Accounting for Russia's Growth in 1961-2012

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Abstract

What are long run sources of economic growth in Russia? Did they change after transition from plan to market economy in early 1990-s? A great deal of previous research into this has suggested the story of a shift of the economy from inputs-driven (extensive) growth before transition (see, e.g., Krugman (1994)) to multifactor productivity-driven (intensive) growth (e.g. Jorgenson and Vu (2013)) afterwards. One question that needs to be asked, however, is why evolution of a command economy to a more efficient market-based model was accompanied by a severe fall of multifactor productivity (MFP) in first years of transition. Was it because of disorganization, as Blanchard and Kremer (1997) suggested or, at least partially, due to mismeasurement, caused by multiple difficulties with data?

This paper examines decomposition of output growth into contributions of labour, output and MFP, which is also called growth accounting, using a recently discovered detailed historical statistics for the planned economy period since 1961, and Russia KLEMS data for years from 1995 onwards. At this stage of the project I consider mostly an Industrial sector, which includes Mining, Manufacturing and Distribution. For capital the paper applies the concept of capital services along with traditional capital stocks, taking into account three types of capital, which are machinery, constructions, and other assets. As it turns out, that capital accumulation before transition was not as high as it follows from official numbers. Surprisingly, being measured both as stocks and as services, before transition it grew slower than in the post-transition resurgence in 1999-2008. Main reason for this discrepancy is underestimation of discards in the official statistics. Next, the Soviet era does not seem more extensive in comparison with the post-transition period. In particular, MFP contribution in the Industrial sector in 2.4 p.p. of GDP growth 5.5 per cent in 1961-1973 (the so called *Kosygin reforms* in years of low level of oil

prices before the first oil price shock) seems comparable with MFP growth 3.0 p.p. of 4.6 GDP growth between 1998 and 2008. And also MFP performance of *Perestroika* in 1985-1990 of 1.0 p.p. is as high as recent post-crisis years 2009-2012. Finally, in contrast with capital stocks, capital services did fall in early years of transition, explaining 0.5 yearly average percentage points of a fall of more than 10 p.p. in 1991-1998, mostly because of the drop in the stock of machinery by 4.1 percentage points a year.

All in all, for this half a century Russia demonstrates alternate periods of extensive and intensive growth both before and after transition. This stresses the point made by Allen (2003), that economic causes of the economic collapse of the Soviet Union have not been entirely understood so far.

JEL: O47; P27

Key words: growth accounting, the Russian economy, long run growth

1. Introduction

What are long run sources of economic growth in Russia? How have they been changing for five decades, which cover last decades of planned economy, transition and the post-transition recovery? The planned economy period is considered in the literature as the textbook example of extensive, inputs-driven economy[1]. Krugman (1994) summarized, that its slowdown and the following collapse were predetermined by diminishing returns to inputs. Following expectations, the literature[2] confirms that post-transition development of the Russian economy, as well as other former Socialist countries, has been productivity-driven (intensive).

However, there is literature, which puts in question this conventional story. Allen (2003) suggests that the slowdown of last decades of planned economy had many causes, including not only immanent failures of Soviet institutions (e.g. the lack of incentive to adaptation of new technologies), but also incidental (e.g. reallocation of research and development personnel to the military). The leading role of productivity in post-transition development also raises two questions. First, once market economy is more efficient, it is productivity that would engine growth immediately after transition. However, in reality economic slump in first years of transition was explained by the fall of productivity, rather than inputs. The disorganization theory (Blanchard and Kremer 1997; Roland and Verdier 1997) explains this with the weakness of old and new institutions to support long production chains. Second, the post-transition recovery of such resources abundant economy, as Russia, in years of the huge inflow of oil and gas revenues was hardly caused by productivity only. Timmer and Voskoboynikov (2014) resolved this puzzle and showed that a more careful data work and a more advanced theoretical framework (e.g. capital services rather than capital stocks in the previous literature) lead to different conclusions. In particular, the role of capital in Russian growth in 1995-2008 was comparable with the contribution of productivity.

By the analogy with the period of 1995-2008, one can imagine that improvements of multiple data related issues for years before 1995 will shed new light on sources of Russia's growth. One of such issues is capital stocks data. The quality of official capital stocks statistics of the Soviet Union was questionable. However, due to lack of alternatives it was used in CIA estimations of Soviet GDP (Maddison 1998) and growth accounting exercises. Another issue is investment deflators in first years of transition was poor (Bessonov and Voskoboynikov 2008).

[1] (Kaplan 1969; Ofer 1987; Krugman 1994; Broeck and Koen 2000).

[2] (Campos and Coricelli 2002; Havlik, Leitner, and Stehrer 2012; Jorgenson and Vu 2013; Entov and Lugovoy 2013).

Finally, there is no detailed industry level growth accounting of the Soviet/Russian economy because of unavailability of detailed industry level statistics in the literature and dramatic changes in industry classification in 2003-2004.

At the same time, many gaps in data have been filled in recent years. New retrospect GDP series for the Russian economy since 1961 were published by Ponomarenko (2002). Poletayev (2008) updated Russia-US comparisons in output levels, starting from 1960. Detailed industry level capital stock and investments statistics by type of assets was brought into being by Voskoboynikov and Dryabina (2010). The approach for improvements of investment deflators in years of high inflation were suggested by Bessonov and Voskoboynikov (2008). The industry classification issue has been resolved by Timmer and Voskoboynikov (2014). This new literature creates opportunities for a revision of growth accounting decomposition of the Russian economy for last half a century.

The present study is not the first, which deals with long run sources of economic growth in Russia. Since the Russian economy was the largest in the Soviet Union, generating around 60% of Soviet GDP, much can be learned from growth accounting decomposition for USSR[3]. A considerable amount of literature has been published on the Russian economy after transition[4]. However, only the study of de Broek and Koen (2000) deals with the Russian economy both before and after transition, using official statistics. The present study develops new data on capital stocks, using published and, mostly, unpublished official detailed historical data starting from 1961. This dataset provides opportunity to decompose investments by types of assets, to calculate net capital stocks rather than gross ones, and build, for the first time for the Russian economy before transition, the measure of capital services rather than stocks.

This paper examines decomposition of output growth into contributions of labour, output and MFP, which is also called growth accounting, using a recently discovered detailed historical statistics for the planned economy period since 1961, and Russia KLEMS data for years from 1995 onwards[5]. For capital the paper applies the concept of capital services along with traditional capital stocks, taking into account three types of assets, which are machinery, constructions, and the other assets. As it turns out, that capital accumulation before transition was not as high as it follows from official numbers. Surprisingly, being measured both as stocks and as services, it

[3] See review in (Ofer 1987).

[4] (Dolinskaya 2002; Bessonov 2004; Izyumov and Vahaly 2008; Kuboniwa 2011; Jorgenson and Vu 2013; Entov and Lugovoy 2013; Timmer and Voskoboynikov 2014; Kaitila 2015)

[5] At this stage of the project I consider mostly the Industrial sector, which includes Mining, Manufacturing and Distribution. It will be extended to other sectors, as well as the more detailed level of the Industrial sector.

grew slower than in the post-transition resurgence in 1999-2008. Main reason for this discrepancy is underestimation of discards in the official statistics. Next, the Soviet era does not seem more extensive in comparison with the post-transition period. In particular, MFP contribution in 2.4 p.p. of GDP growth 5.5 per cent in 1961-1973 (the Kosygin reforms in years of low level of oil prices before the first oil price shock) seems comparable with MFP growth 3.0 p.p. of 4.6 GDP growth between 1999 and 2008. And also MFP performance of Gorbachev's perestroika in 1985-1990 of 1.0 p.p. is as much productive as recent post-crisis years 2009-2012. Finally, in contrast with capital stocks, capital services did fall in early years of transition, explaining 0.5 yearly average percentage points of a fall of more than 10 p.p. in 1991-1998, mostly because of a drop in the stock of machinery by 4.1 percentage points.

All in all, for this half a century Russia demonstrates alternate periods of extensive and intensive growth both before and after transition. This stresses the point made by Allen (2003), that economic causes of the collapse of the Soviet Union have not been entirely understood so far.

This paper begins with reviewing historical facts concerning sources of economic growth and structural change of the Russian economy, available in the literature, as well as questions, which have not been answered in the literature so far. It will then go on to the growth accounting theoretical framework and existing data sources for real value added, labour and capital. The fourth section summarizes main findings of the present study and answers to some of these questions. Finally, the fifth section concludes and proposes directions for development of this project.

2. Stylized facts on long run development of the Russian economy

Economic growth of the Russian economy for more than half a century, from 1961 to 2012, was 2.96 per cent per year[6], which is just 0.11 p.p. lower than the US economy annual growth rate in the same period[7]. This period includes positive and negative shocks for the Russian economy, such as the oil crises of 1970-s, fall of oil prices in 1985, collapse of the Soviet Union, accompanied by transformation from command to market economy, the financial crisis of 1998, years of soaring oil prices and, finally, the global economic crisis of 2008.

[6] GDP growth rates are calculated using data of Ponomarenko in 1961-1990 (2002) and the Russian statistics office (Rosstat) afterwards. See details about sources used in the following section.

[7] Real GDP growth rates for the US economy in 1961-2012 are 3.07 per cent a year. Real GDP in billions of chained 2009 dollars in 1961-2012. Retrieved from the BEA website http://www.bea.gov/national/xls/gdplev.xls. Release of June 26, 2015.

These shocks made Russian GDP growth volatile. According to figure 1, its level in 1989 was five times as much as in 1961. In the following years it experienced a steep decline, coming down by 1998 to the level of 1973, or around 60% relative to 1990. After the financial crisis of 1998 the Russian economy started growing with rates, which exceeded values of the last decades of planned economy. In these years many observers compared Russia with leading developing economies, such as Brazil, India and China. However the global crisis of 2009 with the following fall of oil prices hit Russia, transforming its exploding growth with rates 5 per cent in 1999-2008 into stagnation around 3 per cent in 2009-2012.

<Figure 1 is somewhere here>

These transformations reflected multiple external and internal shocks of different origins. By the end of Stalin's era in early 1950-s the "orthodox" command economy model with controlled prices, central allocation of consumption and investment goods, transformation of resources to heavy industries, mostly related with military production, demonstrated its multiple weaknesses and inefficiencies. The Soviet economy of 1930-s – early 1950-s was designed to concentrate labour and capital for production maximization of relatively homogeneous manufacturing goods, such as military equipment or raw materials. However, this economy failed to meet a growing demand on myriads of consumption goods, adjusting needs of growing population. In 1950 – early 1960-s multiple shortages of basic consumption goods generated social tensions (Nove 1992). To a certain extent, this shifted priorities of the Soviet government in the direction of production of consumption goods.

One more reason for concern of the Soviet government was depletion of resources for fast extensive growth. The countryside as a source of cheap labour was exhausted. The issue of productivity growth acceleration became the origin of attempts of the Soviet government to stimulate economic growth in late 1950-s – middle of 1960-s. These attempts included tilling of the wild land in North Kazakhstan, large investments in Chemistry, as well as introduction of some elements of market economy for state factories (self-support; profitability), also known as the 1965 Kosygin reform. The outcome of these reforms was evaluated by policy makers as ambiguous. On the one hand, GDP grew with relatively high rates in 1960-s – early 1970-s. On the one hand, the shortage of consumption goods and, in particular, foodstuff, had not been eliminated. Moreover, grain import, which began in 1963 as an exceptional event, grew rapidly. Eventually, reforms were stopped after the First Oil crisis, accompanied by a sharp increase of

oil prices. Starting from early 1970-s, oil and gas import provided necessary resources for import of consumption goods machinery.

At the same time, GDP growth halved in these years from 6.6 per cent in 1961-1973 to 3.4 per cent in 1974-1985. Among reasons of this the literature (Nove 1992; Gregory and Stuart 2001) mentions the long term depletion of cheap labour, multiple state subsidies of inefficient firms, active and expensive social policy (working time reduction, growing incomes), extensive program of development of resources of Far East and Siberia with no short term return, and increasing military expenditures. It is economic slowdown as well as a sharp drop of oil prices in 1985 that motivated Mikhail Gorbachev for a new wave of economic reforms within the planned economy framework, called Perestroika. However, with no free pricing for stimulation of market incentive on the one hand and weakening of state control, on the other, this leaded to weakening of economic ties, increase of multiple shortages and disorganization. So, GDP growth rate falls close to zero, being equal to 0.8 per cent a year in 1986-1990.

Early years of transition from plan to market economy in 1991-1998 were accompanied by output fall, which was common for all East European post-communist economies (Campos and Coricelli 2002) because of the lack of ability of the economy to support long chains of production, investments fall, international trade flows reorientation, substantial shifts in the structure of demand and labour force, as well as high inflation. Only after the ruble devaluation in the crisis of 1998 and growing revenues from oil and gas import starting from 1999 the economy came back to the upward trend until 2008, the year of the global financial crisis.

What are the supply-side sources of this growth pattern and how did they change in time? This is the issue of the following sub-section.

3. Growth accounting framework and data sources

3.1. Growth accounting

To analyse the sources of Russian growth we use the standard growth accounting methodology, descended from the pioneering studies of Solow (1956; 1957), which enables a breakdown of output growth rates into a weighted average of the growth of various inputs and productivity change (see Schreyer (2001) for an overview). I follow the representation of value added-based industrial growth accounting of Jorgenson, Ho and Stiroh (2005 ch. 8).

The quantity of value added (Z_j) by industry j can be represented as a function of capital services (K_j), labour services (L_j) and technology (T_j):

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

Assuming a translog production function, competitive markets for inputs and constant returns to scale, the change in multifactor productivity $\left(A_j\right)$ is defined as

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

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

(3) $$v_{K,j}^{Z} = \frac{p_j^K K_j}{p_j^Z Z_j}; \;\; v_{L,j}^{Z} = \frac{p_j^L L_j}{p_j^Z Z_j}$$

such that they sum to unity. Rearranging equation (2), industry value added growth can be decomposed into the contributions of capital, labour and MFP:

(4) $$\Delta \ln Z_j = \bar{v}_{K,j}^{Z} \Delta \ln K_j + \bar{v}_{L,j}^{Z} \Delta \ln L_j + \Delta \ln A_j.$$

This decomposition is done at the industry level, and the aggregate results are obtained by using the direct aggregation across industries approach of Jorgenson, Ho and Stiroh (2005). Then the volume growth of GDP is defined as a Törnqvist weighted average of value added growth in industries:

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

where $\bar{v}_{Z,j}^{GDP}$ is the period-average GDP-share of value added of industry j. Substituting (4) into (5) gives

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

This equation enables decomposition of GDP growth rates by contributions of factors and multifactor productivity growth by industry.

In this study we pay particular attention to the measurement of capital, given the various difficulties and uncertainties in deriving a proper empirical measure in the Russian context. Here we outline our theoretical approach and in the next section the empirical implementation. Following the growth accounting tradition, we measure capital input as the flow of capital services, which takes into account different marginal productivities of various asset types. Aggregate capital input in industry j (K_j) is defined as a Törnqvist volume index of individual capital assets stocks:

(7) $$\Delta \ln K_j = \sum_k \bar{v}_{k,j}^{K} \Delta \ln K_{k,j},$$

where $\Delta \ln K_{k,j}$ indicates the volume growth of capital stock of asset k. Assets are weighted by the period average shares of each type in the value of capital compensation, given by

(8) $$v_{k,j}^{K} = \frac{p_{k,j}^{K} K_{k,j}}{p_j^{K} K_j}$$

such that the sum of shares over all capital types is unity. The estimation of the compensation share of each asset is related to the user cost of each asset. The rental price of capital services $p_{k,j}^{K}$ reflects the price at which the investor is indifferent between buying and renting the capital good via a one-year lease in the rental market. In the absence of taxation the familiar cost-of-capital equation is given by

$$(9) \qquad p^K_{k,j,t} = p^I_{k,j,t-1} i_{j,t} + \delta_k p^I_{k,j,t} - \left(p^I_{k,j,t} - p^I_{k,j,t-1}\right),$$

where $i_{j,t}$ represents the nominal rate of return in industry j, δ_k the depreciation rate of asset type k, and $p^I_{k,j,t}$ the investment price of asset type k. This formula shows that the rental fee is determined by the nominal rate of return, the rate of economic depreciation and an asset-specific capital gain.[8]

The empirical base for growth accounting is the System of National Accounts (SNA). In case of Russia SNA was adapted by the official statistics in late 1980-s – early 1990-s instead of the alternative system of macroeconomic accounts, called the Balance of National Economy (BNE)[9] and inconsistent with SNA. Although there are multiple estimations of SNA-based GDP[10] of the Soviet Union, a consistent retrospect estimation of GDP of the Russian Federation, or Russian Soviet Federative Socialist Republic, in last decades of planned economy has been published only a decade after transition by Ponomarenko (2002). It provides the full set of accounts for the total economy and some indicators for six major industries in the Soviet industrial classification, inconsistent with any international classification[11]. At the same time, the growth accounting study assumes also availability of the series of labour and capital inputs, as well as inputs' shares in value added. These issues will be discussed in the following subsections.

3.2. Real value added, labour input and labour shares

The study of Ponomarenko (2002) provides the GDP series for total Russian economy, as well as for Industry, in 1991-1990, while the Russian Statistics Office (Rosstat) publishes Russian GDP series for the following years (Rosstat 1998; 2004; 2010; 2014). Starting from 1995 I use Russia the KLEMS dataset[12]. At the same time, since the Russia KLEMS dataset includes the official SNA series of real value added, there is no inconsistency in this aspect.

[8] Ideally, taxes should be included to account for differences in tax treatment of different asset types and different legal forms (household, corporate and non-corporate). However, this refinement would require data on capital tax allowances and rates, which is beyond the scope of this study.

[9] In Western literature BNE is also referred to as the Material Balances System. See more about the process of adaptation of SNA in Russia in the study of Herrera (2010).

[10] See studies (Maddison 1998; Ark 1999) for an overview.

[11] See more about this in (Masakova 2006).

[12] http://www.worldklems.net/data.htm

Starting from 2005 Rosstat stopped publishing data in the old Soviet industrial classification and shifted to international industrial classification NACE 1.0. Total economy aggregates for previous years were not changed, but revision for industry-level aggregates in the new classification changes can be substantial [13]. Dealing with the Industrial sector (*Promyshlennost'* in Russian) in the old classification in the present study, I assume that it roughly corresponds to the sum of three industries in NACE 1.0, which are Mining (NACE 1.0 code C), Manufacturing (D) and Energy Distribution (E).

The best measure of labour input for growth accounting is the series of hours worked, consistent with National Accounts. Such data has been publishing by Rosstat from 2005 only. Following the Russia KLEMS approach, I used the level of hours worked in 2005 as a basis and made backcast projection with growth rates of the yearly average number of workers, available from official data of the Balance of Labour Force for the whole period in question.

Ideally, labour shares can be obtained from National accounts directly or from econometric estimations. However, both ways are not applicable for the Russian economy before 1990, because of absence of data on nominal value added in market prices and market wages. Such data exists after 1990, but simple extension of these shares to the planned economy period seems unreasonable, because it is unclear what transformations in labour shares took place were in first years of transition. One more reason for this is uncertainity of labour shares in the informal economy in first years of transition[14]. That is why, following the literature[15] I used labour share 0.7 for the whole period in question both for total economy and for Industry. However, further research and some sensitivity analysis are needed in this aspect. For example, data on labour shares in Russia KLEMS remarkably differs from this and closer to recommendations of Gollin (2002) for developing economies with no national accounts series of a proper quality. Some other studies also use different labour shares[16].

3.3. Capital

Estimation of capital growth rates is the most data intensive part of this study. It starts from estimation of net capital stocks for each type of asset with the Perpetual Inventory Method (PIM) on the basis of the geometric depreciation pattern. For this the following data is necessary: nominal investments, depreciation rates and investment deflators by type of assets, and also net

[13] See studies of Masakova (2006) and Voskoboynikov (2012) for details.

[14] Bessonov(2004) and Voskoboynikov (2012) discuss this issue in detail.

[15] (Broeck and Koen 2000; Dolinskaya 2002; Bessonov 2004; Rapacki and Próchniak 2009)

[16] (Izyumov and Vahaly 2008; Kuboniwa 2011; Jorgenson and Vu 2013; Entov and Lugovoy 2013)

benchmark capital stocks for a certain year. As can be seen from equations (7)-(9), with net capital stock series and rates of return it is possible to obtain capital services. All this data is expected to be given in national statistics. Although the Russian statistics has a long history of a thorough capital and investments data collection, some additional efforts are needed to obtain relevant information from available data.

SNA-consistent series of investments, called Gross Fixed Capital Formations, are available from 1961 to 1990 in the study of Ponomarenko (2002) and in the official publication of Rosstat afterwards. However, these series are not broken down by industries and types of assets. This decomposition can be implemented with two additional sources, which are the Balance of Fixed Assets (BFA)[17] and data of survey F11[18]. Both sources have a long history in Russian statistics, being the part of the Balance of National Economy in the past, cover the whole period in question, and have been developing until present. Data from these sources can be found both in official publications and archives. For the present study the lion's share of historical primary statistics from F11 survey was published by Voskoboynikov and Dryabina (2010), and now publically available[19].

BFA provides capital stocks in the beginning and in the end of the year, as well as acquisitions[20] and discards during the year. BFA has been developing in current prices for gross and net capital stocks, while in constant prices – only for gross stocks. BFA covers all firms in the economy and 10-15 sectors. However, it does not provide a split by types of assets. In turn, having lower coverage (large and medium firms in up-to-date Russian statistics and most organizations in the planned economy period), survey F11 provides data on gross and net stocks, acquisitions and discards by 6-8 types of assets in current prices. So, nominal investments by type of assets were obtained with breaking down GFCF with BFA acquisitions in industries, and acquisitions from F11 for a split by type of asset.

Following the Russia KLEMS approach, I opt for net capital stocks at the beginning of 1995 as a benchmark, imputing capital stocks back and forth. This choice seems reasonable, because this is the first estimation after total revaluation of capital stock in the Russian economy

[17] In Russian: *Balans Osnovnykh Fondov*

[18] Bratanova (2003) provides a detailed English description of both sources.

[19] http://www.hse.ru/org/hse/expert/lipier/data

[20] Acquisition is a booked value of an asset put into operation by the end of the year. This measure coincides with traditional investments if the period of installation/construction of the asset is within a year. However, if the construction period is longer, acquisitions also include costs, which took place in previous years. In case of planned economy the value of acquisitions seems a better proxy of investments than investments (*kapital'nye vlozheniia* – in Russian) themselves, because construction periods could take decades and because of this the lion's share of investments were wasted.

into market prices[21] with a certain consistent framework. Further, in this year all sources of data – GFCF from official SNA, Balance of Fixed Assets, F11 survey with the full coverage of the economy – co-existed, which provides an opportunity of making a consistent dataset. In case of earlier potential benchmark years, such as 1990 or 1961, data on F11 is available for sub-industries of the Industrial sector only with no total economy coverage. Finally, 1995 as the base year provides consistency with the Russia KLEMS capital stock series.

Investment deflators for the planned economy period were calculated implicitly from nominal and real acquisitions, given in BFA. As to the market economy period, I implemented producer price indices in constriction by type of asset[22]. Depreciation rates were calculated on the basis of the official survey of assets' service lives of 2008 (Gordonov 2010). In addition, the declining balance rates[23] have been adjusted to provide consistency with official net capital stocks. Finally, I used the *ex-ante* real interest rate, assuming it fixed at the level of four per cent a year[24].

3.4. Summary

Although this approach provides data for the growth accounting exercise, there is room for improvements. First, the assumption of fixed and conventional labour shares should be relaxed. One more issue is the neoclassical assumptions of growth accounting, which seem questionable for the planned economy period. A possible solution for this is matching results with alternative inputs and productivity indices, which are based on weaker assumptions. Finally, the external rate of return is not accurate in case of substantial changes in capital utilization. Hulten (1986) suggested a better approach on the basis of the ex-post interest rate.

4. Results and Discussion

I start analysis with the growth accounting decomposition on the basis of official data on gross capital stock in the Russian economy, which is represented in Fig. 5A. This data shows, growth in Russia in 1961-2012 was extensive. Indeed, only 1.1 p.p. of almost 3 per cent yearly average growth, or less than 40%, was contributed by MFP. At the same time, there is a clear split of the structure of growth into extensive and intensive before and after transition. While before transition MFP contributed just above one third at the best (1961-1973), after transition its

[21] See Bratanova (2003) about revaluations of capital stocks in the Russian economy.

[22] See a thorough discussion in (Timmer and Voskoboynikov 2014), why these indices are preferred in comparison with the official investment deflators.

[23] See more about the link of service lives and geometric depreciation rates in (Fraumeni 1997).

[24] The OECD Productivity Manual (Schreyer 2001) recommends this approach in case of the lack of other sources of information.

impact increased, being equal, at least, 60% (2009-2012) of GDP growth. Next, economic growth slowdown in last decades of the planned economy period can be explained not only MFP deceleration, but also moderation of inputs' growth[25]. This, in turn, reflected depletion of cheap labour and limitations of the post-Stalin' Soviet economic system in reallocation of resources from consumption to investments. All these findings correspond to the growth accounting decomposition of the USSR (Ofer 1987) and the Russian Federation before and after transition (Broeck and Koen 2000)[26].

<Fig. 2 is somewhere here>

<Table 2 is somewhere here>

Growth accounting decomposition of Industry[27] (Fig. 2B; table 2) shows a similar picture with some additional details. In comparison with total economy its output growth was lower, while inputs growth was higher in most of the periods in question. Thus MFP growth was also lower. Indeed, as can be seen, yearly average MFP growth rates in total economy for the whole period are 1.1 per cent; while in industry they are close to nil. This raises the following question. In principle, manufacturing is traditionally considered as a sector with high potential for MFP growth in comparison with other sectors, because sophisticated technologies in, say, machinery, provide more opportunities for diminishing real costs of production, than retail or business services. Also in planned economies substantial resources were allocated to research in development in manufacturing, closely related to military production. However, the level of development of services was so low[28] that small improvements and debottlenecking could lead to substantial gains in performance. At the same time, inefficient allocation of resources within Industry in the planned economy period leaded to losses in MFP growth.

[25] Deceleration of official gross capital stock for the Soviet economy was noticed by western observers – see, e.g., (Powell 1979).

[26] Many studies on the basis of official statistics and various adjustements confirm the intensive growth structure after transition – see, for example, the literature review in (Timmer and Voskoboynikov 2014).

[27] In the Soviet industrial classification OKONKh Industry includes Mining (NACE 1.0 code C), Manufacturing (D) and Distribution (E) (Voskoboynikov 2012).

[28] Timmer and Voskoboynikov (2014) report that by 1995 the level of technologies in Financial intermediation and Business services, measured as the level of MFP, was just 9% of the level of Germany, being inferior not only to developed, but also many post-communist economies.

<Fig 3 is somewhere here>

Relatively low MFP growth rates in Industry can be explained also by mismeasurement of capital stock. It is gross capital stock measure, which is widely used in the literature. However, one of widely reported feature of the Soviet/Russian economic development in last decades of the planned economy period was growing wear and tear of fixed assets[29]. Figure 3 shows both gross (1) and official net (3, 4) capital stock trends of the Russian economy. As can be easily seen, net capital stock grew with lower rates than the gross one. Using the modeled PIM-based series of net capital stock, which matches curves 3 and 4, we can estimate net capital stock growth rates. As a result, net capital stock growth rates before transition are lower than gross ones. Correspondingly, net capital stock-based MFP growth rates are higher. Indeed, for the whole period net capital stock-based MFP growth rates in Industry are 1.1 per cent, which is almost 29 times higher than gross capital stock ones. This huge difference originates from the fact that firms do not report about discards in time and do not care about accuracy of gross capital stock value of discarded assists. This leads to overestimation of gross capital stock trends, especially taking into account years of high inflation in 1990-s.

In theory, both gross and net capital stocks are *not* the best measure of capital inputs (Schreyer 2009). The flow of capital services, introduced by Jorgenson (1963) within the neoclassical growth accounting framework of Solow (1956; 1957), is considered as a superior one. The flow of capital services is defined as time the asset is engaged in production times the rental price of this asset. Intuitively the difference between capital stocks and services can be explained in the following way. One ruble of investments to a railway sleeper with the service life 25 years generates the lower flow of capital services in comparison with, say, investments to a computer with 3 years of service. In case of stocks both assets are weighted with the initial purchasing price, while in case of services the rental price of an asset used, which depends directly on service lives (see equation (9)).

<Table 3 is somewhere here>

<Table 4 is somewhere here>

[29] See the study of Powell (1979) and also results of the last official census of capital stocks in the Soviet Union in 1986 (Rosstat 1989).

Substitution of capital stocks for services also changes results of growth accounting, as it follows from comparisons of Fig. 2C and D, and also tables 3 and 4. In total growth rates of capital stocks are slightly higher than services. However, services demonstrate lower growth rates before transition and higher afterwards, which can also be seen in Fig. 4. The difference between growth rates of capital stocks and services is caused by differences in growth of stocks in machinery and constructions, as well as different contributions to the aggregate indicator of capital input. According to Table 4, machinery grew slower than constructions before transition, and higher in years of recovery from 1999 onwards. In turn, machinery with shorter service lives provides higher contribution to aggregate capital services growth rates, rather than stocks. Figure 5 illustrates this point. Indeed, the share of machinery in stocks varied between 20% and 30%, while in services it contributed at least 50%, except years of transition between 1992 and 2006. All in all, differences between the two measures of capital input are explained by change in relative contributions of machinery and constructions to capital input aggregate. Before transition capital services grew slower, than capital stocks, because of higher investments to infrastructure, and faster in years of recovery because of higher growth in machinery. This illustrates one of the stylized facts of this period that large investments to infrastructure in Siberia in 1960-s and 1970-s took place at the expense of investments to machinery and did not provide high returns in the short term. This point is essential for understanding changes in the time pattern of MFP growth depending on a measure of capital input.

<Fig 4 is somewhere here>

<Fig 5 is somewhere here>

Improvements in measurement of capital input change the role of MFP as a source of growth. Figure 6 summarizes these findings, representing MFP growth rates for all three measures of capital input, gross capital stocks, PIM-based net stocks and capital services. Although MFP contribution for the whole period, 1961-2012, does not change, MFP time pattern differs. In case of gross capital stock the figure replicates the story of extensive growth with relatively low MFP performance before transition and intensive growth afterwards. However, with more accurate capital input measures the role of MFP growth increases before transition, decreases and after transition.

<Fig 6 is somewhere here>

This pattern of MFP growth raises the question of sources of MFP growth before transition. There are two potential explanations of this. The first one is the outcome of Kosygin's reforms in the middle of 1960-s, which could, to a certain extent, improve efficiency of the Soviet economy, providing more freedom to regions and organizations. That is why MFP growth rates in 1961-1973 were the highest for the planned economy period. We see the same in a lower scale in years of Perestroika in late 1980s. In contrast, years of high oil prices after the first oil crisis provided an opportunity for the Soviet government to postpone reforms and pay less attention to efficiency of allocation of resources.

The second explanation deals with some technology improvements, which took place in these years. MFP growth reflects not only the extension of the production possibility frontier, but also movement of the economy towards this frontier. These efficiency improvements have two components, which are allocative and technological efficiencies. The former deals with better allocation of inputs, taking into account relative prices on inputs. This type of efficiency hardly worked planned economy in the absence of market prices and wages. At the same time, growth of technological efficiency, which is defined as output growth with the same level of physical volumes of inputs (e.g. hours worked, kilowatt-hours of electrical power, tons of iron ore), could be improved and even targeted in official plans. For example, starting from 1950-s, the Soviet economy shifted to more cost effective sources of energy. Wood and coal were substituted with oil, gas and atomic power. Developments in constriction of oil and gas transportation infrastructure, such as major cross-country pipelines, were impressive, making energy widely available and cheap. Similar changes took place in Soviet rail roads. Diesel electric and electric locomotives forced out steam locomotives in these years, making transportation services less energy- and labour demanding.

Concerning years of transition two main points should be mentioned. First, in contrast with stocks, the measure of capital services captures the output fall. Indeed, because of a substantial drop in machinery and the other types of assets (Table 2) capital input dropped with rates -1.6 per cent in 1991-1998. Nature of this fall is mass discards in machinery and lower rental prices of the communist capital – serviceable assets, installed in the planned economy

period, but inefficient for production for free market[30]. At the same time this fall explains only 0.5 p.p. of a total drop by -10.5 per cent in 1991-1998, leaving most of it to MFP and labour. Second, in contrast with the bulk of the growth accounting literature[31] and in line with the Russia KLEMS-based study of Timmer and Voskoboynikov (2014) this paper also confirms the substantial role of capital services in Russian growth after 1999. Interestingly, taking into account PIM-based net capital stocks and capital services, 1999 growth capital growth rates grew more than in 1961-1990. To a certain extent, this period can be called "New Industrialization".

5. Conclusion

The main goal of this study was identification of supply-side sources of long run economic growth in Russia. In this study I develop a new dataset of historical statistics of fixed capital in the Industrial sector, which includes Mining, Manufacturing and Distribution. Paying more attention to measurement capital inputs within the neoclassical growth accounting framework I have argued that for this half a century Russia demonstrates alternate periods of extensive and intensive growth both before and after transition. This story differs from the bulk of existing growth accounting literature for the Soviet/Russian economy, which suggests extensive, inputs-driven growth before transition and intensive, productivity driven growth afterwards, and also stresses the point made by Allen (2003), that economic causes of the collapse of the Soviet Union have not been entirely understood so far.

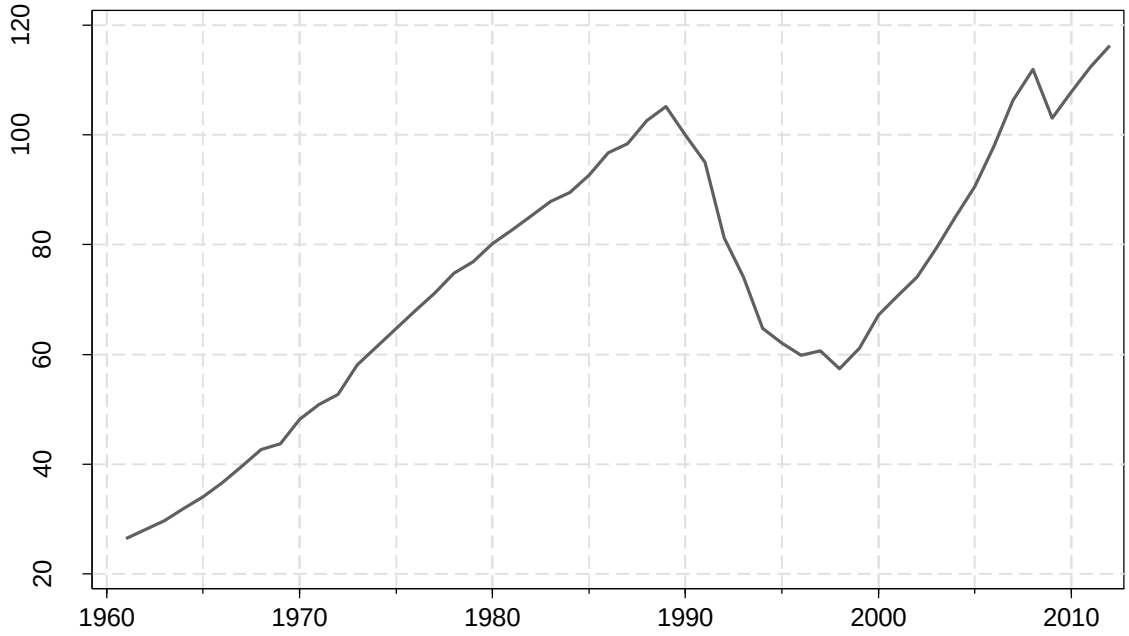
Further research could answer the question what is the nature of MFP growth in the Soviet era. The present study suggests that MFP growth before transition could be originated from such technology improvements, as development of energy distribution infrastructure. It might be interesting to test this hypothesis within the full gross-output growth accounting framework, which provides opportunities of splitting labour-energy and capital-energy substitution and "pure" MFP growth. All this will shed light on the pattern of Soviet economic development, and also will improve our understanding of opportunities for long run growth of the Russian economy.

[30] See more about the communist capital problem in (Campos and Coricelli 2002; Izyumov and Vahaly 2008).

[31] See review in (Timmer and Voskoboynikov 2014) and also (Kaitila 2015).

Figures

Fig. 1. Economic growth in Russia in 1961-2012 (1990 = 100)

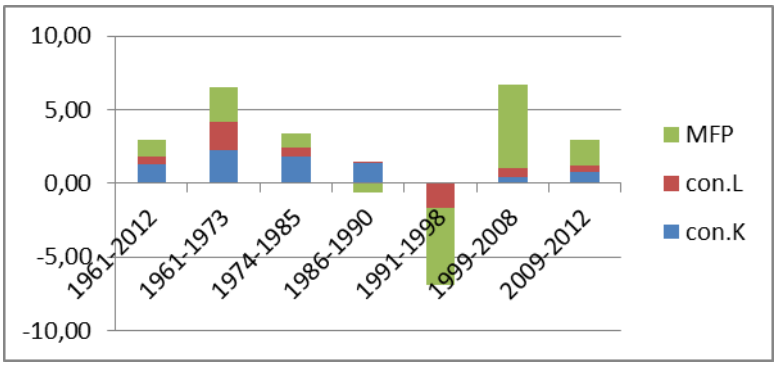


Sources: 1961-1990 – Ponomarenko (2002); 1990-2012 – Rosstat.

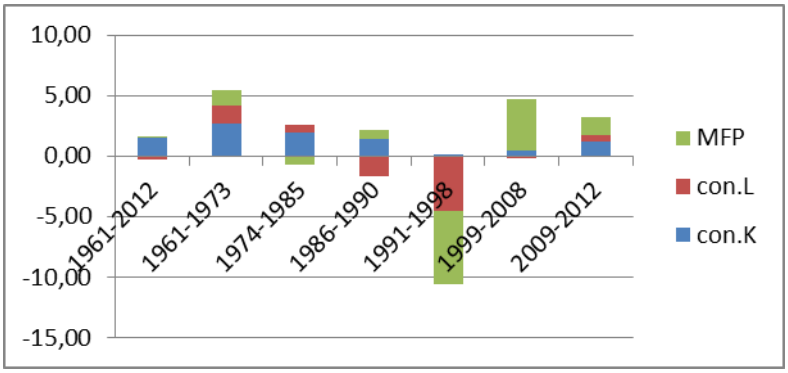
Fig. 2. Growth accounting for Total economy and Industry in 1961-2012

(contributions, p.p.)

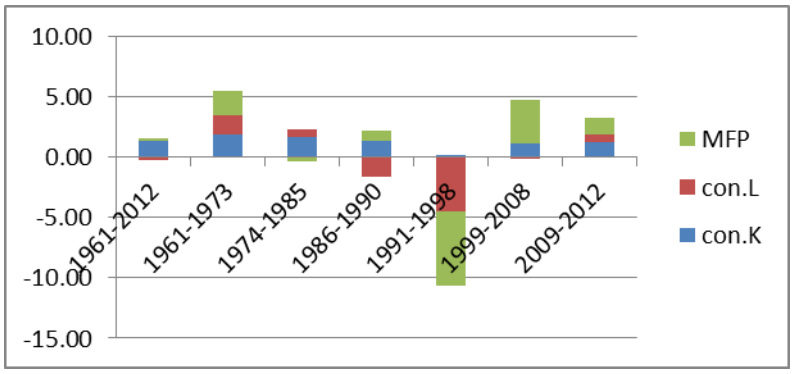
A. Total economy. Official gross capital stock capital input



B. Industry (Mining, Manufacturing, Distribution). Official gross capital stock capital input



C. Industry (Mining, Manufacturing, Distribution). PIM-based net capital stock capital input



D. Industry (Mining, Manufacturing, Distribution). Capital services

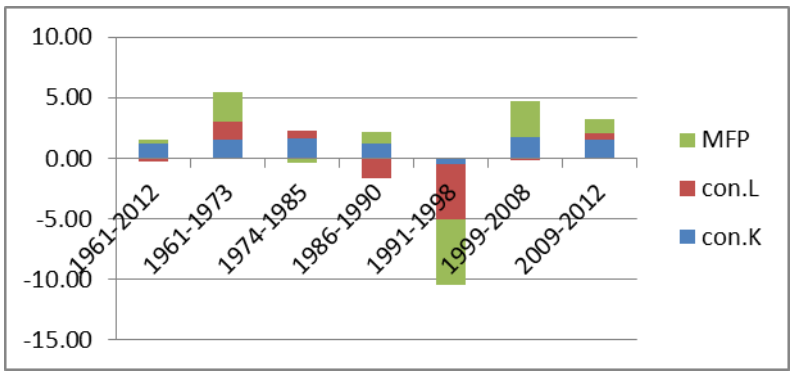


Fig. 3. Alternative measures of capital stock trend in Industry in 1961-2012

(Gross capital stock level in 1995 = 100)

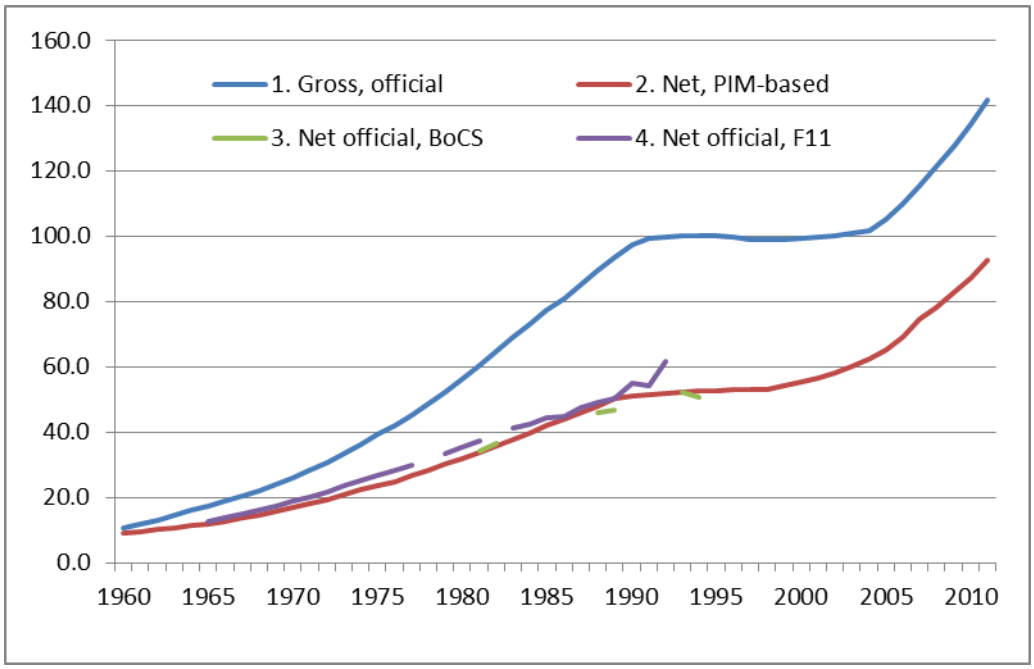


Fig. 4. Growth rates of alternative measures of capital input in Industry

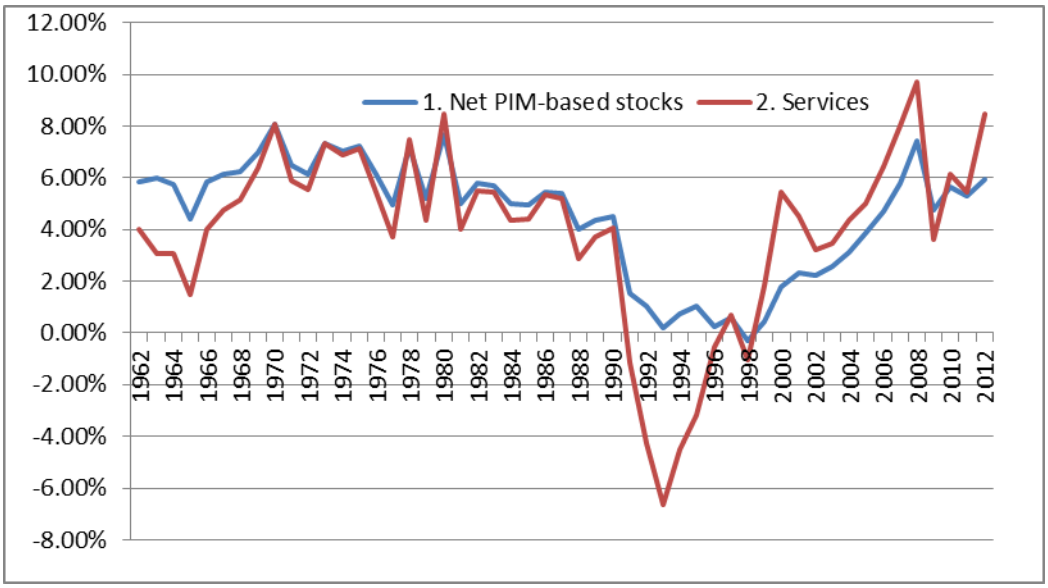
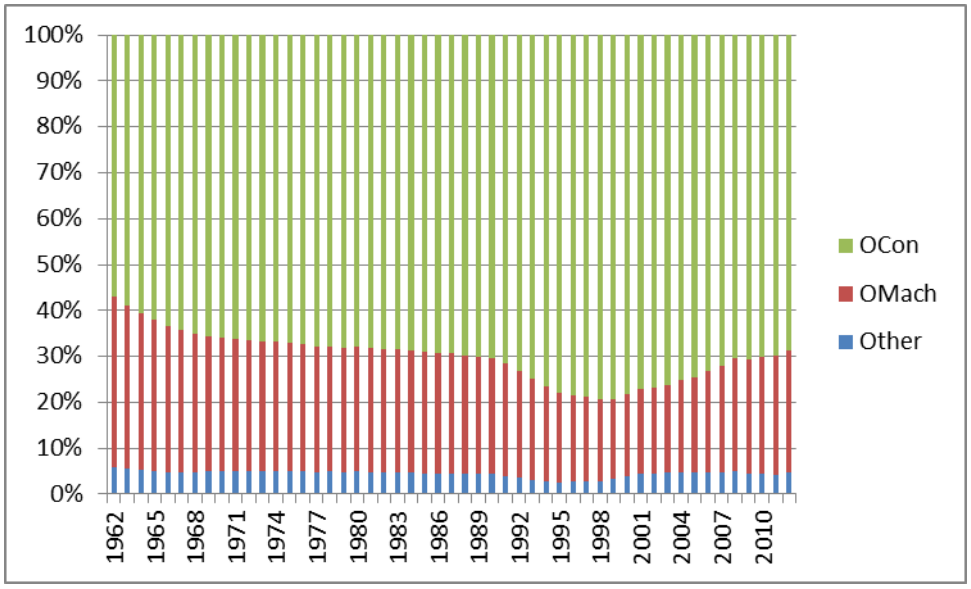


Fig. 5. Shares of types of assets in Industry (%)

A. PIM-based net stocks



B. Services

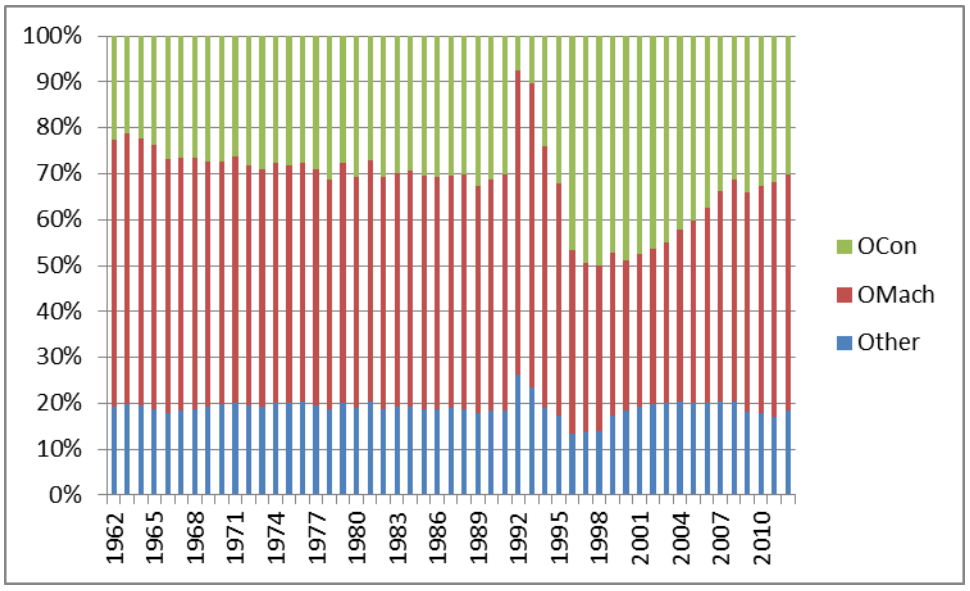
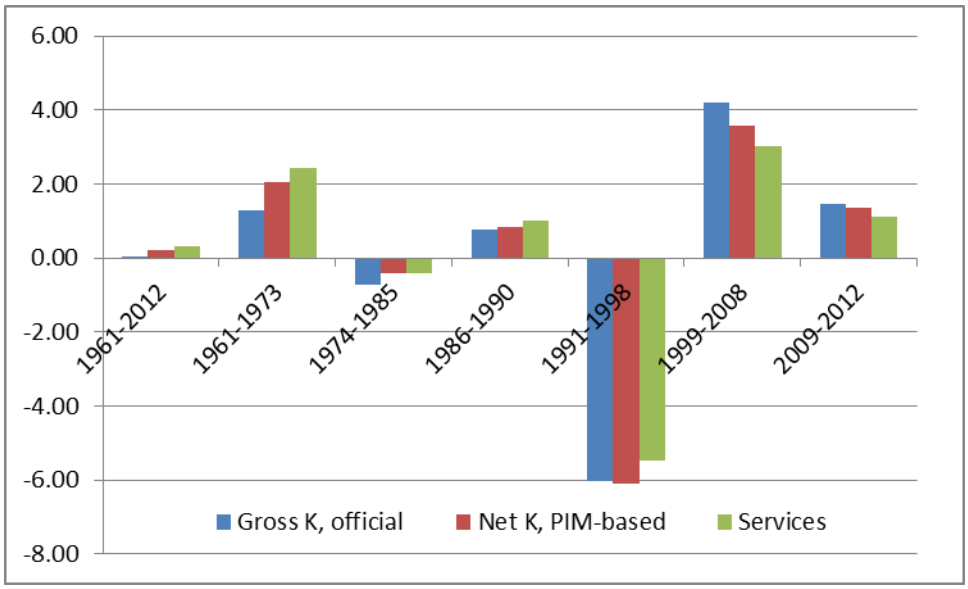


Fig. 6. MFP growth in Industry for alternative measures of capital input



Tables

Table 1. Growth accounting. Total economy

	1961-2012	1961-1973	1974-1985	1986-1990	1991-1998	1999-2008	2009-2012
Yearly average growth rates, %							
Output	2.96	6.56	3.42	0.83	-6.83	6.72	2.98
Capital	4.42	7.57	5.99	4.70	0.20	1.49	2.72
Labour	0.70	2.72	0.86	0.04	-2.41	0.89	0.54
MFP	1.14	2.38	1.02	-0.60	-5.20	5.65	1.79
Contributions, p.p.							
Output	2.96	6.56	3.42	0.83	-6.83	6.72	2.98
Capital	1.33	2.27	1.80	1.41	0.06	0.45	0.82
Labour	0.49	1.91	0.60	0.03	-1.69	0.62	0.38
MFP	1.14	2.38	1.02	-0.60	-5.20	5.65	1.79

Table 2. Growth accounting. Industry (Mining. Manufacturing and Energy Distribution)

	1961-2012	1961-1973	1974-1985	1986-1990	1991-1998	1999-2008	2009-2012
Yearly average growth rates, %							
Output	1.32	5.46	1.84	0.52	-10.48	4.59	3.20
Capital	5.08	8.84	6.57	4.76	0.24	1.74	3.88
Labour	-0.34	2.19	0.86	-2.39	-6.46	-0.18	0.83
MFP	0.04	1.28	-0.74	0.77	-6.03	4.19	1.46
Contributions, p.p.							
Output	1.32	5.46	1.84	0.52	-10.48	4.59	3.20
Capital	1.52	2.65	1.97	1.43	0.07	0.52	1.17
Labour	-0.24	1.53	0.60	-1.68	-4.52	-0.13	0.58
MFP	0.04	1.28	-0.74	0.77	-6.03	4.19	1.46

Table 3. Growth accounting. Industry. PIM-based capital stock

	1961-2012	1961-1973	1974-1985	1986-1990	1991-1998	1999-2008	2009-2012
Yearly average growth rates, %							
Output	1.32	5.46	1.84	0.52	-10.48	4.59	3.20
Capital	4.55	6.28	5.44	4.56	0.52	3.76	4.22
Labour	-0.34	2.19	0.86	-2.39	-6.46	-0.18	0.83
MFP	1.14	2.38	1.02	-0.60	-5.20	5.65	1.79
Contributions, p.p.							
Output	1.32	5.46	1.84	0.52	-10.48	4.59	3.20
Capital	1.36	1.88	1.63	1.37	0.16	1.13	1.27
Labour	-0.24	1.53	0.60	-1.68	-4.52	-0.13	0.58
MFP	0.20	2.05	-0.40	0.83	-6.11	3.59	1.35

Table 4. Growth accounting. Industry. Capital services

	1961-2012	1961-1973	1974-1985	1986-1990	1991-1998	1999-2008	2009-2012
Yearly average growth rates, %							
Output	1.32	5.46	1.84	0.52	-10.48	4.59	3.20
Capital	4.17	4.98	5.49	3.95	-1.64	5.69	5.00
Other	4.10	5.12	4.93	3.27	-3.99	8.24	4.72
Machinery	3.80	3.58	5.31	3.55	-4.13	7.57	6.08
Constructions	4.98	7.87	6.18	5.02	2.01	2.46	3.50
Labour	-0.34	2.19	0.86	-2.39	-6.46	-0.18	0.83
MFP	0.31	2.44	-0.41	1.01	-5.46	3.01	1.12
Contributions, p.p.							
Output	1.32	5.46	1.84	0.52	-10.48	4.59	3.20
Capital	1.25	1.49	1.65	1.19	-0.49	1.71	1.50
Other	0.23	0.30	0.29	0.18	-0.20	0.47	0.26
Machinery	0.63	0.59	0.82	0.54	-0.54	0.95	0.91
Construction	0.39	0.61	0.54	0.47	0.24	0.29	0.34
Labour	-0.24	1.53	0.60	-1.68	-4.52	-0.13	0.58
MFP	0.31	2.44	-0.41	1.01	-5.46	3.01	1.12

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