Balance of National Economy (the different term for the Material Product System) - see the lecture compendium on the Balance of National Economy of the head of the Statistical Office of the U.S.S.R. Vladimir Starovskiĭ (2007) delivered in 1938. BLF as a part of MPS was also mentioned by the head of the State Planning Committee of the USSR Nikolaĭ Voznesenskiĭ (1948, p. 64) in his monograph about the Soviet Economy in the Second World War.

Data of *BLF* for the period in question is available in (Rosstat 2001, tab. 6.6; Rosstat 2005b, tab. 5.6; Rosstat 2010c, tab. 5.5)

[36] (Vishnevskaya and others 2002, ch. 1); detailed methodology description is also available in (Rosstat 1996, sect. 3.2) and in (Rosstat 2003a, sect. 5).

[37] In Russian statistics *the Full Circle* set of organizations is called *Polnyĭ krug organizatsiĭ*. Data of labour of *the Full Circle* is available in (Zhikhareva 2007, tab. 1-2; Rosstat 2009c, tab. 3.13; Rosstat 2012).

[Fig. F2 is here]

Figure F2 shows employment levels of the total economy obtained from different sources. It is useful for the comparison of FTE jobs, *BLF* and *BLI*. The level of employment consistent with *SNA* production frontier is represented by the line of FTE-jobs (curve 1). It starts in 2003 at the level of 75 million jobs and increases until 2008 to almost 80 million jobs, and then it falls back to the level of 76.6 million in 2009, the year of the crisis. The average number of workers form *BLF* (curve 3) shows the same trend, but differs from the FTE-jobs line by around 10 million workers. Leaving apart adjustments for full employment, this gap is explained by the omission in BLF of secondary employment and persons who are involved in non-market production of agricultural goods in households (Rosstat 2003a; Rosstat 2009c, tab. 3.4). In 2008 the share of jobs of such *non-market households* (NMH) was equal to 70% of jobs in Agriculture and one fifth of the total economy (Rosstat 2009c, tab. 3.4).

Trends of employment in *NMH* and of the other agricultural producers are different. In 2005-2008 employment (in FTE jobs) in agricultural firms declined with average annual growth rates -1.8 per cent, whereas it remained almost constant in *NMH*[38], which could stem from different microeconomic foundations of market and non-market sectors of Agriculture. The market sector exists in a normal market environment. Workers are hired by firms at market wages and firms sell goods at market prices. In contrast, a substantial share of goods produced in *NMH* cannot be sold on the market, and many workers are engaged in *NMHs*, because they are not able to find job elsewhere, particularly in periods of crises such as 1998 and 2009[39].

Another point in the graph F2 is the diverging trends of employment in *BLF* and *FC*. The difference between the two levels of employment is related to workers, who do not hold

[38] It has been calculated on the basis of FTE jobs in Agriculture (Rosstat 2010c, tab.3.5). Total employment in Agriculture (A) was split into shares of non-market households and the rest with the data of hours worked from (Rosstat 2009c, tab. 3.9).

[39] Different trends of employment in market and non-market sectors of Agriculture reflect the specific role of NMH in the Russian economy. NMH smooth shocks of early 1990-s and of the crisis of 1998 in the labour market, absorbing excessive labour from the rest of the economy (Poletayev 2003).

positions in formal organizations. This group of workers includes self-employed entrepreneurs, people who work for individuals, workers engaged in households which produce for the market (*market households, MH*), and farmers (Vishnevskaya and others 2002, p. 55). The deviating tendencies of employment reflect mass reallocation of labour from organizations to these individual forms of professional activity. This reallocation accelerated after the crises of 1998 and 2009 such that even the post-crisis employment recovery did not take place in organizations[40].

4.2. Approach

As it follows from the previous sub-section, for the construction of time series of labour two problems should be solved. First, employment time series are to be broken down and backcasted to 1995 for the total economy except non-market households. Second, employment of non-market households in years before 2003 should be imputed.

This subsection explains details of labour time series compilation. The empirical strategy for each level of aggregation is to build the best proxy of the number of FTE jobs within *SNA* borders of production with respect to data available. Basic framework for this is the official data of FTE jobs from *BLI*, which is extended and broken down with *BLF* and *FC* (see A.T6).

The approach is summarized in table A.T6a. Initially I obtained the employment data at the level of one digit. For this I used FTE jobs from BLI in 2003-2009 and extended these time series back until 1995 with growth rates of labour from *BLF*. Since more detailed data of *the Balance of Labour Inputs* is not available, shares of *BLF* and *FC* were used for further breaking down.

Table A.T6b summarizes how different sources were used breaking down and extension of the *BLI* series. The first step was to compile official *BLF* data of the average

[40] Long-run reallocation of workers from organizations to other institutional forms of employment both in Russia and in other economies in transition has been broadly discussed in the literature – see, e.g. (Brown and others 2006; Vishnevskaya, Gimpelson, and Kapeliushnikov 2006). For the discussion how home production could influence the response of the economy on external shocks see, e.g. Pissarides (2007).

number of workers for one-digit industries. For the period of 1995-1997, in which the *BLF* data in the new classification is not available, I used growth rates of average number of workers of the old classification industry – the closest counterpart of the corresponding new classification industries, controlling coherence of trends in the overlapping years of 1998-2004. For example, data on *Fishing* (code B) is available in *BLF* in the new classification for 1998-2009. For the extension of the time series back to 1995 I used growth rates of *the Full Circle* average number of workers in *Fishing industry* (code 18300) in the old classification.

The next step is breaking down of the data to more detailed levels. The levels of employment were obtained for a year, for which the most detailed *BLF* data is available. Then the series were extended with growth rates of *the Full Circle* data, which is available for most industries from 1995 in the new classification. Eventually, the series were adjusted to make the sum of employment in imputed sub-industries equal to the official data of *BLF* at the parent level of aggregation.

For the period 1998-2004 published the *BLF* data is the most detailed. Remaining gaps were filled with shares of corresponding *Full Circle* data in 2002. If data of corresponding industries is not available in the Full Circle dataset in the New classification, I used the best counterparts from the Old classification. For this it was necessary to decompose data to a more detailed level than 34 industries.

The last step was to impute employment in *NMH* in 1995-2002, which was done with the additional assumption of null productivity growth rate in *NMH*, as was suggested by Poletayev (2003)[41]. Curve 2 presents the trend of FTE jobs before 2003 on Fig. F2.

4.3. Results and discussion

The newly developed detailed dataset unveils drastic structural changes in Russia in years of transition. It also shows how important the detailed industrial perspective is in comparison with the macro level. While total employment growth in 1995-2010 is close to

[41] Detailed description of the model is available in the Appendix (see A.T7). Kapeliushnikov (2006) suggested an alternative approach for imputations of labor costs in NMH for years before 1999 on the basis of changes of the area of plowing.

null[42] (Fig. F2), it varies in industries with a wide range from shrinking industries such as *Footwear* (-6.6 per cent a year) to booming industries like *Wholesale trade* (4.9 per cent) (Fig. F3). The results also show that the overall structural transformation process in Russia is not too different from that of other developed economies and economies in transition. There is a clear reallocation of labour from *Agriculture* and *Manufacturing* to *Services*, in particular market services (Campos and Coricelli 2002; World Bank 2008).

Nevertheless, the growth pattern of the Russian economy has some specific characteristics. While Havlik, Leitner and Stehrer (2012) show that employment in *Mining* in five East European economies in transition[43] (EE-5) in 1995-2004 declines strongly with growth rates in on average -8 per cent a year, labour in Russian *Mining* decreases only -1 per cent a year. This illustrates the specific role of the *Oil and Gas* sector in the Russian economy. Employment growth in trade in EE-5 is slow and varies between -0.7 and 2.0 per cent[44], whereas the Russian *Trade* grows 4.5 per cent a year indicating the backward situation of the Russian retailing system in early 1990s even in comparison with other former Socialist countries. Finally, *Public Administration and Defense* in Russia grows 4.6 per cent a year, which is steeper than 0.5-1.6 per cent in EE-5 (with the exception of Slovenia with 4.1 per cent a year). The most likely causes of this outstanding extension of public sector are three overlapping processes. First, because of decentralizing of public employment in 1990-s regional governments hired more staff. Gimpelson and Treisman (2002) have explained this incentive by intention of local authorities to attract more federal transfers. Next, in the decade after the crisis of 1998 wages in *Public Sector* grew faster than average wages in the economy, accelerating by 2006-2007 on the eve of the parliamentary and presidential elections (Gimpelson and Lukiyanova 2007). Finally, in crisis of 2008-2009 preventing growth of unemployment the government took such steps in public sector as a sharp increase of wages by 30 per cent in the end of 2008 and cancellation of planned reduction the army personnel by 200 thousands persons (Kapeliushnikov 2009).

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[42] Growth rates of employment between the trough in 1998 and the peak in 2008 are 1.1 per cent a year.

[43] Czech Republic, Hungary, Slovak Republic, Poland, and Slovenia

[44] Exception is Slovakia with labour growth rates in *Trade* 4.2 per cent a year.

[Fig. F3 is here]

A number of important limitations of labour time series need to be considered. The dataset relies heavily on the *BLF*, which is built up mainly from firm-level statistics[45]. Estimates of self-employed workers, that are prevalent in *Agriculture* and *Trade*, are relatively weak. Another concern is the *BLF* concept of average number of workers, which is inconsistent with such internationally acknowledged measures of employment as hours worked or FTE jobs. However, the difference in growth rates of these measures in overlapping years is not substantial most likely because the measure of average number of workers is the most accurate indicator of employment available at the level of firms.

A possible alternative is the Labour Force Survey. This survey[46] is detailed, regular and representative survey of households. It has been designed on the basis of the International Labor Organization (ILO) recommendations, which provides a certain level of consistency with similar surveys in other countries. The survey covers total economy, market and non-market households, and workers involved in the informal economy. It provides such indicators of employment as the number of employee and self-employed, hours worked, the number of jobs and FTE jobs. Since 1998 data is available by industries (one digit) in the new classification[47].

I have chosen not to use the *LFS* for a number of reasons. Most importantly, the *LFS* data does not provide a detailed indication of the industry of employment. Household

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[45] Rosstat uses various sources for compilation of BLF, which are based not only on reports of firms, but also on surveys of households. However, firm-report based sources traditionally dominate in the BLF framework.

[46] In Russian statistics it passes by the name *Obsledovanie naselenia po problemam zaniatosti*. Detailed description of methodology is given in (Vishnevskaya and others 2002, Ch. 2), and (Rosstat 1999a, sect. 4.1.3). Data is available in statistics digests (Rosstat 2002a; Rosstat 2006a; Rosstat 2008; Rosstat 2010a), regular reports (Rosstat 1999b) and for the following years, and in the *ILO* database.

[47] ILO has also published data of LFS for Russia up to two digits for sub-industries of Manufacturing (D) until 2008 (ILO 2010a; ILO 2010b).

respondents typically have limited knowledge about the classification of their jobs. Therefore *LFS* data is only published at the level of one digit industry. There are also changes in methodology of LFS, which make the survey data before 2002 of limited use[48]. Figure F4 presents the comparison of employment growth rates in industries obtained from our basic dataset and *LFS* at the level available in official publications of *LFS*.

[Fig. F4 is here]

In comparison with *the Labour Force Survey*, *the Balance of Labour Force* seems to be better as the basic framework for industrial growth accounting in years before 2003. In contrast with *LFS*, *BLF* covers the whole period in question at the detailed industrial level; there is no seasonal variations and *BLF* data may be broken down with the conceptually consistent dataset of *the Full circle*[49].

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[48] The survey has been held in Russia since November of 1992 in the form of interview of the households' members about their activity during the reference week. Such schedule creates additional noise in data before 1999 because of seasonality. For example, in 1992, 1996 and 1997 the survey was provided once a year in different periods, so data on March of 1996 is inconsistent with data on October 1997. Only from 1999 the survey has been delivering on the regular basis. There are also other changes in the methodology of the survey. For example, starting from 1999 conscripts and households' workers have been included into employment. It led to the sharp increase of employment (Rosstat 2003a; Kapeliushnikov 2006, 224-280) (see Fig. F2). It is impossible to remove this artificial effect, because it is overlapped by the real increase of employment after the crisis of 1998. Fig. F2 demonstrates also the slight difference between *LFS* and *BLS* employment levels, because the *BLF* employment does not include such small categories of labor as women who are on maternity and childcare leave (Rosstat 2009c, pp. 178-9).

LFS data in industries for the period 1997-2002 is available, but the series have sharp non-documented changes, probably because of the adjustment of the questionnaire to the new classification. For example, employment in *Social and Personal Services* dropped from the level of 4300 thousands to the level of 2100 (Rosstat 2002d, tab. 2.40; Rosstat 2003b, tab. 2.40).

[49] In Russian statistics this dataset is called *Polnyĭ krug organizatsiĭ*. Data is available in (Zhikhareva 2007, tab. 1-2; Rosstat 2009c, tab. 3.13; Rosstat 2012).

5. Capital services

For the purposes of this study the user-cost approach is applied and capital input is evaluated as capital services as introduced by Jorgenson (1963) and Jorgenson and Yun (1991). This approach takes into account variations in productivity of different types of assets. For example, one ruble of investment in buildings generates much less capital services per year, than the same ruble invested in software, because buildings are in operation for decades, whereas software is in active use for say at most five years.

Measurement of capital input is based on the assumption that the flow of capital services from each asset type *k* (K_{kj}) is proportional to the average of the stock available at the end of the current and the prior period ($S_{kj,t}$ and $S_{kj,t-1}$). In this case growth of capital services of industry *j* ($\Delta \ln K_j$) is the weighted growth of stocks of each asset:

(15) $$\Delta \ln K_j = \sum_{k=1}^{Nk} \bar{v}_{kj}^K \cdot \Delta \ln S_{kj},$$

where N_k is the number of types of assets, and

(16) $$\bar{v}_{kj}^K = \frac{1}{2}\left(v_{kj,t}^K + v_{kj,t-1}^K\right)$$

is the period-average share of the asset type *k* in total capital costs

(17) $$v_{kj}^K = \frac{p_k^K \cdot S_{kj}}{\sum_{k=1}^{Nk} p_k^K \cdot S_{kj}}.$$

The rental price of capital services, $p_{k,t}^K$, represents the price at which the investor is indifferent between buying and renting the capital good for a one-year lease in the rental

market. In the absence of taxation the equilibrium condition can be rearranged, yielding the familiar cost-of-capital equation:

(18) $$p^K_{k,t} = p^I_{k,t-1} \cdot r_t + \delta_k \cdot p^I_{k,t}$$

with r_t representing the nominal rate of return, δ_k the depreciation rate of asset type *k*, and $p^I_{k,t}$ the investment price of asset type *k*. This formula shows that the rental fee is determined by the rate of return, the rate of economic depreciation and the asset specific capital gains.

Capital stock of each type of asset is calculated with the perpetual inventory model. This model defines the capital stock as the weighted sum of past investments with weights given by the relative efficiencies of capital goods at different ages

(19) $$S_{k,t} = \sum_{\tau=0}^{\infty} \partial_{k,\tau} \cdot I_{k,t-\tau}$$

with $S_{k,t}$ the capital stock (for a particular asset type *k*) at time *t*, $\partial_{k,\tau}$ the efficiency of a capital good *k* of age τ relative to the efficiency of a new capital good, and $I_{t-\tau}$ the investments in period *t* - τ. An important implicit assumption made here is that the services provided by assets of different vintages are perfect substitutes for each other. As in most studies, a geometric depreciation pattern is applied here. With a given rate of depreciation δ_k which is assumed constant over time, but different for each asset type, I get $\partial_{k,\tau} = (1-\delta_k)^{\tau}$, so that:

(20) $$S_{k,t} = \sum_{\tau=0}^{\infty}(1-\delta_k)^{\tau} \cdot I_{k,t-\tau} =$$

$$= \sum_{\tau=0}^{t-Tb-1}(1-\delta_k)^{\tau} \cdot I_{k,t-\tau} + (1-\delta_k)^{t-Tb} \cdot S_{k,Tb},.$$

where $S_{k,Tb}$ is net capital stock by the end of benchmark year *Tb*.

For the estimation of capital services based on the model outlined above, it is necessary to have time series on nominal investments by types of assets from the year, which

follows the benchmark year, investment price indices $p^I_{k,t}$, net capital stocks $S_{k,Tb}$ by the end of the benchmark year *Tb*, real rates of return r_t and depreciation ratesδ_k.

In this study the first three components are obtained from the official statistics. The real rate of return is considered as exogenous and assumed to be equal to 4 per cent per year following international guidelines (OECD 2001b, p. 133). For purposes of cross-countries comparisons depreciation rates are used from the EU-KLEMS methodology (Timmer and others 2010). The assumption of common depreciation rates across countries is a strong one, as they might differ due to differences in the economic environment. E.g. in a crisis one would expect higher depreciation rates than in boom periods, and Russia had a number of idiosyncratic crises. However, as it will be discussed later in this subsection, data on economic depreciation available from Russian statistics will not change capital series substantially.

5.1. Data sources

This section provides the review of relevant data sources available in Russian statistics for estimation of capital inputs. It starts from nominal investments, and then it follows with investment price indices and capital stocks. For each measure the following issues are discussed: coverage (total economy, all establishments, or only large and medium firms); years and industrial classification for which data is available; the industry-level detail, and availability of data by types of assets.

Our basic starting point for nominal investment in this study is the series for gross fixed capital formations (GFCF) from *NAS*. *NAS* provides GFCF for the total economy and total assets only[50]. GFCF should be broken down by industries and types of assets.

The most relevant measure for this decomposition is data on so-called "investment to fixed capital and intangible assets", because they are conceptually close to GFCF in *NAS*[51].

[50] The time series of GFCF is available from (Rosstat 2004, tab. 1.1.7; Rosstat 2009b, tab. 2.1.7; Rosstat 2011, tab. 2.1.7; Rosstat 2012).

[51] (Rosstat 2009a, p. 139).

These series are available at the level of two digit industries in the old classification until 2004, and in the new classification - from 1990 until present[52].

For the breakdown by asset type, detailed information can be obtained from the yearly survey of fixed assets for large and medium firms called "*Form F11*"[53]. The survey provides series of booked values of new capital stock put into operation in the current year, called "*new acquisitions"*[54], for large and medium firms. In 1994-2004 data of the survey has been collected in the old classification[55], and starting from 2005 - in the new classification[56]. Adjustments were also made for the structure of investments of households using data of new acquisitions of the *Balance of Households Property (BHP)*, which cover households (Table A.T9 of the Appendix).

The overall investment price index in *NAS* is composed with the price indices on construction works, machinery and equipment, and other capital works and investments[57]. The indices are available in the official publications at the level of two-digit industries in the old

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[52] (Rosstat 2001; Rosstat 2005a; Rosstat 2009a; Rosstat 2010b; Rosstat 2010c; Rosstat 2012), and unpublished official data for years before 1994.

[53] Detailed data of survey F11 is issued by Rosstat in yearly internal publications *Otchet o nalichii i dvizhenii osnovnykh sredstv i drugikh nefinansovykh aktivakh (f. №11)* (Statement of inventories and flows of fixed assets and other non-financial assets (form 11)). The full list of sources for various years is available in (Voskoboynikov and Dryabina 2009). Detailed description of the survey in Russian statistics of capital in English is given by (Bratanova 2003).

[54] In Russian: *vvody novykh osnovnykh fondov*.

[55] For a number of sectors data of *Survey F11* is available for previous years as well. For example, for sub-industries of Manufacturing in the old classification (code 10000), which roughly corresponds to industries *Mining* (C), *Manufacturing* (D) and *Electricity, Gas and Water Supply* (E) in the new classification, data is available since 1970 (Voskoboynikov and Dryabina 2009). There is both published and unpublished data of survey F11 for years before 1994 for *Agriculture* (20000) and Construction (60000). For example, data on *Agriculture* (20000) has been partially published in (Rosstat 1991). However, only since 1994 *Survey F11* has become unified and consistent for all industries of the economy.

[56] The correspondence between the Russian classification of fixed assets and the international one is presented in Appendix A.T8.

[57] (Rosstat 1998, p. 157-8; Rosstat 2002b).

classification until 2004, and in the new classification from 2005[58]. All three investment price indices are not of constant quality.

According to the report of Boskin commission[59], traditional price indices overestimate inflation. In particular, this effect is strong for ICT goods, because of fast changes of models and substantial variety in quality. In contrast with traditional price indices constant quality indices take into account changes in characteristics of commodities and eliminate the bias. For the Russian economy there are only few publications on the topic[60]. Since the indices in these publications are developed for personal computers only, do not cover the whole period in question and based on non-representative samples, I do not use them, relying on traditional official price indices instead.

Existing data on capital stocks in the *NAS* is based on the concept of replacements costs. The source of net capital stock data in starting year 1995 is the Balance of Fixed Assets (*BFA*)[61], which covers the total economy and includes the Balance of Households' Property[62]. Corresponding data of capital stocks in *BFA* in the old classification until 2004 and in the new classification since 2005 is published[63]. For breaking down of *BFA* data of net capital stock to the level of two-digit industries and eight types of assets necessary for this study, net capital stocks of the *F11 survey* is used.

5.2. Approach

[58] Detailed data is available in (Rosstat 2012).

[59] Final Report to the Senate Finance Committee from the Advisory Commission To Study The Consumer Price Index. DECEMBER 4,1996. http://www.ssa.gov/history/reports/boskinrpt.html#cpi5

[60] (Students, Griliches, and Hamermesh 1994; Parkhomenko and Redkina 2006)

[61] Short description of the concept of the Balance of Fixed Assets for former Socialist countries of Central and Eastern Europe is available in (OECD 2001a, 8.10-8.15; Bratanova 2003).

[62] In Russian *Balans sobstvennosti grazhdan.* See also (Rosstat 1998, section 8.2; Bratanova 2003, 3.14; Rosstat 2006b, tab. 2.1.1).

[63](Rosstat 2001; Rosstat 2006c; Rosstat 2010b; Rosstat 2010c).

This section provides a discussion of the approach to the construction of real investments series and benchmark values of net capital stock for the estimation of capital services with (15)-(20). As an input, this approach uses data of nominal investments, acquisitions, net capital stocks and deflators, which have been reviewed in the previous section. The dataset is constructed in two steps. In the beginning data on acquisitions, investments and capital stocks is compiled in the industrial classification of the input data. Before 2005 the data is built in the old classification, and starting from 2005 in the new classification. Then the old classification part is transformed into the new classification providing long time series.

5.2.1. Nominal investments, benchmark capital stock values and deflation

Official data of nominal investments to fixed assets and intangibles $\left(PI_{j,t}\right)$ in year *t* for industry *j* is broken down by types of assets *k* with nominal acquisitions from survey of large and medium firms *F11* $\left(PA_{kj,t}^{LM}\right)$

$$PI_{kj,t} = \left(\frac{PA_{kj,t}^{LM}}{\sum_k PA_{kj,t}^{LM}}\right) \cdot PI_{j,t}. \quad (21)$$

It is assumed here that asset shares in new acquisitions and investments are comparable.

Benchmark capital stock values are calculated by breaking down the net capital stock values from *BFA* with data of survey *F11* for large and medium firms. While the reasonable choice of the starting year would be a year before the period of high inflation[64], which is 1990 in case of Russia, it is 1995 that was chosen as the benchmark for two reasons. First, as it was discussed in the previous subsection, only from 1994 detailed data of capital stock and acquisitions by types of assets are available for all industries. Second, price indices in early years of transition were of poor quality in many former Socialist countries, and Russia is not an exception (Campos and Coricelli 2002; Bessonov 2005). A particular issue is the reliability of

[64] (OECD 2001a, 8.15).

indices which may be used for deflation of investments, starting from the official investment price index.

The accuracy of deflation of a stock in year *t* to the level of year *T* depends on accuracy of all deflators for years in between. If this is a high-inflation period, errors will accumulate[65]. Such measurement errors in official investment price indices of 1992-1995 have been unveiled by Bessonov and Voskoboynikov (2008) by comparing the investment and overall GDP deflators. This relationship based on official data is shown in Graph F5. As can be seen, the ratio of real investments in GDP to nominal ones rises steeply up to 4 in 1995, which suggests that in 1991-1995 prices on investment goods grew much faster than the overall level of prices in the economy.

[Fig. F5 is here]

However, this is unlikely because typically investment price indices are falling relative to the overall price levels (Greenwood, Hercowitz, and Krusell 1997). Another explanation of this fast growth of the investment deflator is the errors in price measurement. For the Russian economy this effect was documented for the consumer price index and explained, among other reasons, by slowly updated weights and rapidly fluctuating relative prices in years of high inflation (Bessonov 1998; Gibson, Stillman, and Le 2008). Bratanova (2003, 4.40) has also pointed out to the overestimation of prices on investment goods in Russian statistics.

Alternatively, investment deflators can be derived implicitly by dividing value indices by quantity indices. These indirect indices might suffer less from weighting problem. In Russian statistics official volume indices of value added are based on direct quantity indices of production[66], and GDP deflators are implicitly derived. In contrast, official investment price

[65] See more detailed and formal representation of this statement in (Bessonov, Voskoboynikov 2008).

[66] See section 3.

indices are directly measured. This strongly suggests that the discrepancy between investments and GDP deflators is mainly explained by inaccuracy of direct investment price indices.

As I built capital stock for various asset types, I need asset-specific deflators. Instead of using official investment price indices I choose the set of producer price indices in construction[67]. The correspondence between these price indices and investments by types of assets is the following. The *price index of construction works* is implemented for deflation of investments to residential and non-residential structures; the *overall investments price index* is used for other assets, and the *index on machinery and equipment as part of investments to fixed capital*(Rosstat 2012) for the remaining types of assets. This correspondence is based on matching of the composition of these price indices[68] and the classification of fixed assets (Gosstandart 1994). I assume that the asset deflators are the same for each industry, because it simplifies bridging between the industrial classifications.

[Fig. F6 is here]

This set of indices is preferred for many reasons. First, according to the official methodology (Rosstat 2006b, p. 60) it is implemented for deflation of capital stocks in estimation of *BFA* in constant prices. Second, in contrast with the official investment deflator this set of indices is derived from corresponding value and quantity indices. Consequently, it suffers less from the problem of crude weights. Finally, it is the only consistent set of indices which catches differences in prices of various types of assets. In particular, it explicitly registers changes of prices on imported machinery and equipment (Rosstat 2002b, pp. 15-8), which contributes substantially to total investments[69]. Fig. F6a shows that the price index of

[67] Russian terms: *indeks tsen proizvoditeleĭ v stroitel'stve; indeks tsen na stroitel'no-montazhnye raboty; indeks tsen na mashiny i oborudovanie v sostave investitsiĭ v osnovnoĭ kapital.*

[68] (Rosstat 1998; Rosstat 2002b)

[69] There is no share of imported investment goods in total investments. However, the rough estimation may be obtained from the ratio of imports of machinery and equipment (Rosstat 2012) converted from

machinery and equipment indicates a slower growth of prices not only in comparison with the official investment price index, but also with the general price level measured by CPI and PPI[70]. This effect is consistent with the slower trend of investment prices discussed by Greenwood, Hercowitz and Per Krussel (Greenwood, Hercowitz, and Krusell 1997) and with the fact that prices on imported equipment for the Russian domestic purchaser grew much slower (curve 5 on Fig. F6a).

5.2.2. Bridging between industrial classifications

The aim of this section is construction of investment and benchmark capital stock values in the new classification for years before 2005 using the data in the old classification and a bridge.

The bridge is the set of coefficients *b* for year 2004, in which data on investments were collected by Rosstat in both classifications[71]. For the coefficients the following identity holds:

(22) $$PI_{j,t} = \sum_{i=1}^{Nold} b_{ji,t} \cdot PI_{i,t}^{old} \ (t = 2004; j = 1, \dots, N_{new}),$$

where N_{old} = 78 is the number of industries in the old classification and N_{new} = 60 is the number of industries in the new classification.

For imputation of investments for years before 2005 I assume additionally that all types of assets and all years before 2004 the bridge is the same as for total investments and does not vary in time. If the benchmark year T_b is chosen before 2005, this approach is also applicable for the transformation of the benchmark values[72].

USD to rubles with the yearly average exchange rate and total investments. The average ratio in 1995-2009 is around 35%.

[70] There is no official GDP deflator available for the whole period in question.

[71] (Rosstat 2006b, pp. 410-2)

[72] This transformation is correct for investments in constant prices of a certain year as well. Transformation to investments I_t in constant prices is provided by multiplication of both sides of (22) by the corresponding price index. Once it has been done, from (20) and (22) We have (in matrix notation): $\mathbf{S}_{k,Tb} = \sum_{\tau=Tb}^{\infty}(1-\delta_k)^{\tau} \cdot \mathbf{I}_{t-\tau} = \sum_{\tau=Tb}^{\infty}(1-\delta_k)^{\tau} \cdot \mathbf{B} \cdot \mathbf{I}_{t-\tau}^{old} = \mathbf{B} \cdot (\sum_{\tau=Tb}^{\infty}(1-\delta_k)^{\tau} \cdot \mathbf{I}_{t-\tau}^{old}) = \mathbf{B} \cdot \mathbf{S}_{\boldsymbol{k,Tb}}^{\boldsymbol{old}}$.

5.3. Results and discussion

What has been known so far about the contribution of capital to Russia's economic growth is based on two approaches. The first[73] explores the concept of *gross capital stock* and uses data of capital growth rates available from the official statistics. According to the official methodology[74], gross capital stock in constant prices is obtained from *BFA*. Gross capital stock by the end of year equals the stock of the previous year plus acquisitions minus scrapping[75] during the year in constant prices of a certain base year. Acquisitions and scrapping are deflated with special price indices, derived from investment deflators (Rosstat 2006b, p. 62-7; Bessonov and Voskoboynikov 2008). Since official investment deflators overestimate price growth, acquisitions and scrapping in constant prices are heavily underestimated, which leads to low capital stock growth rates as found by many studies (see Tab. T1).

[Tab. T1 is here]

A second approach used in the literature is based on the concept of *net capital stock* in which depreciation is taken into account based on different varieties of the Perpetual Inventory Method (PIM). They deal with cross-country comparisons of productivity among transition economies including Russia[76], evaluation of potential GDP and the output gap[77] and explain

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[73] (De Broeck and Koen 2000; Dolinskaya 2002; Kvintradze 2010); see also the review in (Izyumov and Vahaly 2008).

[74] (Rosstat 1998; Rosstat 2006b). The representation of official methodology in (Bessonov and Voskoboynikov 2008) is used here. It is also discussed in detail by Bratanova (2003, ch. 3).

[75] The concept of scrapings should be clearly separated from depreciations. Scrapings are the value of assets that have been taken out from service, whereas depreciation is a part of the market value of the asset, which has been lost in the process of normal operation. I follow the terminology of Maddison (1987, p. 656) in this distinction.

[76] (Iradian 2007) for the period 1991-2006; (Rapacki and Próchniak 2009) for the period 1990-2003, (Izyumov and Vahaly 2008) for the period 1995-2005.

Russia's output decline and recovery[78]. But also these papers still rely on official data of real investment, so that capital stock growth remains underestimated.

One major criticism of both types of studies is associated with the notion of aggregate *stock* as a measure of capital input. Theoretically both gross and net capital stocks are inconsistent with output and labour *flows* in the growth accounting framework because of the "dimensions" of the variables: stocks versus flows[79]. Aggregate stocks also do not reflect productive efficiency of capital as no account is taken of different asset types. For example, one ruble of buildings is assumed to deliver the same amount of services per year as a ruble of software asset.

The present study sets out to provide better and more detailed capital input data. It adds value to the literature of growth accounting for the Russian economy for three main issues. First, it is based on the superior concept of capital services flows instead of capital stocks. Second, it avoids the use of the implausible official investment deflators. Finally, it introduces a long time series of capital inputs at the detailed 34-industry level by bridging the two industrial classifications for eight types of assets. The recent literature uses capital input measures at the level of the total economy only with no distinction of capital by industries. The exception is the paper of Kuboniwa (2009), which reports results capital growth rates within growth accounting decomposition for three sectors - Mining, Manufacturing, and Electricity, gas and water supply - in 2005-2007. The older literature does attempt an industry breakdown but offers only analysis for years before 2002. Dolinskaya (2002) considers four major sectors of the economy, Lugovoy and Astaf'eva analyze Russian Manufacturing with 10 sub-industries (2003), whereas Bessonov (2004) deals with fifteen industries of the economy in the old classification.

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[77] (Oomes and Dynnikova 2006) for the period1999-2003, (Michaelides and Milios 2009) for the period 1994-2006; (Kuboniwa 2011) for the period 1995-2010 on imputed quarterly data.

[78] (Voskoboynikov 2003) for the period 1990-2001; (Michaelides and others 2004) for the period 1992-1999.

[79] See (OECD 2001b, p. 84).

I start with the replication of net capital stock series on the basis of official investment deflators and depreciation rates which do not vary across industries (Fig. F6b, curve 2). As it has been shown in the corresponding literature (Tab. T1, (Izyumov and Vahaly 2008; Rapacki and Próchniak 2009)), the growth rate of such net capital stock is negative and almost zero.

[Fig. F7 is here]

Figures F6b and F7 demonstrate various alternative measures of capital input growth rates for the total economy, starting with the official estimate based on gross capital stocks and official discard data (F7, curve 4). The official trend of gross capital stocks exhibits growth rates 1.3 per cent a year. However, growth rates achieve 2.2 per cent a year (F7, curve 2; F6b, curve 1) once the series has been transformed into net capital stocks in constant prices of 1995. In comparison with these two curves the net capital stock growth deflated with the official investment deflator (F6b, curve 2) seems biased downward.

Fig. F7 shows the influence of different patterns of depreciation rates on capital in comparison with the official series of gross capital stock (curve 2), final results of net capital stock (curve 3) and services (curve 1). In comparison with this difference variation of net capital stock because of differences in service lives based on data of the Bureau of Economic Analysis (curve 3) and *Rosstat* is minor in industries and almost the same at the macro level.

Growth of capital services (F7, curve 1) is 3.3 per cent per year, which is higher than 2.7 per cent per year of capital stocks. Figure F8 shows that capital services growth rates exceed growth of stocks in almost all industries except *Financial Intermediation* and *Inland Transport*. Explanation is clear from a more detailed level, which is presented in Tab. T2. The table demonstrates the growth rates of capital stocks and services by types of assets in *Food and Beverage*. These two measures of capital input consist of the same set of growth rates of capital stocks of seven types of assets (column 2), but with different weights (columns 2 and 4). Average shares of stocks and services have been calculated with equations (16) and (17). However, for services $p_{k,t}^{K}$ is calculated according to (18), while for stocks it was assumed that

$p^K_{k,t}$= $p^I_{k,t}$. Table T2 shows that the difference in growth rates between capital stocks and capital services is mainly explained by a higher contribution of *Machinery* and a diminishing role of non-residential structures. Another interesting point is a higher contribution of *ICT capital* and *Software*. Both differences match the idea of an increasing use of capital assets with shorter service life. I find this pattern for almost all industries, except *Inland Transport* and *Financial intermediation* that have a low share of *Machinery and equipment* use.

[Tab. T2 is here]

Finally, a number of important limitations needs to be considered. Investment deflators could be improved to better reflect changes in the quality of assets For example investment price indices of IT and intangibles could be based on adjusted U.S. data (Schreyer 2002).

In addition, within the concept of capital services it is assumed that the capacity utilization rate for each asset is constant and the same across different types of assets. Some studies have tried to adjust for this directly by using capacity utilization rates[80] or indirectly through unobserved components of effective capital stock which are extracted with a Kalman filter.[81] Such corrections are based on patchy data on physical capacity utilization of some kinds of assets in Russian Manufacturing only, and suffer from a lack of theoretical foundation. By using an internal rate of return approach, this issue could be fully addressed (Hulten 1986).

6. Shares of factors' compensation

This sub-section provides the approach to the estimation of shares for the incomes of factors within the growth accounting framework. As it follows from (2) and (3), with output,

[80]E.g., (Dolinskaya 2002; Bessonov 2004; Michaelides and others 2004; Oomes and Dynnikova 2006; Michaelides and Milios 2009)

[81] (Hall and Basdevant 2002);

labour and capital growth rates given the factors' shares are necessary for the evaluation of multifactor productivity growth rates.

The conventional approach to the evaluation of factors' shares is straightforward. Labour share for each industry may be obtained as the ratio of labour compensation of employees and nominal value added given in *SNA*, whereas capital share is derived from value identity (5) as one minus the labour share. However, this method has a number of limitations both in general and when applied to the Russian statistics. First, labour compensation of employees from *SNA* is underestimated because it does not take into account labour income of self-employed and family firms. Gollin (2002) shows that this bias could be substantial, in particular for less-developed countries. Second, the shadow economy contributes at least one fifth of GDP in Russia and the official value added data has already been corrected for this. Labour compensation data should also be adjusted, but it has not been done so far in the industrial accounts of the official statistics. Third, a substantial share of income in Russia is paid unofficially because this way firms avoid high wage taxes and social expenditures. Since 1993 *Rosstat* publishes the total amount of these hidden wages balancing official incomes and consumption[82]. For industry analysis this should be allocated somehow among industries. Finally, data on labour compensation in 1995-2002 should be transformed to the new classification.

Our approach is based on sequential adjustments of labour shares in value added, dealing with the limitations, and consists of three steps. First, shares of labour compensation in industries have been calculated on the basis of official labour compensation of employees and value added of *NAS*. It has been done in the old classification for 1995-2004 and in the new classification for 2003-2009. The old-new classifications transformation has been done using nearest industries in both classifications[83] and has been verified in overlapping years 2003-2004.

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[82] See Appendix A.T11.

[83] The same correspondence was used as in case the classification bridging of value added – see section 3.

Then an adjustment for hidden wages is made. For 2002 and consecutive years the overall amount of hidden wages has been allocated among industries in proportion to the value added share of shadow activities. The later data is imputed by the official statistics[84]. For years before 2002 the hidden wages were allocated in proportion to shadow value added of 2002.

Finally labour income of self-employed is added. For all industries except *Agriculture* it was assumed that the hourly earnings of self-employed are the same as of employees. For *Agriculture* it is calculated with data from the RLMS survey[85] as the ratio of hourly wages of high-qualified to low qualified workers in the economy (see Table T3 and with consecutive adjustment coefficients; disaggregated data is available in Appendix A.T12).

[Tab. T3 is here]

Summing up, the estimated labour share in value added is represented as

$$(23) \quad v_{L,j}^{Z} = \frac{p_j^L \cdot L_j}{p_j^Z \cdot Z_j} = \frac{p_j^L \cdot L_j^e}{p_j^Z \cdot Z_j}\left(1 + \left(\frac{L_j^s}{L_j^e}\right)\left(\frac{H_j^e}{H_j^s}\right)\left(\frac{W_j^e}{W_j^s}\right)\right),$$

where $p_j^L \cdot L_j^e$ is labour compensation of employees in industry *j*; $p_j^Z \cdot Z_j$ is nominal value added given in *NAS*; $\left(\frac{L_j^s}{L_j^e}\right)$ is the ratio of the number of self-employed to employees given in the *LFS*

[84] Data is available in official publications – see (Rosstat 2010b, tab. 2.3.46-2.3.53).

[85] "Russia Longitudinal Monitoring survey, RLMS-HSE", conducted by Higher School of Economics and ZAO "Demoscope" together with Carolina Population Center, University of North Carolina at Chapel Hill and the Institute of Sociology of the Russian Academy of Science.

survey; $\left(\frac{H_j^e}{H_j^s}\right)$ is the ratio of average hours worked by employees to self-employed from the LFS survey; $\frac{W_j^e}{W_j^s}$ is the ratio of hourly earnings of employees and self-employed. For all industries except *Agriculture* the latter is assumed to be equal 1.

Most previous growth-accounting studies of the Russian economy (Tab. T4, column 7) ignored these issues, using fixed exogenous shares of labour and capital for the total economy such as 0.3 and 0.7, with no differentiation by industries[86]. Two papers[87] use an econometric approach, estimating an aggregate production function on either the long time series for the total economy or panel data of total economy aggregates of economies in transition including Russia.

[Tab. T4 is here]

In contrast with the extant literature which is mainly focused on the level of the total economy, in our exercise of detailed industrial growth accounting variations of factor shares across industries and in time are crucial. Table T3a shows that the lowest level of labour share corresponds to capital intensive *Extended Oil and Gas sector*, whereas highest shares are found in labour-intensive *Non-Market Services* (Education, Public Administration) and *Other Goods* (*Agriculture, Construction*). The influence of shadow wages is substantial in *Other Goods* and *Business Services* (e.g. *Retail*) with significant informal activity. In comparison with the effect of hidden wages the contribution of self-employed is modest. However, for such industries as *Agriculture*, *Automotive* and *Retail trade* it is substantial.

As it follows from table T3b, the share of labour compensation demonstrates a positive time trend. It indicates that wages grow faster in this period than labour productivity, in

[86] (De Broeck and Koen 2000; Dolinskaya 2002; Bessonov 2004; Izyumov and Vahaly 2008; Rapacki and Próchniak 2009)

[87] (Iradian 2007; Kuboniwa 2011)

particular in the years of crisis of 2008-2009 (Appendix, tab. A.T10). This growth is particularly pronounced in *Business Services* and relatively modest in *Manufacturing*.

7. Multifactor productivity

In this section I will investigate the sensitivity of MFP estimates to new estimates of output, labour and capital input, and factor income. To this end I will compare our results with a standard growth accounts based on official data.

There are two main strands in the growth accounting literature for Russia (Tab. T4). The first uses official data of capital stock. The second imputes its own capital stocks series with the Perpetual Inventory method (PIM). Some of them use rough adjustments on capacity utilization for capital and/or labour. All are based on the aggregate production possibility frontier approach (APPF). As it has been discussed in Section 2, this approach is very restrictive. In particular, it assumes that there is no price variation for inputs across industries. Following the methodology of Jorgenson, Ho and Stiroh (2005, Chapter 8) I relax these assumptions and shift from the aggregate production possibility frontier to direct aggregation of industrial production functions. This allows us to see which of the assumptions used in the previous literature have been most restrictive.

I start with the APPF decomposition (8) on the basis of official investment deflators, fixed shares of factors (0.7 for labour and 0.3 for capital) and fixed depreciation rate equal 5 per cent per year[88]. As can be seen from table T5, in this case multifactor productivity is the main source of economic growth and the contribution of factors is close to null. This is in line with the corresponding literature in Tab. T4 (Izyumov and Vahaly 2008; Rapacki and Próchniak 2009; Kuboniwa 2011- (1)).

[Tab. T5 is here]

[88] These parameters are typical for the literature. See tables 1.3 and 1.4 for review.

Results for total economy are important for comparisons with the extant literature. However, since output measures in the non-market part of the economy are mainly costs-based, productivity growth rates should be equal one by default. That is why hereafter I focus on market economy, for which growth accounting decomposition is similar (Tab. T6).

[Tab. T6 is here]

As it has been discussed in Section 2, the APPF framework is grounded on the assumption that factor prices in industries are the same. Differences in factor prices in industries are taken into account by direct aggregation of industrial production functions (11), which is the most flexible framework. The link between APPF and direct aggregation may be established if reallocation effects of labour and capital in (11) are taken into account. Table T6 shows that one fifth of multifactor productivity growth rates are explained by reallocation of labour and capital to industries with higher factors' returns.

[Tab. T7 is here]

Table T7 shows growth rates and contributions of value added, labour and capital obtained by direct aggregation across industries (7). The first column (I) corresponds to the initial growth accounting decomposition, which has been considered above. As it follows from Section 5, official investment deflators overestimate inflation on investment goods. The substitution of this price deflator with our preferred set of price indices (column II) leads to an increase of contribution of capital from 0.11 to 0.93 p.p. In the next column (III) the fixed share of labour of 0.7 is replaced by industry and time-specified labour shares as discussed in the previous section. Since the average labour share was much lower than (54.6 %), the contribution of labour to output growth was much less, while the contribution of capital increased even more

Next, column IV demonstrates the effect of introduction of detailed data on depreciation rates instead of using a fixed 5% level. For example, the depreciation rate of ICT capital is 12 %, and the depreciation rate of non-residential buildings is 3 % Overall, this leads to only a slight decrease of capital contribution from 1.69 to 1.53 p.p. and a corresponding increase of MFP contribution. Finally, I change in the concept for capital input from stocks to our preferred measure of services (dataset V). This leads to further reallocation of contributions between different types of assets. Whereas the role of assets with high depreciation rates (such as *Machinery* and *ICT*) increases, the contribution of long-live assets (e.g. *Non-residential constructions*) falls. In total, the contribution of capital input has increased by 0.24 p.p. However, this relatively modest correction at the macro level shades substantial changes at the level of industries (Fig. F8). In many industries the reallocation of contributions between *Machinery*, *ICT equipment* and *Non-residential structures* leads to higher capital growth rates (see Tab. T2 for *Food and Beverage*). This effect is strong in such machinery-intensive sectors as *Other Manufacturing*, *Paper and Publishing*, *Metals* and ICT-intensive *Post and Telecommunications*. In contrast, a negative change of the shift to capital services is observed in *Inland Transport*, which depends heavily on infrastructure.

[Fig. F8 is here]

The results of growth accounting decomposition in the basis of dataset V are our preferred estimates. I tested its robustness by using an alternative set of deprecations rates (based on the survey of *Rosstat* on service lives; VII, tab. A.T5) and labour shares excluding self-employed (VIII, tab. A.T5). But the differences are very minor. In contrast, the results are very sensitive to the use of double deflation (Tab. T7, column VI). Above I indicated that measured value added growth would be much less by 0.64 p.p. when taking into account differences in price changes on output and intermediate goods (like low domestic prices on energy). The MFP growth is diminished by the same amount and its contribution to output growth is now lower than that of capital.

These findings suggest that the aggregate production productivity frontier (APPF) - based approach which is used in most studies is misleading for understanding the sources of Russian growth and detailed industrial level data is important. Using the APPF approach I confirm the conclusion of the literature that the main source of growth in Russia is multifactor productivity. However, with the preferred measures for capital input and the labour share, I explained more than one half of growth attributed earlier to MFP by the contribution of factors. I conclude that Russian growth has been more capital-driven in comparison with the literature during the period 1995 to 2009, relying for the greater part on investments and not on improvements in efficiency

Further data improvements would be worthwhile to consider. The growth accounting literature (e.g. (van Ark, O'Mahony, and Timmer 2008)) points out the importance of the composition of labour, such as changes in the skill composition. Rather, further work needs to be done to improve capital data - in particular investment price indices. As shown in this chapter, measures of capital are highly sensitive to the assumptions made about deflators. Also improved deflation of value added needs reconsideration. The theoretically superior method of double deflation will have a better empirical counterpart once a second benchmark year of dataset of SUTs will become available.

This newly developed dataset is eventually a step forward in international comparisons of productivity at the detailed industrial level. Placed in the international context, data on Russian economy may clarify many issues about growth, structural change, and transition.

Appendix

A.T1. GDP in purchasers' prices in four revisions of the National Accounting System.
(billion RUR 1990-1997; million RUR 1998-2009)

	Rev. 1	Rev. 2	Rev. 3	Rev. 4
1990	644	-	-	-
1991	1 399	-	-	-
1992	19 006	-	-	-
1993	171 510	-	-	-
1994	610 745	-	-	-
1995	1 540 493	1 428 522	-	-
1996	2 145 656	2 007 825	-	-
1997	2 478 594	2 342 514	-	-
1998	2 741 051	2 629 623	-	-
1999	4 766 835	4 823 234	-	-
2000	7 302 233	7 305 646	-	-
2001	9 040 821	8 943 582	8 943 582	-
2002	-	10 817 536	10 830 535	10 819 212
2003	-	13 201 074	13 243 240	13 208 234
2004	-	16 778 775	17 048 122	17 027 191
2005	-	-	21 625 372	21 609 766
2006	-	-	26 903 494	26 917 201
2007	-	-	33 111 382	33 247 513
2008	-	-	41 668 034	41 428 561
2009	-	-	-	39 100 653

COMMENT: (-) No official data consistent with the corresponding revision is available.

SOURCES:

Rev. 1: (Rosstat 2002c);

Rev. 2: (Rosstat 2003c; Rosstat 2004);

Rev. 3: (Rosstat 2009b);

Rev. 4: (Rosstat 2010b).

Differences among revisions of National Accounts bring some errors to the dataset. Four revisions of SNA have been issued, which cover 1990-2001, 1995-2004, 2001-2008 and from 2002 onwards. For some years, relevant data could be slightly different in different revisions (see also (Poletayev 2008, pp. 45-6)). Since *Rosstat* does not provide backcast estimations for each revision slight inter-temporal inconsistencies remain in our data.

In addition to these errors, there is one more problem with the official approach of Financial Intermediation Services Indirectly Measured (FISIM). In the fourth revision, *Rosstat* changed the approach to imputations of FISIM, but did not revise the final demand components in 1995-2001. In the period before 2002 FISIM was considered simply as intermediate inputs of a virtual industry with zero value added, whereas starting from 2002 FISIM was split into intermediate inputs and value added, and broken down by industries. Hence a part of the growth in total value added in 2002 could be explained by a jump of the FISIM value added from zero to a positive value. Although the contribution of this jump to real growth rates of the total economy is insignificant, it could be substantial in some industries.

A.T2. Industries and sectors in the New classification (OKVED/NACE 1.0)

N	Industry	Code
1	Agriculture, Hunting, Forestry And Fishing	AtB
2	Mining And Quarrying	C
3	Food , Beverages And Tobacco	15t16
4	Textiles and textile	17t18
5	Leather, leather and footwear	19
6	Wood And Of Wood And Cork	20
7	Pulp, Paper, Paper , Printing And Publishing	21t22
8	Coke, refined petroleum and nuclear fuel	23
9	Chemicals and chemical	24
10	Rubber and plastics	25
11	Other Non-Metallic Mineral	26
12	Basic Metals And Fabricated Metal	27t28
13	Machinery, Nec	29
14	Electrical And Optical Equipment	30t33
15	Transport Equipment	34t35
16	Manufacturing Nec; Recycling	36t37
17	Electricity, Gas And Water Supply	E
18	Construction	F
19	Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of fuel	50
20	Wholesale trade and commission trade, except of motor vehicles and motorcycles	51
21	Retail trade, except of motor vehicles and motorcycles; repair of household goods	52

22	Hotels And Restaurants	H
23	Other Inland transport	60
24	Other Water transport	61
25	Other Air transport	62
26	Other Supporting and auxiliary transport activities; activities of travel agencies	63
27	Post And Telecommunications	64
28	Financial Intermediation	J
29	Real Estate Activities	70
30	Renting of machinery and equipment, and other business activities	71t74
31	Public Admin And Defense; Compulsory Social Security	L
32	Education	M
33	Health And Social Work	N
34	Other Community, Social And Personal Services	O
35	Private Households With Employed Persons	P

A.T3. Industries in the Old Russian industrial classification OKONKh

Code	Name
10000	Industry
11100	Electric power industry
11200	Fuel industry
11210	Oil extracting industry
11220	Oil refining industry
11230	Natural gas industry
11300	Coal industry
11410	Shale industry
11610	Peat industry
12100	Ferrous metallurgy
12110	Extraction and concentration of ferrous metal ores
12120	Extraction and concentration of ferrous nonmetallic feed
12160	Chemical-recovery coal carbonization
12170	Refractory materials (flux) production
12200	Non-ferrous metallurgy
13000	Chemical and petrochemical industry
13100	Chemical industry
13120	Chemical fibers and threads
13150	Paint and varnish industry
13170	Synthetic dyes
13300	Petrochemical industry
13320	Products of organic synthesis
13360	Rubber and asbestos industry

14000	Machine-building and metal working
14100	Machine building
14130	Machine-building for metallurgy
14140	Machine-building for mining and ore mining
14150	Materials handling machine building
14160	Railway machine-building
14170	Electrical engineering industry
14172	Cable industry
14173	Electric-bulb industry
14175	Accumulator and elemental industry
14200	Machine-tool and tool-making industry
14320	Instrument-making industry
14330	Computer and office equipment
14340	Motor-car construction
14342	Motorcycles, bikes, and spare parts for them
14350	Bearings
14400	Tractor and farm-machine building
14510	Machine-building for road works and construction
14540	Equipment for municipal economy and consumer services
14610	Manufacturing equipment for light industry
14640	Manufacturing equipment for printing industry
14650	Home appliances and equipment
14710	Sanitary and hygiene equipment; gas equipment and articles
14780	Machine-building, other

14830	Metal structures and articles
14900	Machine and equipment maintenance
15000	Logging, woodworking and pulp-and-paper industry
15270	Furniture industry
15300	Pulp and paper
15400	Resin industry
16100	Building materials industry
16110	Cement
16120	Asbestos-cement goods
16130	Soft roofing and waterproofing materials
16140	Prefabricated concrete and ferroconcrete items (excl. walling)
16150	Walling
16160	Building ceramics
16170	Polymeric building materials
16180	Non-metallic building materials
16500	Glass, porcelain and earthenware industry
17000	Light industry
17100	Textile industry
17150	Knitting industry
17200	Clothing industry
17370	Shoe industry, excl. repair
17900	Light industry, other
18000	food industry
18111	Sugar industry

18121	Oil-and-fat industry
18122	Soap and fat-base detergents
18131	Perfume and cosmetic production
18143	Wine industry
18150	Fruit and vegetable processing industry
18180	Tobacco industry
18210	Meat industry
18220	Butter, cheese and milk industry
18300	Fishing industry
18411	Confectionary industry
19100	Microbiological industry
19200	Flour-and-cereals industry
19210	Flour industry
19220	Mixed fodder industry
19310	Chemical and pharmaceutical industry
19320	Medical equipment industry
19330	Glass, porcelain and plastic medical items
19400	Printing industry
19700	Industry, other
20000	Agriculture
21000	Farm production
21100	Crop raising
21200	Cattle production
22000	Farm services

30000	Forestry
50000	Transport and communications
51000	Transport
51111	Land Rail-Road transport (except Trams)
51112	Tram transport
51113	Subway transport
51121	Automobile fleet
51122	Trolley transport
51123	Road facilities
51130	Main pipeline transport
51210	Sea transport
51220	Inland water transport
51300	Air transport
52000	Communications
60000	Construction
70000	Trade and Catering
71300	Catering
80000	Procurement and distribution
81000	Procurements
82000	Information services
83000	Real estate operations
84000	Other business activities
85000	Geology and exploration works; geodesy and hydrometeorology
87000	Production of goods, other

87100	Publishing
87400	Private security
90000	Housing and public utilities
90100	Housing
90200	Public utilities
90300	Non-production types of every-day services
91000	Health care physical culture and social security
92000	Education
93000	Culture and art
95000	Science and related services
96000	Finances, credit, insurance, pension security
96100	Banking
96200	Insurance
96300	Provision of pensions
97000	Administration
98000	Public amalgamations

SOURCE: (Rosstat 1976)

A.T4. Concordance of value added-gross output ratios of the Old classification and the New industrial classifications

#	The New Classification (OKVED/NACE 1.0)		The Old Classification (OKONKh)	
	Industry name	Code	Industry name	Code
1	Agriculture, Hunting, Forestry And Fishing	AtB	Agriculture	20000
2	Mining and Quarrying	C	Oil Extracting Industry	11210
			Oil Refining Industry*	11220
			Natural Gas Industry*	11230
3	Food , Beverages And Tobacco	15t16	Food industry	18000
4	Textiles and textile	17t18	Light industry	17000
5	Leather, leather and footwear	19	Light industry	17000
6	Wood and Products of Wood and Cork	20	Logging, woodworking and pulp-and-paper industry	15000
7	Pulp, Paper, Paper , Printing and Publishing	21t22	Logging, woodworking and pulp-and-paper industry	15000
8	Coke, Refined petroleum and Nuclear Fuel	23	Fuel Industry	11200
9	Chemicals and chemical products	24	Chemical and Petrochemical Industry	13000
			Chemical and Pharmaceutical Industry*	19310
10	Rubber and Plastics Products	25	Chemical and Petrochemical Industry	13000
			Chemical and Pharmaceutical Industry*	19310
11	Other Non-Metallic Mineral Products	26	Machine-building and metal working	14000
			Medical Equipment Industry*	19320

12	Basic Metals and Fabricated Metal Products	27t28	Machine-building and metal working	14000
			Medical Equipment Industry*	19320
13	Machinery, nec	29	Machine-building and metal working	14000
			Medical Equipment Industry*	19320
14	Electrical and Optical Equipment	30t33	Machine-building and metal working	14000
			Medical Equipment Industry*	19320
15	Transport Equipment	34t35	Machine-building and metal working	14000
			Medical Equipment Industry*	19320
16	Manufacturing nec; Recycling	36t37	Machine-building and metal working	14000
			Medical Equipment Industry*	19320
17	Electricity, Gas and Water Supply	E	Electric Power Industry	11100
18	Construction	F	Construction	60000
19	Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of fuel	50	Trade	70000;
20	Wholesale trade and commission trade, except of motor vehicles and motorcycles	51	Wholesale trade	71100
21	Retail trade, except of motor vehicles and motorcycles; repair of household goods	52	Retail trade	71200
22	Hotels and Restaurants	H	Catering	71300
23	Inland Transport	60	Transport	51000
24	Water Transport	61	Transport	51000
25	Air Transport	62	Transport	51000

26	Supporting and Auxiliary Transport Activities; Activities of travel Agencies	63	Transport	51000
27	Post and Telecommunications	64	Communications	52000
28	Financial Intermediation	J	Finances, credit, insurance, pension security	96000
29	Real Estate Activities	70	Trade	70000;
30	Renting of machinery and equipment and other business activities	71t74	IT Services	82000
			Publishing	87100
			Private Security	87400
31	Public Admin And Defense; Compulsory Social Security	L	Administration	97000
32	Education	M	Education	92000
33	Health and Social Work	N	Health care, physical culture and social security	91000
34	Other Community, Social and Personal Services	O	Culture and Art	93000

COMMENT:

The concordance is used for the imputations of value added and labour shares in the new classification on the basis of data in the old classification. See details in sections 3 and 6.

(*) The choice of some industries in the old classification is explained by a grouping in the official publications. The choice of some counterparts in the new classification seems strange, but it is explained with the data published. With the exception of the last release of *NAS*, *Rosstat* brought data into open at the level of 25 industries in the old classification and 15 industries in the new classification. In some cases it was impossible to split the industry, which is a real counterpart, from other industries in the publication grouping.

A.T5. Basic and alternative datasets

#	Investments deflators	Economic Depreciation	Concept of capital input	Labour share	Comment
I	Investment deflators	5% per year	Stocks	0.7	
II	Inv. ind. in construction	5% per year	Stocks	0.7	
III	Inv. ind. in construction	5% per year	Stocks	A.T12 (3)	
IV	Inv. ind. in construction	(Fraumeni 1997)	Stocks	A.T12 (3)	
V	Inv. ind. in construction	(Fraumeni 1997)	Services	A.T12 (3)	Basic (preferred) dataset
VI	Inv. ind. in construction	(Fraumeni 1997)	Services	A.T12 (3)	Double deflation
VII	Inv. ind. in construction	(Fraumeni 1997; Gordonov 2010)	Services	A.T12 (3)	Russian data of asset service lives is implemented for machinery and equipment, transport, residential and non-resid. buildings.
VIII	Inv. ind. in construction	(Fraumeni 1997)	Services	A.T12 (2)	No correction for self-employed

A.T6. Imputations of FTE jobs in the economy excluding non-market households

A.T6a. Availability of BLI data in industries

Code	Euk Industry	1995-2002	2003-2009
TOT	TOTAL INDUSTRIES	Ext. BLF	BLI
AtB	AGRICULTURE, HUNTING, FORESTRY AND FISHING	Ext. BLF	BLI
C	MINING AND QUARRYING	Ext. BLF	BLI
D	TOTAL MANUFACTURING	Ext. BLF	BLI
15t16	Food , beverages and tobacco	Ext. BLF	Ext. BLF
17t19	Textiles and textile	Ext. BLF	Ext. BLF
20	Wood and of wood and cork	Ext. BLF	Ext. BLF
21t22	Pulp, paper, paper , printing and publishing	Ext. BLF	Ext. BLF
23	Coke, refined petroleum and nuclear fuel	Ext. BLF	Ext. BLF
24	Chemicals and chemical	Ext. BLF	Ext. BLF
25	Rubber and plastics	Ext. BLF	Ext. BLF
26	Other non-metallic mineral	Ext. BLF	Ext. BLF
27t28	Basic metals and fabricated metal	Ext. BLF	Ext. BLF
29	Machinery, nec	Ext. BLF	Ext. BLF
30t33	Electrical and optical equipment	Ext. BLF	Ext. BLF
34t35	Transport equipment	Ext. BLF	Ext. BLF
36t37	Manufacturing nec; recycling	Ext. BLF	Ext. BLF
E	ELECTRICITY, GAS AND WATER SUPPLY	Ext. BLF	BLI
F	CONSTRUCTION	Ext. BLF	BLI
G	TRADE	Ext. BLF	BLI

50	Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of fuel	Ext. BLF	Ext. BLF
51	Wholesale trade and commission trade, except of motor vehicles and motorcycles	Ext. BLF	Ext. BLF
52	Retail trade, except of motor vehicles and motorcycles; repair of household goods	Ext. BLF	Ext. BLF
H	HOTELS AND RESTAURANTS	Ext. BLF	BLI
I	TRANSPORT AND STORAGE AND COMMUNICATION	Ext. BLF	BLI
60t63	Transport and storage	Ext. BLF	Ext. BLF
60	Other inland transport	Ext. BLF	Ext. BLF
61	Other water transport	Ext. BLF	Ext. BLF
62	Other air transport	Ext. BLF	Ext. BLF
63	Other supporting and auxiliary transport activities; activities of travel agencies	Ext. BLF	Ext. BLF
64	Post and telecommunications	Ext. BLF	Ext. BLF
J	FINANCIAL INTERMEDIATION	Ext. BLF	BLI
K	REAL ESTATE, RENTING AND BUSINESS ACTIVITIES	Ext. BLF	BLI
70	Real estate activities	Ext. BLF	Ext. BLF
71t74	Renting of m&eq and other business activities	Ext. BLF	Ext. BLF
L	PUBLIC ADMIN AND DEFENCE; COMPULSORY SOCIAL SECURITY	Ext. BLF	BLI

M	EDUCATION	Ext. BLF	BLI
N	HEALTH AND SOCIAL WORK	Ext. BLF	BLI
O	OTHER COMMUNITY, SOCIAL AND PERSONAL SERVICES	Ext. BLF	BLI
P	PRIVATE HOUSEHOLDS WITH EMPLOYED PERSONS	n/a	n/a

COMMENTS:

If data of the Balance of Labour Inputs (BLI) is available in official publications for a particular year, it is noted as BLI. Otherwise is marked as Ext. BLF (Extended Balance of Labour Force). Extended Balance of Labour Force is based on the Balance of Labour Force broken down by industries with the Full Circle data. Its structure is presented on Tab. A.T6b;

A.T6b. Extended Balance of Labour Force

Code	Industry	1995-1997	1998-2004	from 2005
TOT	TOTAL INDUSTRIES	Σ	Σ	Σ
AtB	AGRICULTURE, HUNTING, FORESTRY AND FISHING	Σ	Σ	Σ
A	agriculture, hunting and forestry	Σ	BLF	BLF
1	agriculture	BLF (20000)	-	-
2	forestry	BLF (30000)	-	-
B	fishing	FC (18300)	BLF	BLF
C	MINING AND QUARRYING	Σ	Σ	Σ
10t12	mining and quarrying of energy producing materials	FC	BLF	FC
13t14	mining and quarrying except energy producing materials	FC	BLF	FC
D	TOTAL MANUFACTURING	Σ	Σ	Σ
15t16	food , beverages and tobacco	FC	BLF	LFS/FC[12]
17t19	textiles and textile	FC	BLF	LFS/FC[12]
20	wood and of wood and cork	FC	BLF	LFS/FC[12]
21t22	pulp, paper, paper , printing and publishing	FC	BLF	FC
23	coke, refined petroleum and nuclear fuel	FC	FC[1]	FC[1]
24	chemicals and chemical	FC	BLF	FC
25	rubber and plastics	FC	BLF	FC
26	other non-metallic mineral	FC	BLF	FC
27t28	basic metals and fabricated metal	FC	BLF	FC
29	machinery, nec	FC	FC[2]	FC[2]

30t33	electrical and optical equipment	FC	BLF	FC
34t35	transport equipment	FC	BLF	FC
36t37	manufacturing nec; recycling	FC	BLF	LFS/FC[12]
E	ELECTRICITY, GAS AND WATER SUPPLY	FC	BLF	BLF
F	CONSTRUCTION	BLF(60000)	BLF	BLF
G	TRADE	Σ	BLF[5], BLI[6]	BLI
50	Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of fuel		FC	FC
51	Wholesale trade and commission trade, except of motor vehicles and motorcycles	BLF (70000 +80000 +81000)	FC	FC
52	Retail trade, except of motor vehicles and motorcycles; repair of household goods		BLF[5], BLI[6]	BLI
H	HOTELS AND RESTAURANTS	BLF (70000)	BLF	BLF
I	TRANSPORT AND STORAGE AND COMMUNICATION	BLF (51000 + 52000)	BLF	BLF
60t63	transport and storage	BLF (51000)	BLF	BLF
60	other inland transport	Σ	Σ	Σ
60.1	transport via railways	FC (51111)	FC (51111)[3], BLF (51111)[4]	FC
60.2	other land transport	Δ[7]	Δ[7], FC[8]	FC
60.3	transport via pipelines	FC (51130)	FC (51130)[5]; FC[6]	FC
61	other water transport	FC (51200)	FC (51200)[5], FC[6]	FC

62	other air transport	BLF (51000)	BLF (60t63)[9], FC[10]	FC
63	other supporting and auxiliary transport activities; activities of travel agencies	BLF (51000)	BLF (60t63)[9], FC[10]	FC
64	post and telecommunications	BLF (52000)	BLF (52000)	BLF
J	FINANCIAL INTERMEDIATION	BLF (96000)	BLF (96000)[5], BLF[6]	BLF
K	REAL ESTATE, RENTING AND BUSINESS ACTIVITIES	Σ	Σ	Σ
70	Real estate activities	FC (83000 + 90100)	FC (83000 + 90100)[5], FC[6]	FC
71t74	Renting of m&eq and other business activities	Σ	Σ	Σ
71	Renting of machinery and equipment	FC (K)	BLF (K)	BLF
72	Computer and related activities	FC (82000)	FC (82000)[5], FC6	BLF
73	Research and development	BLF (95000)	BLF (95000)[5], FC[6]	BLF
74	Other business activities	FC (84000 + 85000 + 87000 + 91000)	FC (84000 + 85000 + 87000 + 91000)[5], FC[6]	BLF
L	PUBLIC ADMIN AND DEFENCE; COMPULSORY SOCIAL SECURITY	BLF (87000)	BLF	BLF
M	EDUCATION	BLF (92000)	BLF	BLF
N	HEALTH AND SOCIAL WORK	BLF (91000)	BLF	BLF
O	OTHER COMMUNITY, SOCIAL AND	Σ	BLF	BLF

	PERSONAL SERVICES			
90	Sewage and refuse disposal, sanitation and similar activities	FC (90200)	-	-
91	Activities of membership organizations nec	FC (98000)	-	-
92	Recreational, cultural and sporting activities	BLF (93000)	-	-
93	Other service activities	FC (90300)	-	-
P	PRIVATE HOUSEHOLDS WITH EMPLOYED PERSONS	n/a	BLF	BLF
Q	EXTRA-TERRITORIAL ORGANIZATIONS AND BODIES	-	BLF[11]	BLF

NOTATION:

BLF – the Balance of Labour Force;

FC – the Full Circle;

LFS – the Labour Force Survey;

Σ – the level of labour has been calculated as the sum of levels of corresponding sub-industries.

COMMENTS:

The number of industries in the table exceeds the number of industries considered in the paper, because in some cases it was easier to impute data at a more detailed level. For example, there is no BLF data for Agriculture and Fishing (AtB) before 1998, but there is the BLF data in the Old classification for Agriculture (20000), Forestry (30000), and the FC data for fishing (18300). Using labour growth rates from these sources and the BLF data of levels in 2005, labour in these industries has been imputed.

[1.] From 2004 onwards data for the Processing of nuclear fuel industry (23.3) has not been publishing. Growth rates of labour in Manufacturing of coke and refined petroleum (23.1 + 23.2) is used as a proxy.

[2.] From 2002 onwards data for Machinery nec is published excluding Manufacturing of weapons and ammunition (29.6). Growth rates of labour in the Machinery nec excluding Manufacturing of weapons and ammunition (29x6) are used as the appropriate proxy from 2004 onwards. To prevent any artificial structural breaks, the average of growth rates of 29 and 29x6 is used in 2003.

[3.] 1998, 2002-2004

[4.] 1999-2001

[5.] 1998-2002

[6.] 2003-2004

[7.] Other inland transport in 1995-2002 was obtained as the difference between the total value of Transport and Communications (I) and the other sub-industries of I.

[8.] 2003-2004

[9.] 1998-2001

[10.] 2002-2004

[11.] Reliable data is available from 2000 only

[12.] There are two versions of the dataset. In the first version the data of LFS is used (preferable), in the second version – FC.

A.T7. The model of employment in Agriculture

This subsection suggests the approach for imputations of labour contribution in FTE-jobs of *NMH* for years before 2003, since the data of labour supply for these households consistent with *NAS* is available in the Balance of Labour Inputs from 2003 onwards[89].

Since the share of jobs in *NMH* of all industries except Agriculture is less than one per cent[90], I assume that the non-market households are concentrated in Agriculture only. For the period of 2003-2009 the number of FTE jobs in *NMH* has been calculated as the total number of FTE jobs in Agriculture[91] multiplied by the share of *NMH* in hours worked in Agriculture[92]. Consequently, this approach provides levels of employment in *NMH* from 2003.

However, for the extension of this series I should also impute rates of labour before 2003. Following (Poletayev 2003) I assume that in *NMH* there is no labour productivity growth

(A.1) $$\Delta \ln LP_{NMH} \equiv \Delta \ln Z_{NMH} - \Delta \ln L_{NMH} = 0$$

or

(A.2) $$\Delta \ln L_{NMH} = \Delta \ln Z_{NMH},$$

where $\Delta \ln Z_{NMH}$ is growth rates of value added of *NMH*. Unfortunately, *NMH* value added growth rates are not available. *Rosstat* provides data on output growth rates of households instead, which includes not only *NMH*, but also market households (*MH*)[93]. Consequently, growth rates of households output $\Delta \ln Z_H$ may be represented as a weighted sum of output

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[89] Data on employment in NMH is also available in LFS starting from 1999. However, it is not fully consistent with BLI and potentially brings one more artificial structural break in 1998-1999.

[90] (Rosstat 2009c, tab. 3.4)

[91] (Rosstat 2010c, tab. 5.6)

[92] (Rosstat 2009c, tab. 3.5)

[93] (Kapeliushnikov 2006, tab. 6.9; Rosstat 2012)

growth rates of market and non-market households:

(A.3) $\Delta \ln Z_H = \bar{v}_{MH}^Z \cdot \Delta \ln Z_{MH} + (1 - \bar{v}_{MH}^Z) \cdot \Delta \ln Z_{NMH}$,

where $\bar{v}_{MH}^Z$ is the time average share of nominal value added of market households in total value added of households. Expressing $\Delta \ln Z_{NMH}$ from (A.3) and assuming that labour productivity growth rates in *Market Households* $\Delta \ln LP_{MH}$ are the same as in agricultural firms $\Delta \ln LP_F$ I have

(A.4) $\Delta \ln Z_{NMH} = \frac{1}{(1-\bar{v}_{MH}^Z)} \cdot (\Delta \ln Z_H + \bar{v}_{MH}^Z \cdot \Delta \ln Z_{MH}) =$

$= \frac{1}{(1-\bar{v}_{MH}^Z)} \cdot \left(\Delta \ln Z_H + \bar{v}_{MH}^Z \cdot (\Delta \ln LP_F + \Delta \ln L_{MH})\right)$,

where $\Delta \ln L_{MH}$ is growth rates of employment in Market Households. Substituting (A.4) into (A.2) I obtain labour growth rates in *NMH*.

Data on total output growth rates in households in Agriculture $\Delta \ln Z_H$ is available. Labour productivity of growth rates of agricultural firms $\Delta \ln LP_F$ is the difference of output growth rates and labour in organizations of the Full Circle. Assuming that the difference between employment levels of *the Balance of Labour Force* and *the Full Circle* in *Agriculture* is equal to employment in *MH*, I calculate$\Delta \ln L_{MH}$. The value of $\bar{v}_{MH}^Z$ may be obtained for years from 2003. In 1995-2004 it is assumed to be equal to the value of 2003.

A.T8. Concordance between types of assets EU KLEMS, the Russian assets' classification and investments price indices

EU KLEMS assets' type	The Russian assets' classification (*exact term in Russian*)
ICT Assets	
Computing equipment	Computing equipment (*Vychislitel'naia tekhnika*)
Communications equipment	Data-processing machines except computing equipment (*Informatsionnye mashiny, ne vkliuchaia vychislitel'nuiu tekhniku*)
Software	Non-material assets (*Menaterial'nye aktivy*)
Non-ICT Assets	
Residential structures	Residential structures (*Zhilishcha*)
Non-residential structures	Buildings and constructions (*Zdaniia, sooruzheniia i peredatochnye ustroĭstva*)
Transport equipment	Transport facilities (*Transportnye sredstva*)
Other machinery and equipment	Power machines and material working machines (*Silovye mashiny i rabochie mashiny*)
Other assets	Other assets (*Prochie aktivy*)

Sources:

EU KLEMS Assets' classification –Timmer and others (2010, tab. 3.5), tab. 3.5;

The Russian Assets' classification – (Gosstandart 1994)

Note: Exact terminology in Russian from the Russian assets' classification is given in brackets.

A.T9. Allocation of investments of households by types of assets

Type of assets from the Balance of Households' Property (*Exact term in Russian*)	Industry (code)	Type of asset [1)]
Livestock (*Skot*)	AtB	Other assets
Perennial plantings (*Mnogoletnie nasazhdeniia*)	AtB	Other assets
Farm machinery (*Sel'skokhoziaĭstvennaia tekhnika*)	AtB	Other Machinery and Equipment
Household outbuildings (*Khoziaĭstvennye postroĭki*)	AtB	Non-residential structures
Private houses (*Individual'nye doma*)	70	Residential structures
Privatized and reacquired residential structures (*Privatizirovannye i vykuplennye zhylyepomeshcheniia*)	70	Residential structures
Vacation houses (*Dachi I sadovye domiki*)	70	Residential structures
Equipment for transport and communications (*Osnovnye fondy transporta I sviazi*)	60	Transport facilities
Equipment for wholesale, retail and retail trade (*Osnovnye fondy oprovoĭ i roznichnoĭ torgovli, remonta avtotransportnykh sredstv, mototsiklov, bytovykh izdeliĭ i predmetov lichnogo pol'zovaniia*)	52	Allocated by all types of assets in proportion to new acquisitions from the survey F11
Equipment for Manufacturing (*Osnovnye fondy VĖD "Obrabatyvaiushchie proizvodstva"*)	15t16	Allocated by all types of assets in proportion to new acquisitions from the survey F11

NOTE: [1)] Concordance between the Russian classification of types of assets and EU KLEMS asset classification is given in Appendix A.T8.

A.T10. Average growth rates of capital stocks and services in 1995-2009 (dataset V)

Code	Industry	Capital stocks	Capital services
		1	2
Tot	**Total economy**	**2.54**	**3.27**
Mecon	**Market Economy**	**2.69**	**3.26**
D	***Manufacturing***	***1.83***	***2.61***
15t16	Food & Bev.	3.02	4.14
17t18	Textiles	-3.07	-3.56
19	Footwear	-1.81	-1.83
20	Wood products	0.95	1.77
21t22	Paper & Publish.	1.19	2.33
23	Fuel	7.78	8.14
24	Chemicals	-0.09	0.47
25	Rubber & plastics	0.21	0.87
26	Non-Met. Miner.	1.44	2.68
27t28	Metal	1.87	3.05
29	Other Machinery	0.09	0.86
30t33	Electr. Equip.	-1.82	-1.58
34t35	Transp. Equip.	-1.76	-1.54
36t37	Oth. Manuf.	1.42	2.45
OthGds	***Other Goods***	***1.28***	***1.99***
AtB	Agriculture	-1.48	-1.46
E	Utilities	2.56	3.02
F	Construction	2.95	4.41

Gas	***Extended Oil and Gas***	***2.78***	***2.99***
C	Mining	4.80	5.38
51	Wholesale trade	1.48	1.45
Bserv	***Business Services***	***3.93***	***4.51***
50	Automotive trade	4.97	6.63
52	Retail Trade	5.85	7.03
H	Hotels and Rest.	1.84	2.81
60	Inland transport	2.64	1.52
61	Water trnsp.	-1.90	-2.13
62	Air trnsp.	3.52	4.19
63	Oth. Trnsp. serv.	6.27	7.52
64	Post & Telecom	7.96	10.64
J	Fin. Intermed.	4.35	3.63
71t74	Rent. & bus.act.	1.51	2.62
O	Soc. & Pers. Serv.	0.56	1.43
NMServ	**N-Market Serv.**	**1.77**	**3.33**
70	Real est. Act.	3.31	4.38
L	Publ. Adm. & Def.	1.68	3.92
M	Education	-0.55	-0.09
N	Health & Soc. Work	2.03	3.92

A.T11. Value added, labour compensation and hidden wages in 1995-2009

	Value added in current basic prices (bn/m RUR)*	Labour compensation (bn/m RUR)*	Hidden wages and mixed income (bn/m RUR)*	Labour share (per cent)	Labour share including hidden ages and mixed income (per cent)
	1	**2**	**3**	**4 = 2/1**	**5=(2+3)/1**
1995	1,420,062	535,804	160,000	37.7	49.0
1996	1,963,166	814,175	250,000	41.5	54.2
1997	2,263,270	948,895	290,000	41.9	54.7
1998	2,501,611	1,015,707	277,000	40.6	51.7
1999	4,271,474	1,408,846	525,000	33.0	45.3
2000	6,469,088	2,126,394	810,000	32.9	45.4
2001	7,941,606	3,066,313	1,002,800	38.6	51.2
2002	9,569,971	3,816,101	1,249,000	39.9	52.9
2003	11,619,750	4,734,988	1,496,400	40.7	53.6
2004	14,858,767	5,849,937	1,995,100	39.4	52.8
2005	18,517,666	6,923,267	2,551,000	37.4	51.2
2006	22,977,344	8,535,906	3,450,000	37.1	52.2
2007	28,484,471	11,076,115	4,450,000	38.9	54.5
2008	35,373,095	14,353,149	5,200,000	40.6	55.3
2009	34,198,196	14,839,690	5,390,000	43.4	59.2

SOURCES: Rosstat. Income accounts for corresponding years.

COMMENTS: *Billion until 1997; million - after 1997.

A.T12. Average shares of labour compensation in 1995-2009 (dataset V)

Code	Industries	Share of labour compensation in value added, based on		
		Official wages	Total (incl. shadow wages)	Total, corr. on self-employed
		1	2	3
Tot	**Total economy**	**40.7**	**54.1**	**57.5**
Mecon	**Market Economy**	**35.9**	**50.7**	**54.6**
D	***Manufacturing***	***44.3***	***53.9***	***55.2***
15t16	Food & Bev.	33.5	43.4	44.4
17t18	Textiles	60.0	69.8	71.5
19	Footwear	58.1	67.9	69.6
20	Wood products	44.1	53.9	55.3
21t22	Paper & Publish.	50.9	60.8	62.3
23	Fuel	11.0	20.9	21.4
24	Chemicals	38.2	48.1	49.3
25	Rubber & plastics	39.9	49.7	51.0
26	Non-Met. Miner.	50.8	60.7	62.2
27t28	Metal	48.9	58.8	60.2
29	Other Machinery	65.6	75.5	77.4
30t33	Electr. Equip.	65.1	75.0	76.9
34t35	Transp. Equip.	73.6	79.4	81.2
36t37	Oth. Manuf.	54.3	64.2	65.8
OthGds	***Other Goods***	***39.2***	***60.4***	***67.3***
AtB	Agriculture	25.6	68.3	84.3
E	Utilities	40.3	40.3	40.4

F	Construction	50.1	66.7	69.9
Gas	***Extended Oil and Gas***	***17.1***	***33.2***	***37.5***
C	Mining	14.8	15.5	15.6
51	Wholesale trade	18.7	45.2	52.2
Bserv	***Business Services***	***40.5***	***53.6***	***57.0***
50	Automotive trade	26.7	53.2	61.3
52	Retail Trade	17.0	43.5	50.3
H	Hotels and Rest.	36.8	65.9	67.7
60	Inland transport	45.4	55.1	58.0
61	Water trnsp.	54.4	64.1	67.5
62	Air trnsp.	47.1	56.9	59.8
63	Oth. Trnsp. serv.	40.6	50.3	52.9
64	Post & Telecom	34.1	43.8	46.0
J	Fin. Intermed.	37.8	37.8	38.1
71t74	Rent. & bus.act.	75.2	74.6	76.7
O	Soc. & Pers. Serv.	67.1	76.3	80.7
NMServ	**N-Market Serv.**	**63.8**	**70.7**	**71.1**
70	Real est. Act.	14.9	36.3	37.4
L	Publ. Adm. & Def.	81.4	81.4	81.4
M	Education	79.5	82.0	82.3
N	Health & Soc. Work	79.0	83.4	84.0

Tables

T1. Estimates of capital input growth in the literature

Reference	Capital growth rates, per cent per year	Period	Approach	Comment on data sources
(De Broeck and Koen 2000, tab. 6)	-0.1	1991-1997	Official stock	
(Dolinskaya 2002, tab. 3)	0.25	1991-1997	Official stock	
(Kushnirsky 2001, pp. 9-15)	0.0	1992-1997	Official stock	
(Khanin and Suslov 1999)	-3.2	1990-1996	Official stock	Based on official data of capital stocks adjusted for undercount capital
(Dolinskaya 2002, tab. 6)	-5.7	1991-1997	Official stock + capacity utilization	Capacity utilization has been calculated in the paper.
(Kvintradze 2010, tab. A5) – (1)	5.3	1998-2004	Official stock + capacity utilization	Capacity utilization data is of the Russian Economic Barometer (REB)
(2)	7.2	1998-2004	Official stock + capacity utilization	Capacity utilization data of the Institute for the Economy in Transition (IET)
(3)	6.6	1998-2004	Official stock + capacity utilization	Capacity utilization data is of the Institute for the Center of Economic Analysis under the Government of Russian Federation (CEA)

(Izyumov and Vahaly 2008, tab. 4)	-1.1	1995-2005	PIM	Starting value is official gross capital stock; depreciation is assumed to be 5 per cent per year. Different efficiency of capital of market and non-market quality is assumed.
(Izyumov and Vahaly 2008, tab. 5)	-0.8	1998-2005	PIM	
(Rapacki and Próchniak 2009, pp. 79-98)	-1.44	1995-2009	PIM	
(Kuboniwa 2011, tab. 1)	3.1[1)]	1998-2010	PIM	Depreciation rate is 1.8 per cent per year.
	7.6	1998-2010	PIM + capacity utilization	Depreciation rate is 1.8 per cent per year; quarterly data; capacity utilization data is of REB
	4.0	1995-2010	PIM + capacity utilization	Depreciation rate is 1.8 per cent per year; quarterly data; capacity utilization data is of REB
(Iradian 2007, tab. 3 p. 17)	4.0	1996-2006	PIM + capacity utilization	PIM; depreciation is 5 per cent; capacity utilization data is of Rosstat, REB, CEA, IET. The paper mentions these sources, but does not clearly indicate what of the four sources is implemented.
(World Bank 2008, p. 51) (1)[a)]	2.6	1999-2005	PIM	Correction on "communist capital"

NOTE: In some cases capital growth rates are not presented in a paper explicitly, but may be calculated unambiguously on the bases of data available in the paper.

[1)] Average growth rates of capital stock of the total economy in 1998-2009, the official investment deflator and the depreciation rate 1.8 per cent with our data is 3.97.

[a)] For the group of countries of East Europe and Central Asia mid-income CIS economies including Russia

T2. Decomposition of growth rates of capital stocks and services by types of assets in *Food and Beverage* in 1995-2009

Types of assets	Average growth of stocks (p.p.)	Average shares of stocks (%)	Contribution to total growth of stocks (p.p.)	Average shares of services (%)	Contribution to total growth of services (p.p.)
	1	**2**	**3 = 1x2**	**4**	**5 = 1x4**
Computing equipment	4.75	0.31	0.01	1.12	0.05
Communications equipment	4.55	1.06	0.05	1.56	0.07
Software	31.75	0.36	0.11	1.13	0.36
Other Machinery and Equipment	5.90	35.73	2.11	49.87	2.94
Non-residential structures	0.75	56.89	0.43	35.97	0.27
Transport equipment	1.09	3.75	0.04	7.77	0.09
Other assets	13.74	1.90	0.26	2.58	0.35
TOTAL	-	100.00	3.02	100.00	4.14

NOTE: residentials are skipped because they are not presented in this industry. Detailed data on average growth rates of capital of stocks and services by industries is available in Appendix A.T10.

Source: own calculations, datasets IV (capital stocks) and V (capital services).

T3. Labour shares in major sectors in 1995-2009.

Tab. T3a. Average labour shares (%)

Sectors	Share of labour compensation in value added		
	Official	Official and shadow	Official and shadow; corrected on self-employed
Total economy	40.7	54.1	57.5
Manufacturing	44.3	53.9	55.2
Extended Oil and Gas	17.1	33.2	37.5
Other Goods	39.2	60.4	67.3
Business Services	40.5	53.6	57.0
Market Economy	35.9	50.7	54.6
Non-Market Services	63.8	70.7	71.1

Tab. T3b. Labour shares in 1995 and 2009 (%)

Sectors	Share of labour compensation in value added (official and shadow, corrected on self-employed)		
	1995	2009	Average
Total economy	51.0	63.9	57.5
Manufacturing	53.1	57.3	55.2
Extended Oil and Gas	33.7	41.2	37.5
Other Goods	62.3	72.4	67.3
Business Services	48.3	65.7	57.0
Market Economy	49.5	59.7	54.6
Non-Market Services	60.6	81.7	71.1

NOTE: disaggregated data and composition of sectors is available in Appendix A.T11.

T4. Contribution of labour and capital to output growth rates in 1995-2009. Comparison with the literature

Reference	Years	Labour contrib. (p.p.)	Capital contrib. (p.p.)	MFP (p.p.)	Output (p.p.)	Labour share
1	2	3	4	5	6	7
(Bessonov 2004, tab. 2, 4)	1990-2002	0.20	-0.83	-1.88	-2.51	0.70
(De Broeck and Koen 2000, pp. 13,15)	1991-1997	-1.54	-0.03	-6.0	-7.5	0.70
(Dolinskaya 2002, tab. 5)	1992-1997	-1.50	0.10	-6.6	-8.0	0.70
(Dolinskaya 2002, tab. 6) [a), b)]	1992-1997	-2.0	-1.7	-4.3	-8.0	0.70
(Izyumov and Vahaly 2008, tab. 4)	1995-2005	0.12	-0.44	4.1	3.9	0.60
(Izyumov and Vahaly 2008, tab. 5)	1998-2005	0.36	-0.32	6.7	6.7	0.60
(Rapacki and Próchniak 2009, pp.71-74)	1995-2003	0.14	-0.43	3.38	3.09	0.70
(Kuboniwa 2011, tab. 1) - (1) [c, d)]	1998-2008	0.1	2.3	4.6	7.6	0.25
(2) [a, c)]	1998-2008	0.5	3.0	4.0	7.6	0.61
(3) [b, c)]	1998-2008	0.3	2.0	4.6	7.6	0.36
(4) [a, b, c)]	1998-2008	2.1	2.6	3.4	7.6	0.66
(5) [a), c)]	1995-2010	0.1	1.8	2.5	3.6	0.56
(Iradian 2007,tab. 3)	1996-2006	0.1	2.4	1.7	4.2	0.40
(World Bank 2008, p. 51) – (1)[e)]	1999-2005	0.28	0.72	4.43	5.42	0.65
(2)[f)]	1999-2005	6.6	n/a	6.1	n/a	0.65

Notes:

Numbers are reproduced with the accuracy of a corresponding paper. Sums may not come up because of rounding off.

If possible with information available in a paper, the growth accounting decomposition has been calculated close to the period 1995-2009.

[a)] Capital stock is adjusted on capacity utilization.

[b)] Labour is somehow adjusted on utilization rate (e.g. underemployment of workers because of short-ended working days and compulsory leaves).

[c)] The sum of contributions does not come up to output growth rates because of statistical errors, which are reported in the paper.

[d)] Calculations on our dataset with the depreciation 1.8%, official investment deflators and labour income share 0.25 is following (in p.p.): GDP growth rates 6.5, labour 1.1, capital 3.5, labour contribution is 0.3, capital contribution is 2.6, MFP is 3.6.

[e)] For the group of countries of East Europe and Central Asia

mid-income CIS economies including Russia

[f)] For mid-income CIS economies including Russia.

T5. Growth accounting for total and market economy based on aggregate production possibility frontier in 1995-2009

	Total economy	Market economy
Contributions, p.p.		
Value-added	3.66	3.73
Labour	0.02	-0.10
Capital	-0.21	-0.13
MFP	3.85	3.97

NOTE: calculations are based on official investment deflators, fixed shares of factors (0.7 for labour and 0.3 for capital) and fixed depreciation rates 5% per year of dataset I (see appendix A.T5).

T6. Aggregate reallocation effects and multifactor productivity in 1995-2009. Aggregate production possibility frontier vs. direct aggregation across industries (p.p)

	Total economy	Market economy
Contributions, p.p.		
MFP	3.85	3.97
Reallocation of labour	0.60	0.65
Reallocation of capital	0.24	0.24
MFP (weighted by industries)	3.00	3.08

NOTE: calculations are based on official investment deflators, fixed shares of factors (0.7 for labour and 0.3 for capital) and fixed depreciation rates 5% per year of dataset I (see appendix A.T5).

T7. Value added decomposition for Market economy in case in 1995-2009 (direct aggregation across industries)

	I	II	III	IV	V	VI
Labour share in value added (%)	70.0	70.0	54.6	54.6	54.6	54.6
Growth rates, p.p.						
Value added	3.73	3.73	3.73	3.73	3.73	3.09
Labour	0.79	0.79	0.79	0.79	0.79	0.79
Capital	0.35	3.09	3.09	2.69	3.26	3.26
ICT Capital	11.40	15.96	15.96	11.12	10.70	10.70
NICT Capital	-0.02	2.60	2.60	2.48	2.84	2.84
Mach. and Equipment	4.52	7.96	7.96	6.20	6.17	6.17
Non-res. buildings	-1.49	0.63	0.63	1.87	1.87	1.87
Other assets	1.62	4.39	4.39	1.26	0.94	0.94
MFP	3.08	2.26	1.69	1.86	1.62	0.98
Contributions, p.p.						
Value added	3.73	3.73	3.73	3.73	3.73	3.09
Labour	0.55	0.55	0.35	0.35	0.35	0.35
Capital	0.11	0.93	1.69	1.53	1.77	1.77
ICT Capital	0.11	0.18	0.29	0.14	0.28	0.28
NICT Capital	-0.01	0.75	1.41	1.39	1.49	1.49
Mach. and Equipment	0.23	0.45	0.74	0.48	0.81	0.81
Non-res. buildings	-0.30	0.12	0.40	0.84	0.58	0.58
Other assets	0.06	0.18	0.27	0.07	0.10	0.10
MFP	3.08	2.26	1.69	1.86	1.62	0.98

NOTE:

I. Official investment deflators; depreciation is 5% and fixed across industries; capital input is net stocks and labour share is 0.7 being fixed across industries.

II. Investment price indices in construction as investment deflators; the rest is the same as in (I).

III. Labour shares vary across industries according to A.T11 (3); the rest is the same as in (II)

IV. Depreciation rates are of (Fraumeni 1997); the rest is the same as in (III).

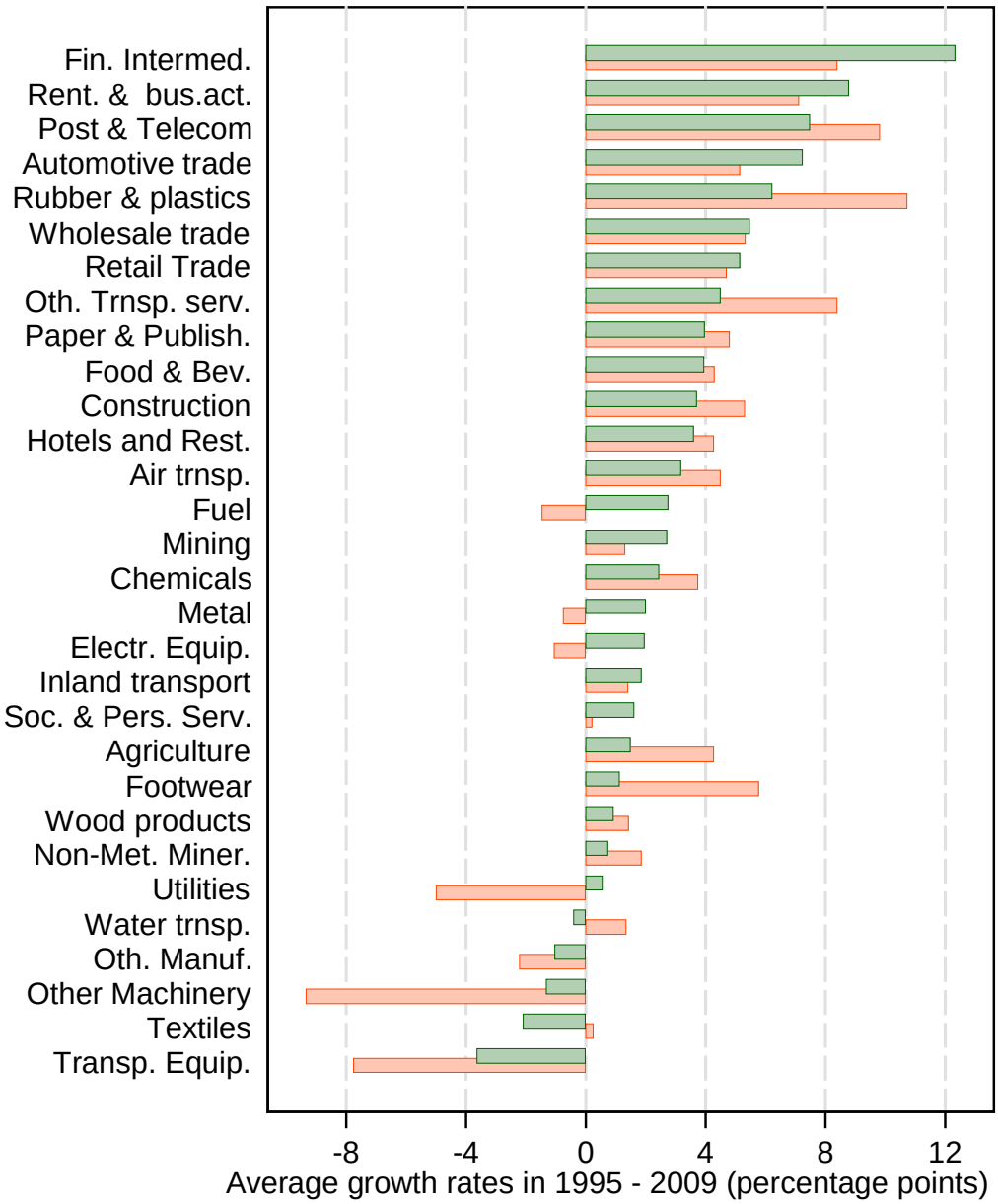
V. The concept of capital input is *services*; the rest is the same as in (IV).

VI. Real value added data are double deflated; the rest is the same as in (V).

Detailed description of datasets is available in Tab. A.T5 of the Appendix.

Graphs

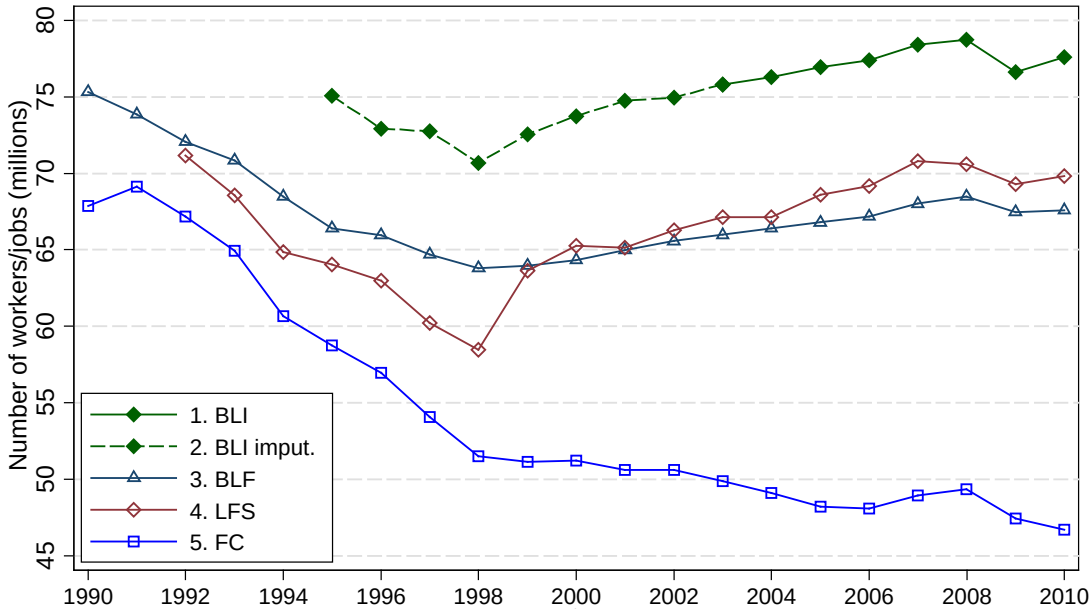
F1. Yearly averaged growth rates of value added in 30 industries of the Market economy, 1995-2009.



Note: Annual compound growth rates of value added volumes by industry.
In green, single deflation-based volumes and, in red, double deflation-based volumes.

Source: Own calculations; datasets (V) and (VI) in A.T5.

F2. Different measures of employment in the Russian economy in 1990-2010



Source: 1, 3-5 - *Rosstat*; 2 - own calculations.

Notes:

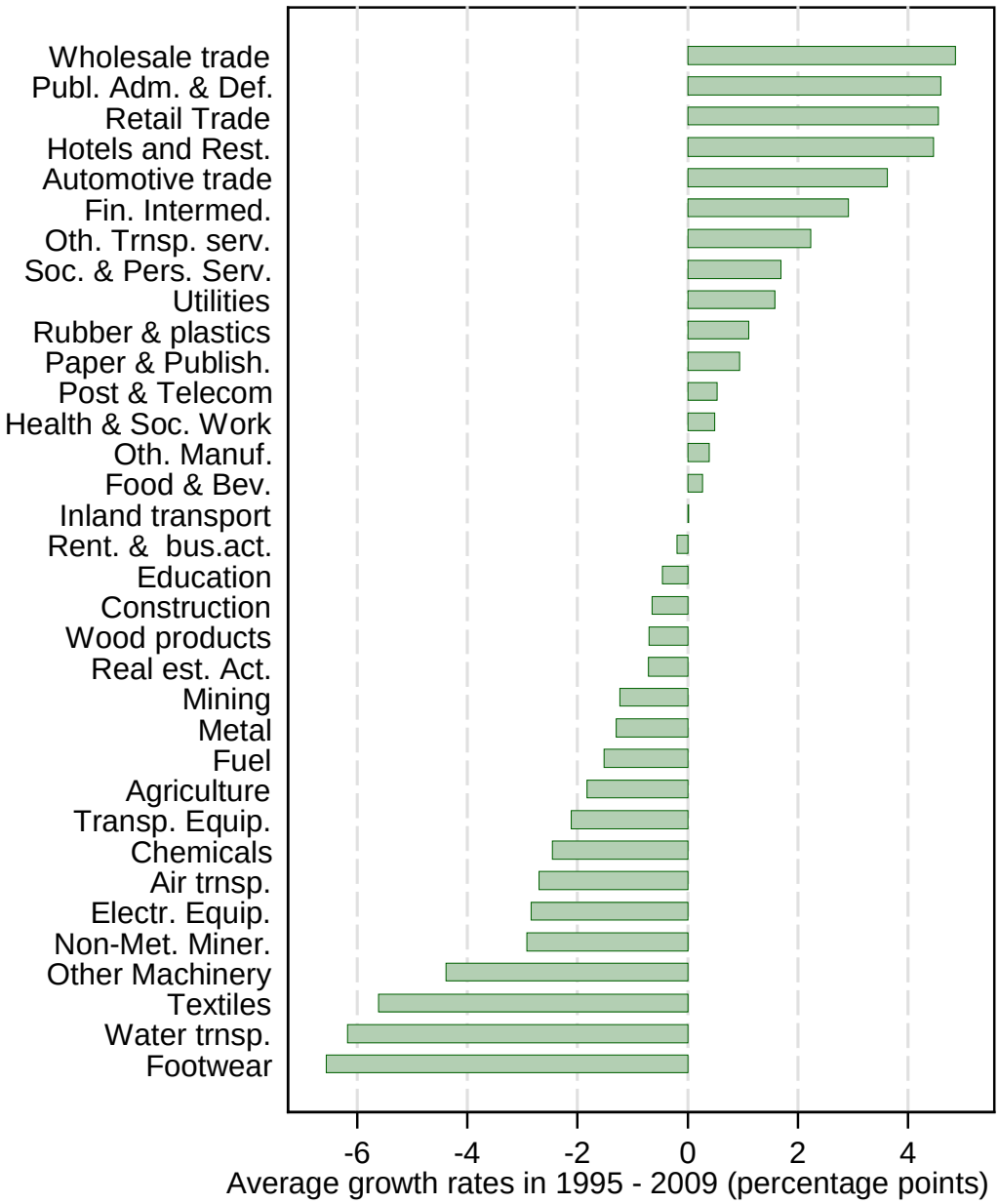
1 - The number of FTE-jobs from *the Balance of Labour Inputs (BLI)*;

2 - The number of FTE-jobs imputed; the number of FTE-jobs imputed assuming null labour productivity growth in Non-market households in *Agriculture*
(see details in sub-section 4.2 and in Appendix A.T6).

3. – The yearly average number of workers from *the Balance of Labour Force (BLF)*;
4. - The total number of workers based on *the Labour Force Survey (LFS)*;

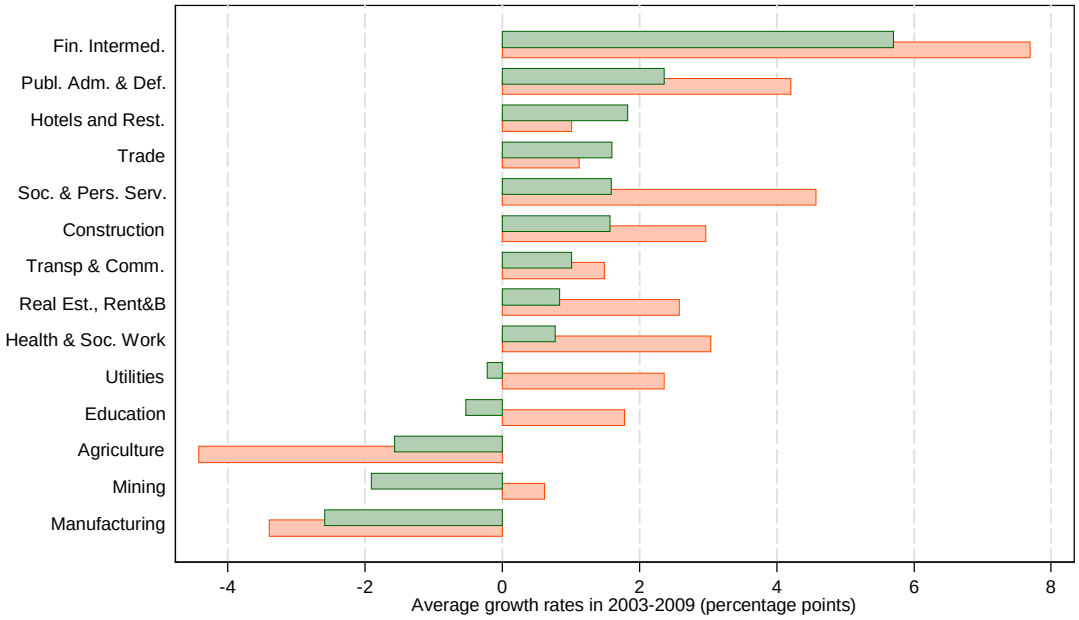
5. - The yearly average number of workers in organizations of *the Full Circle (FC)*;

F3. Average growth rates of labour in 34 industries, 1995-2009.



Source: own calculations.

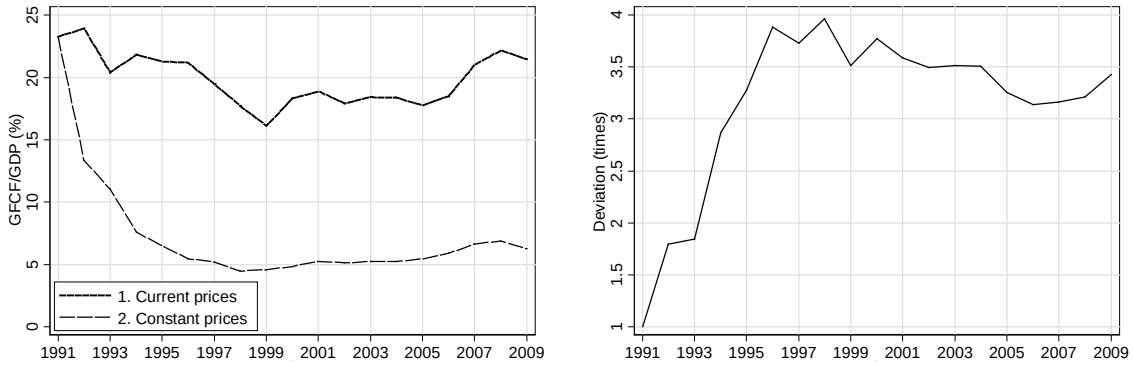
F4. Average growth rates of FTE jobs and LFS number of workers in industries in 2003-2009



Source: (Rosstat 2003b, tab. 2.40) and these publications for the following years; own calculations.

Note: Annual growth rates of the number of workers by industry.
In green, FTE jobs and, in red, the number of workers engaged in industries by primary job from *LFS*.

F5. Discrepancy of investments-GDP ratio in constant and current prices



a. **b.**

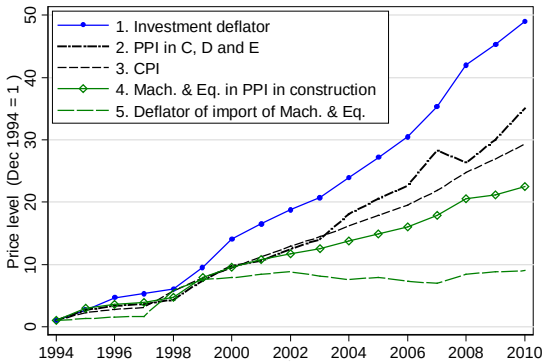
Sources: own calculations on the basis of official data of GFCF and GDP for the total economy; the approach was suggested by Bessonov and Voskoboynikov (2008)

Note:

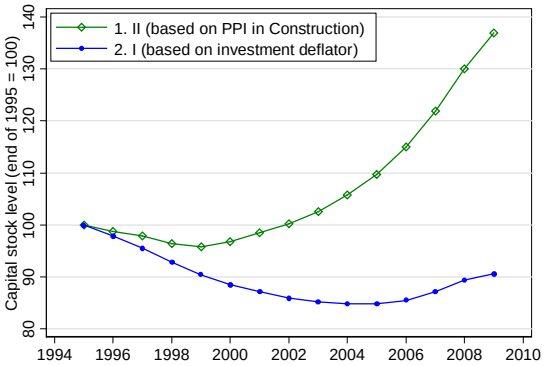
a. GFCF-GDP ratio in current (1) and constant (2) prices in %. The ratio in constant prices is normalized to the level of the ratio in current prices in 1991.

b. A deviation between the investments-GDP ratios in current and constant prices (times).

F6. Price deflators and capital stock



a.



b.

Sources: a.1-4 – *Rosstat*; a.5, b. 1-2 - own calculations.

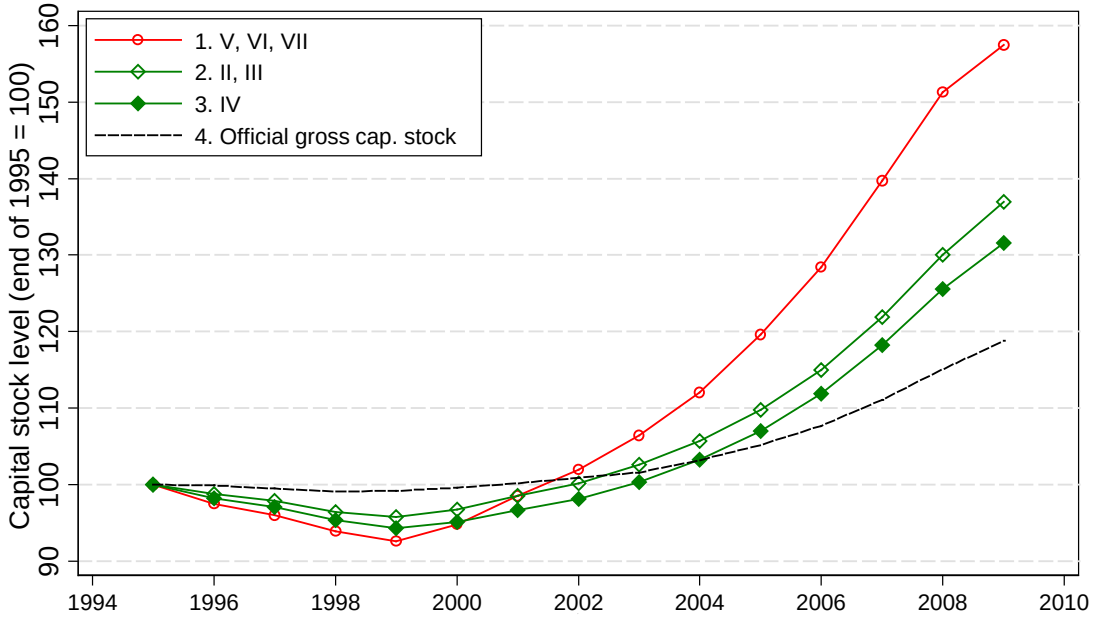
Note:

a. – Price level measured by investments deflator (1); producer price index in manufacturing (2); consumer price index (3); price index on machinery and equipment as part of investments to fixed capital (4); price index on imported machinery and equipment (5)[94].

b. – (1) - Capital stock calculated with real investments deflated with price indices of construction works including the index on machinery and equipment as part of investments to fixed capital (dataset II; Appendix A.T5); (2) - the investment deflator (dataset I; Appendix A.T5).

[94] The price index on imported machinery and equipment captures price changes on imported machinery from the perspective of a Russian domestic purchaser. It has been calculated on the basis of the series of imported machinery and equipment in U.S. dollars (*Import po tovaram i tovarnym gruppam v razreze TN VĖD Rossii; Mashiny i oborudovanie*) available in {{817 Rosstat 2012}}, producer price index on machinery and equipment of *BLS* (BLS 2012) and yearly averaged exchange rates of U.S. dollars to Russian rubles of the Central Bank of Russia. This approach is based on the assumption that prices on imported equipment in a foreign currency change in the same way as corresponding prices in the U.S., which is just a rough approximation.

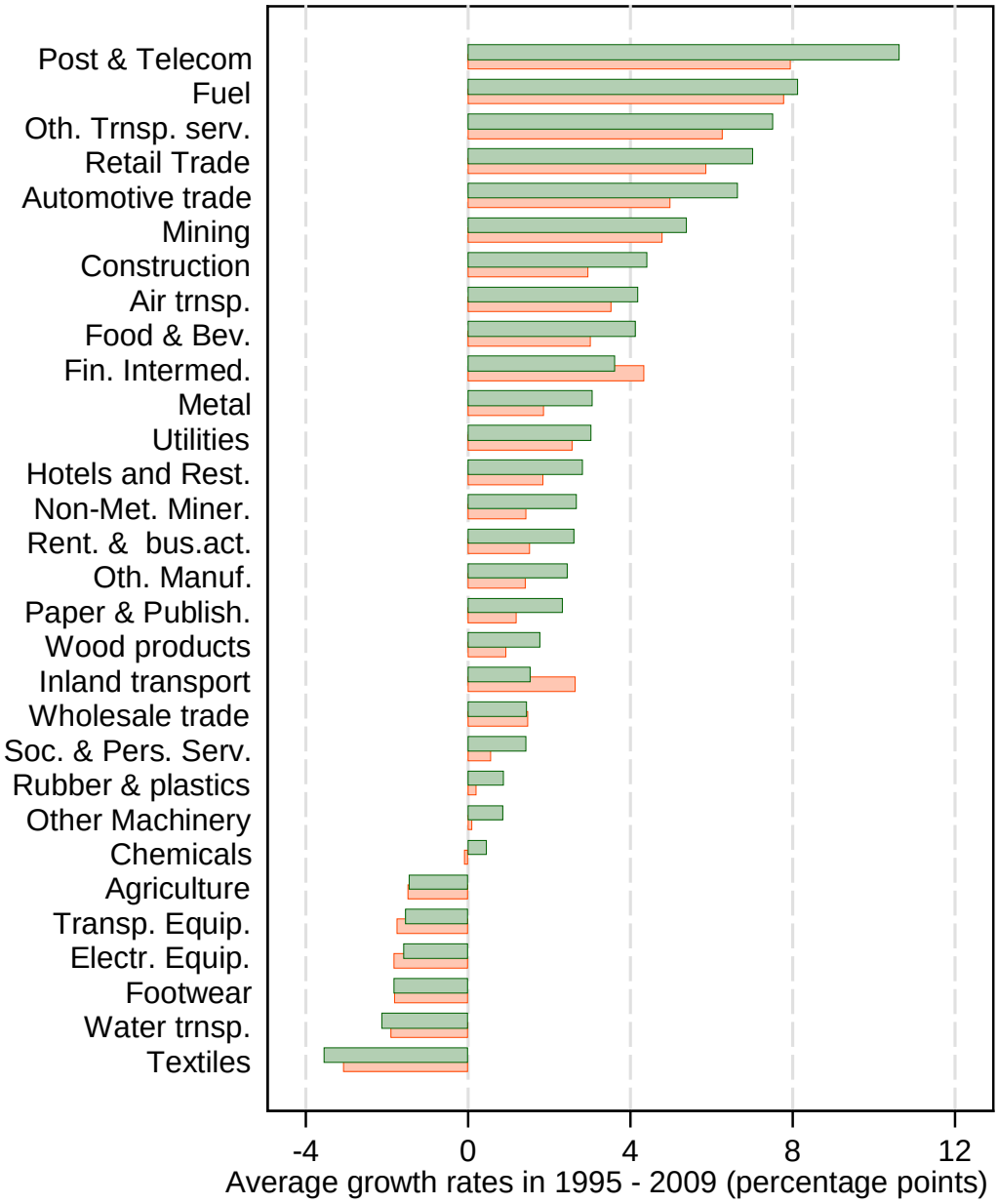
F7. Alternative measures of capital in 1995-2009



Sources: (1)-(3) - own calculations; (4) - *Rosstat*.

Note: Roman numbers correspond to alternative datasets (see Appendix A.T5).

F8. Capital stock and services in 30 industries of the Market economy in 1995-2009



List of Acronyms

APF	Aggregate production function
APPF	Aggregate production possibility frontier
BFA	the Balance of Fixed Assets
BHP	the Balance of Households Property
BLI	the Balance of Labour Inputs
BLF	the Balance of Labour Force
BLS	the U.S. Bureau of Labour Statistics
EE-5	the group of five Central-East European economies: the Czech Republic, Hungary, Poland, the Slovak Republic and Slovenia.
EU	the European Union
FC	The Full Circle survey (the set of all organizations, which includes large, medium and small firms)
FISIM	Financial Intermediation Services Indirectly Measured
FTE jobs	The number of jobs in the full-time employment equivalent
GDP	Gross Domestic Product
GFCF	Gross Fixed Capital Formations
ICT	Information and Communication Technologies
ILO	the International Labour Organization
LFS	the Labour Force Survey
LM	Large and Medium firms; the subset of the Full Circle.
MH	Market households
MPS	the Material Product System
MFP	Multifactor productivity

NAS	the National Accounting System (localization of the System of National Accounts in Russia)
NMH	Non-market households
OECD	the Organization for Economic Co-operation and Development
PIM	the Perpetual Inventory Method
Rosstat	the Federal State Statistics Service (the Russian statistical office)
SNA	the System of National Accounts
SUT	Supply and Use tables
UN	the United Nations

Note on Translation and Transliteration

For transliteration of Russian words the Library of Congress system (LOC) is used with exceptions of personal names. The names are used as they are mentioned in international publications.

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