Productivity, Structural Change and Informality: the Case of Russia

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The paper explores how structural change in the Russian economy affects aggregate labour productivity growth, taking into account informality. Structural change refers to the long term change of labour composition, which includes reallocation between industries as well as between formal and informal segments within each industry. Using Russia KLEMS data and exploiting four alternative approaches to the shift-share analysis, I decompose aggregate labour productivity growth into within and between components. I show that labour reallocation was growth enhancing. In 1995-2012 it provided more than one fifth of aggregated labour productivity growth rates. Considering 2005-2012 I report that the expansion of the informal employment acted in the opposite direction. As this study documents, it can be explained mostly by the expanding employment share of informal activities with low labour productivity levels, rather than with low growth rates.

Key words: labor reallocation, labor productivity, informal economy, the Russian economy, Russia KLEMS, shift-share analysis

JEL: O47, O17

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1. Introduction

Labour productivity growth is often considered as an outcome of modernization of production processes, investments to human and physical capital, as well as technology and managerial innovations. Indeed, being successful, this fuels labour productivity growth of *firms*. However, the response of *the total economy aggregate* may be ambugous, depending also on labour flows, which accompany these firm-level efficiency improvements (Denison 1962; Baumol 1967). Indeed, in most cases modernization assumes labour saving such that a replaced qualified worker can find a new job in a small shop, shifting from a modern well equipped factory to a small-scale shop. In turn, labour share of a highly productive manufacturing shrinks and of low productive retail expands. In terms of the national economy level aggregates, labour productivity level of the total economy will grow slowly in comparison with manufacturing, or even fall.

Recent evidence suggests that labour reallocation between industries can be growth enhancing or growth reducing (McMillan and Rodrik 2011; G. de Vries, Timmer, and Vries 2015). As McMillan and Rodrik (2011) show, starting from 1990-s, in East Asian countries labour reallocation stimulated productivity growth, while in Latin America and Africa its effect was mainly negative. Extending the study of McMillan and Rodrik for 1960-s and 1970-s in Africa, De Vries with colleagues (2015) highlighted distinction of labour reallocation between industries with different productivity levels, which they refer to as a static effect, and with different labour productivity growth rates, as a dynamic one. In case of eleven African countries they demonstrate that the static and dynamic components can affect aggregate productivity growth in the opposite directions.

All these studies consider labour as a homogenious input. While starting from Denison[3] scholars placed this assumption in question[4], pointing at informal labour as an important source of labour heterogeneity, only the study of de Vries et al (2012) attempted to investigate the impact of labour reallocation to informality on labour productivity growth in cases of two emerging economies, Brazil and India. Following one of the issues, raised by de

[3] He wrote that there was a significant in numbers category of workers ("the "fringe" group" made of self-employed), a reduction of which and reallocation into waged employment would give a remarkable addition to the national income. Denison does not call selfemployed as "informal workers". This term (for informal workers) was coined in the literature later (in the 1970s) in order to characterize labor markets in the developing countries. Its use in relation to the developed countries is a more recent phenomenon (Denison 1967, 204).

[4] See discussion of this issue in the context of developing and emerging economies in (McMillan and Rodrik 2011; G. de Vries, Timmer, and Vries 2015). Labour can be heterogeneous within one industry not only because of formal and informal employment, but also because workers differ by age, education and gender. See more about critical evaluation of the shift-share analysis in terms of the assumption of inputs' homogeneity in (Timmer and Szirmai 2000, 382).

Vries et al (2012), we examine the impact of cross-industry labor reallocation on the aggregate LP growth, taking into account formal/informal split within each industry. The present paper provides new insights into the problem, considering for the first time a post-transition economy with abundant natural resources and expanding informality, Russia. For this we develop new industry-level data set that includes variables for output, labor input and LP for three dozen industries for the period spanning from 1995 to 2012, using industry-level series of the Russia KLEMS data base (Timmer and Voskoboynikov 2014) and splitting them into formal and informal segments. One more novelty of this paper is application of superior methods of the shift share analysis, better tailred for strong volatility of domestic relative prices (Tang and Wang 2004; Diewert 2014), for the analysis of informality.

Two main results are worth mentioning here. First, dealing with the Russian economy we confirm findings of de Vries et al (2012) for India, that the expansion of the informal employment slows down labour productivity growth. Second, splitting the reallocation effect into the static and the dynamics ones we found, that the former is more important. Indeed, with expanding informality variation in labour productivity levels goes up, which leads to a higher contribution of labour reallocation across industries with different productivity levels, rather than growth.

The paper has the following structure. The Section 2 describes alternative approaches to the shift-share analysis that are used in the following sections. Section 3 presents the data set and its sources. Section 4 overviews major industry-level productivity and employment trends. Section 5 discusses the outcomes of decomposing the LP growth rates into within- and between-industry effects. Section 6 concludes.

2. Approach. Methods of structural decomposition

The reallocation of workers across industries contributes to aggregate labour productivity growth. There is a large volume of published studies[5] describing this phenomenon, originating from Fabricant (1942), which decomposes the increment of aggregate labour productivity growth into intra-industry (within) and inter-industry (between) and components. The former is caused by accumulation of human and physical capital, intangible assets, and with technological progress[6], while the latter depends on structural changes in the economy. With the assumption of additivity of output in constant prices

[5] See, e.g., the review in (G. de Vries, Timmer, and Vries 2015).

[6]The contribution of multifactor productivity growth, which is ususally interpreted as the outcome of technological change, could be also explained by temporary disequilibrium, caused by a delayed reaction on

(1) $\bar{\bar{Y}}^t = \sum_n^N \bar{\bar{Y}}_n^t$,[7]

where $\bar{\bar{Y}}^t$ is aggregate output in year *t*, $\bar{\bar{Y}}_n^t$ is the output of industry *n*, and *N* is the number of industries, the change in the aggregate labour productivity $\Delta\bar{\bar{X}}$ $(X \equiv Y/L)$ can be written as follows

(2) $\Delta\bar{\bar{X}} = \sum\left(s_{L,n}^0 \Delta\bar{\bar{X}}_n\right) + \sum\left(\Delta s_{L,n} \bar{\bar{X}}_n^1\right) = \sum\left(s_{L,n}^0 \Delta\bar{\bar{X}}_n\right) + R.$

The last term in the second expression captures the reallocation effect $R \equiv \sum\left(\Delta s_{L,n} \bar{\bar{X}}_n^1\right)$. In turn, weights $s_{L,n}^t$ are shares of industry n in total labour.

Vries et al (2012, sec. 4) showed that (2) depends on the level of disaggregation. Formally, applying (2) to the case when each industry *n* consists of M_n sub-industries, the corresponding labour productivity increment can be represented as

(3) $\Delta\bar{\bar{X}}_n = \sum_m^{M_n}\left(\left(\frac{L_{n,m}^0}{L_n^0}\right)\Delta\bar{\bar{X}}_{n,m}\right) + R_n,$

where $\left(\frac{L_{n,m}^0}{L_n^0}\right)$ – the labour share of industry *n*, and $\Delta\bar{\bar{X}}_{n,m}$ is the labour productivity growth of subindustry *m* in industry *n*. In turn, R_n is the effect of labour reallocation between sub-industries of *n*. Substituting (3) into (2), we have

(4) $\Delta\bar{\bar{X}} = \sum_n^N \sum_m^{M_n}\left(s_{L;n,m}^0 \Delta\bar{\bar{X}}_{n,m}\right) + \sum\left(s_{L,n}^0 R_n\right) + R,$

where $s_{L;n,m}^0 = \left(L_{n,m}/L\right)$.

It is useful to represent decomposition (2) in terms of growth rates, rather than levels. Dividing both sides of equation (2) by $\bar{\bar{X}}$ and making simple algebra manipulations we come to

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technological changes in previous preiods, terms of trade, low mobility of labour and capital, as well as various competitive barriers. (Reinsdorf 2015).

[7] For brevity sake, below we skip summation indices. Variables are marked with the double bar if it depends on output in constant prices with fixed weights (the Laspeires index formulae).

(5) $$\bar{\bar{\gamma}} = \sum\left(s^0_{\bar{\bar{Y}},n}\bar{\bar{\gamma}}_n\right) + \sum\left(s^0_{\bar{\bar{Y}},n}\sigma_n\right) + \sum\left(s^0_{\bar{\bar{Y}},n}\sigma_n\bar{\bar{\gamma}}_n\right).$$

Here $\gamma \equiv \Delta X/X_0$ is labour productivity growth rates, $s_{\bar{\bar{Y}},n}$ are the shares of the output of industry n in aggregate output, and σ is the growth rates of labour shares. Equation (5) originates from studies of Denison (1962; 1967). While the first term represents the contribution of labour productivity growth in industries. In turn, the second and the third terms taken together are associated with reallocation, or between effect. Nordhaus (2002) labeled them the *Denison* and *Baumol effects*, consequently.

The Denison effect is the contribution of labour reallocation between industries with different productivity levels (Denison 1962). It explains why labour productivity acceleration in a certain industry can slow down the aggregate productivity growth. Indeed, consider two industries in the economy, being industry A more productive than B $\left(\bar{\bar{X}}^0_A > \bar{\bar{X}}^0_B\right)$. Then because of, say, technology improvements in industry A its labour productivity level goes up, remaining unchanged in the rest of the economy. Under the condition of constant demand for product A industry A starts releasing workers, who find new jobs in B. As a result, labour share in A shrinks, and in B extends, being both equal in absolute magnitude, or $\Delta s_{L,B} = -\Delta s_{L,A} > 0$. Then terms of industries A and B in the Denison effect component of (5) are

(6) $$s^0_{\bar{\bar{Y}},A}\sigma_A + s^0_{\bar{\bar{Y}},B}\sigma_B = \Delta s_{L,B}\left(s^0_{\bar{\bar{X}},B} - s^0_{\bar{\bar{X}},A}\right) < 0.$$

In other words, the negative contribution of the employment share in A is more harmful for aggregate growth, than a positive contribution of B, because *initial* productivity of A is higher than B[8].

The Baumol effect, represented by the last term in (5), reflects the contribution of labour reallocation between progressive industries with high productivity *growth* and stagnant ones with low growth (Baumol 1967; Baumol, Blackman, and Wolff 1985). The studies conclude then, that labor reallocation from progressive manufacturing to stagnant services leads to the slowdown of aggregated productivity.

[8] As it follows from (6), the Denison effect is independent of labour productivity growth in industries. Its direction is specified by shifts in labour shares and relative productivity levels only. Denison stresses this, mentioning, that the aggregate labour productivity growth can be negative even if productivity growth in all industries is nill.

One limitation of TRAD, mentioned in the literature[9], is a counter-intuitive interpretation of reallocation in some cases. Consider industry *n* with a below average productivity level. Intuitively, if it hires more workers from more productive industries ($\sigma_n > 0$), the reallocation effect should be negative. However, as it follows from (5), contribution $s^0_{\bar{\bar{Y}},n}\sigma_n$ is positive. Another case is when the employment share of an industry with the below average productivity level shrinks ($\sigma_n < 0$), and its labour productivity falls ($\bar{\bar{\gamma}}_n < 0$). As can be seen from the third term in (5), $s^0_{\bar{\bar{Y}},n}\sigma_n\bar{\bar{\gamma}}_n$, the contribution of reallocation will be also positive.

Resolving this, the CSLS approach accounts for the difference between productivity levels in an industry and in the economy as a whole. With some more algebra we have the explicit expression for the CSLS decomposition:

$$(7) \qquad \bar{\bar{\gamma}} = \sum\left(s^0_{\bar{\bar{Y}},n}\bar{\bar{\gamma}}_n\right) + \sum \sigma_n\left(s^0_{\bar{\bar{Y}},n} - s^0_{L,n}\right) + \sum \sigma_n\left(s^0_{\bar{\bar{Y}},n}\bar{\bar{\gamma}}_n - s^0_{L,n}\bar{\bar{\gamma}}\right).$$

Compared together TRAD (5) and CSLS (7) one can be seen that the first term in both equations are the same. However, industry-level components of the second term in (7) (Denison effect) become negative, if employment expands in an industry with the below average level of labour productivity. Certainly, in this case, $\sigma_n\left(s^0_{\bar{\bar{Y}},n} - s^0_{L,n}\right) = \Delta s_{L,n}\left(\frac{\bar{\bar{X}}^0_n}{\bar{\bar{X}}^0} - 1\right) < 0$. On the analogy, the Baumol effect in case of the low productive shrinking industry is positive.

A major source of uncertainty of TRAD and CSLS is assumption (1) of additivity of output in constant prices. Since (1) holds if aggregated output is calculated with fixed weights in constant prices of a certain base year, the output series are sensitive to the choice of this year. This measurement uncertainty is the stronger the higher are changes of relative prices of a current year relative to the base one. It is worth mentioning that such dramatic changes took place both in developed economies and in economies in transition. At that, if relative prices in developed economies varied mostly because of rapid development of ICT technologies (Nordhaus 2002; Stiroh 2002), transition economies experienced smoothing of multiple distortions of the planned economy period (Campos and Coricelli 2002; Bessonov 2005).

[9] See, e.g., (De Avillez 2012; Reinsdorf 2015).

One more source of intensive variations in relative prices, specific for the Russian economy, is world oil price trends.

A conventional solution for this mismeasurement problem is the substitution of volume indices in constant prices with chained volume indices, as it is recommended by the System National Accounts[10]. In this case the exact additivity assumption (1) does not hold any more. So, one needs also other approaches to the shift-share analysis, consistent with the chained volume indices system, which were suggested by Tang and Wang (2004) and called GEAD.[11] The counterpart of (1) in GEAD is additivity of output V in current, rather than constant prices

$$(8) \qquad V = \sum V_n.$$

Then real output Y refers to nominal output, adjusted for the level of current prices relative to the price level of a certain base year $Y \equiv V/P$.

With (8) an aggregated labour productivity level X can be represented as

$$(9) \qquad X \equiv \frac{Y}{L} = \frac{V}{PL} = \frac{\sum V_n}{PL} = \frac{1}{L}\sum \frac{V_n}{P_n}\frac{P_n}{P} = \sum \frac{Y_n}{L_n}\frac{L_n}{L}\frac{P_n}{P} = \sum s_{L,n} p_n X_n,$$

where где $p_n \equiv (P_n/P)$ is the relative price index of industry *n*. Specifying $s_n \equiv s_{L,n} p_n$, we represent the aggregated labour productivity level as

$$(10) \qquad X = \sum s_n X_n,$$

and, with small manipulations, aggregated labour productivity growth as

$$(11) \qquad \gamma = \sum s^0_{Y,n}\gamma_n + \sum s^0_{X,n}\,(s^1_n - s^0_n) + \sum s^0_{X,n}\,(s^1_n - s^0_n)\gamma_n,$$

where $s^0_{Y,n} = (Y^0_n/Y^0)$ and $s^0_{X,n} = (X^0_n/X^0)$ is the ratio of productivity level in industry *n* to the aggregated one. Equation (11) is the GEAD decomposition with the first term being

[10] (System of National Accounts 1993: 1.17; System of National Accounts 2008: 15.21), See more about using chain volume output indices in Russian statistics in (Rosstat 2014, section 3).

[11] See also the literature reviews in studies of Balk (2014) and Reinsdorf (2015).

within contributions of industries, the second one is interpreted as the Denison effect, and the third one is the Baumol effect.

Dumagan (2013) shows, that compared with TRAD, along with the superiority in terms of the fixed weights problem, GEAD has two additional advantages. First, the within component in GEAD (the first term in (11)) depends only on industry price deflators, while in TRAD it (the first term in (5)) it also rests on the price deflator for the total economy.[12] In other words, the TRAD decomposition is sensitive to the relationship between industry level deflators and the aggregated deflator. Second, in contrast with TRAD, GEAD takes into account changes in the aggregate productivity growth, caused by variations in relative prices. Such changes do not necessary lead to labour reallocation and can be explained, for example, by extra inflow of capital services.

From the previous discussion, it can be seen that changes in relative prices can influence the between effect of GEAD implicitly. From this perspective, it is of a particular interest to look at the effects of relative prices and labour reallocation separately.

A proper modification of GEAD has been suggested by Diewert (2014). Using the representation of aggregate labour productivity growth (9), he demonstrated that labour productivity *growth* (growth rates plus one) (X^1/X^0) can be expressed as the sum of three factors, which are growth rates of relative prices(p_n^1/p_n^0) in industries, labour shares $\left(s_{L,n}^1/s_{L,n}^0\right)$ and labour productivity (X_n^1/X_n^0)

$$(12)\quad \frac{X^1}{X^0} = \frac{\sum s_{L,n}^1 p_n^1 X_n^1}{\sum s_{L,n}^0 p_n^0 X_n^0} = \sum \left(\frac{p_n^1}{p_n^0}\right)\left(\frac{s_{L,n}^1}{s_{L,n}^0}\right)\left(\frac{X_n^1}{X_n^0}\right) s_{Y,n}^0.$$

Shifting from *growth* to *growth rates* for relative prices $(\rho_n \equiv (p_n^1/p_n^0) - 1)$, labour shares $(\sigma_n \equiv (s_n^1/s_n^0) - 1)$ and labour productivity $(\gamma_n \equiv (X_n^1/X_n^0) - 1)$ this decomposition can be represented as

$$(13)\quad \Gamma \equiv \gamma - 1 =$$
$$= \sum s_{Y_n}^0 \big((1+\gamma_n)(1+\rho_n)(1+\sigma_n) - 1\big) =$$
$$= \sum s_{Y_n}^0 (\gamma_n + \rho_n + \sigma_n + \gamma_n\rho_n + \gamma_n\sigma_n + \rho_n\sigma_n + \gamma_n\rho_n\sigma_n) =$$

[12] See equations (4.1) and (4.2) in (Dumagan 2013) for the explicit exposition of this.

$$= \sum s_{Y_n}^0 \gamma_n + \sum s_{Y_n}^0 \rho_n + \sum s_{Y_n}^0 \sigma_n + \sum s_{Y_n}^0 \gamma_n \rho_n + \sum s_{Y_n}^0 \gamma_n \sigma_n + \sum s_{Y_n}^0 \rho_n \sigma_n + \sum s_{Y_n}^0 \gamma_n \rho_n \sigma_n.$$

This expression is the exact decomposition of aggregated labour growth rates γ_n, relative prices ρ_n and labour shares σ_n. As it followes from the second row, the contribution of industry *n* to the aggregate labour productivity growth is $s_{Y_n}^0\big((1+\gamma_n)(1+\rho_n)(1+\sigma_n)-1\big)$. This expression can be interpreted as follows. If relative prices and labour shares in industry *n* remain constant, which assumes $\rho_n = 0$ and $\sigma_n = 0$, the contribution of industry *n* is the product of its labour productivity growth $(1+\gamma_n)$ and its labour share in the initial year $s_{Y_n}^0$. The positive value of σ_n amplifies the contribution of this industry because of its expanding share in total labour inputs. In turn, positive growth of relative prices $(\rho_n > 0)$ leads to a higher contribution of insustry *n* because of higher relative prices on its product.

The last row in (13) represents aggregated labour productivity growth decomposition, being almost totally contributed by weighted averages of industry growths of labour productivity $\left(\sum s_{Y_n}^0 \gamma_n\right)$, relative prices $\left(\sum s_{Y_n}^0 \rho_n\right)$ and labour shares $\left(\sum s_{Y_n}^0 \sigma_n\right)$. The four remaining components are interaction terms between productivity, relative prices and labour shares. They are negligible in comparison with the first three ones.

These three key terms in (13) can be easily interpreted. Component $\sum s_{Y_n}^0 \gamma_n$ represents labour productivity growth, if relative prices and employment structure remain constant. This term, which is defined as *the direct effect*, represents aggregation of labour productivity growth rates in industries. In turn, component $\sum s_{Y_n}^0 \rho_n$, defined as *the effect of relative prices*, characterizes aggregated labour productivity growth rates, assuming no changes in industry labour productivities and structure of employment. This effect is caused by changes in weights of products in aggregate productivity growth because of variation of relative prices. Finally, term $\sum s_{Y_n}^0 \sigma_n$ shows aggregate labour productivity growth if labour productivity within industries and relative prices remain unchanged. This effect is caused by labour reallocation across industries and defined as *the reallocation effect*. It is important to notice that term $s_{Y_n}^0 \sigma_n$ should *not* be interpreted as the contribution of industry *n* to total reallocation, because changes, caused by labour reallocation, take place also in other industries and appear in corresponding terms.

It is worth mentioning that this decomposition (13) and TRAD (5) interdependent. Indeed, if relative prices do not change $(\rho_n = 0)$, (13) can be easily transformed into (9). Consequently, TRAD can be considered as a special case of (13) in case of fixed relative prices.

Eventually, providing exact equality in (13) one takes into account not only the first three terms, but also the following four. Diewert (2014) suggests the following approach. He compiles the following three terms, which are responsible for changes of labour productivity, relative prices and labour shares[13]:

$$(14) \quad \Gamma \equiv \gamma - 1 = \sum \Delta X_n + \sum \Delta p_n + \sum \Delta s_{L,n},$$

where $\Delta X_n = s_{Y_n}^0 \gamma_n \left\{1 + \left(\frac{1}{2}\right)\rho_n + \left(\frac{1}{2}\right)\sigma_n + \left(\frac{1}{3}\right)\rho_n\sigma_n\right\}$, $\Delta p_n = s_{Y_n}^0 \rho_n \left\{1 + \left(\frac{1}{2}\right)\gamma_n + \left(\frac{1}{2}\right)\sigma_n + \left(\frac{1}{3}\right)\gamma_n\sigma_n\right\}$, and $\Delta s_{L,n} = s_{Y_n}^0 \sigma_n \left\{1 + \left(\frac{1}{2}\right)\gamma_n + \left(\frac{1}{2}\right)\rho_n + \left(\frac{1}{3}\right)\gamma_n\rho_n\right\}$.

Decomposition (21) amounts to the three-factor version of GEAD, which will be referred to as GEAD 3f.

Summing up, we implement four methods of labour productivity growth decomposition. The first one, TRAD, assumes fixed relative prices on industry products. It is widely used in the literature for the analysis of structural changes, so that the literature provides rich context for comparisons across time and space. In addition, it provides an opportunity for interpretation of the reallocation effect as a sum of two effects, which are labour reallocation between industries with different productivity levels (Denison effect) and growth rates (Baumol effect). Next, CSLS uses the same assumption of fixed product weights, as TRAD. However, it provides better interpretation, when TRAD does not work well. Weakening the limitation of fixed relative prices leads to GEAD. This approach also explores the split of the reallocation effect into Denison's and Baumol's components. Finally, GEAD-3f suggests an alternative split of the reallocation effect, which separates impacts of labour reallocation and variation in relative prices.

[13] In the following discussion in Section 5 these three components in (21) are referred to as the direct effect, the effect of relative pricesm and the reallocation effect consequently.

Certainly, taking into account rich literature on structural change and labour productivity growth[14], the list of these four decompositions is not comprehensive. Moreover, these methods are not perfect[15]. At the same time, the discussed framework amounts to the coherent system of methods with the well-developed economic interpretation. In the sections that follow we show how these methods work in case of Russia.

3. Data

As discussed above, methods of the shift-share analysis require industry-level time series data on nominal value added, real value added, and labour input. Taking account of informality we are also expected to split these series into formal and informal segments within each industry.

The first best option of the data source is the official National Accounts series. However, in case of Russia the Russian statistical office (Rosstat) provides consistent industry-level series only form 2003. The only alternative data source with longer time series, which come back to 1995, is Russia KLEMS (Timmer and Voskoboynikov 2014). It includes backcast estimations of output and inputs back to 1995, being consistent with the total economy level official SNA series in 1995-2002, and the official industry-level SNA series afterwards.

The next step is breaking down of the series into formal and informal segments. We refer to a worker as an informal one if (s)he is *not* engaged in an organization, which belongs to the corporate sector or, in other words, has no status of legal entity[16]. The informal segment, therefore, is measured statistically as the production in the institutional sector of households in SNA.

Industry-level nominal value added is estimated by Rosstat as the sum of value added in the corporate sector and the household sector. The latter is measured by using various indirect estimates in accordance with international guidelines.[17] The share of the informal segment in value added is assumed to be the share of the households' sector in total value added of a

[14] See. for example, the alternatives in the following studies (G. J. de Vries et al. 2012; Diewert 2014; Roncolato and Kucera 2014; Reinsdorf 2015).

[15] See more about shortages and limitations in (Timmer and Szirmai 2000; G. J. de Vries et al. 2012; Reinsdorf 2015)

[16] Being interested also in labor reallocation between formal and informal segments we disaggregate data for each industry by these segments, correspondingly. There is a long discussion in the literature how to define informality; we rely here on the productive definition which associates informality with properties of firms, not workers. For alternative definitions of informality and their application to the Russian employment see in (Gimpelson and Kapeliushnikov 2014a). See also (Lehmann 2015).

17 Methodology description of output and value added of the economy, including the informal segment, is available by Rosstat (1998). International experience of this is generalized by OECD (2002).

particular industry.[18] Unfortunately, this subset of data is available at 1-digit level only. For example, Manufacturing (code D in Russia KLEMS) includes thirteen industries, among which the informal segment in 2005 varied from 3% of hours worked in electrical and optical equipment (30t33) to 38% in Wood and products of wood and cork (20). To resolve the issue for an industry at the two-digit level we use shares of a corresponding parent industry from the higher aggregation level. Thus, the informal share of both Electrical and optical equipment (30t33) and Wood (20) are assumed to be equal to that in all Manufacturing (D).In turn, the share of hours worked in the informal segment of each industry was calculated with data on hours worked in total and in the corporate sector, which is available starting from 2005.

There are two exceptions in application of this general approach. First, we set informal share in Mining (C) and Financial intermediation (J) to be nil. Official data estimates for value added in these industries produced by SMEs are under 0.2% and 1%, correspondingly.

Finally, we need to estimate real VA series in formal and informal segments. Assuming that price deflators in these two segments within each industry are the same, we deflate nominal value added applying the implicit GDP deflators in each industry. These deflators are calculated implicitly with real and nominal value added in each industry, given in Russia KLEMS.

[18] Data is available in official publications of Rosstat. See, for example, (Rosstat 2014, tab. 2.3.44), and similar publications for previuos years. Starting from 2002, Rosstat publishes also shares of value added, adjusted for unobserved economic operations (Rosstat 2010, tab. 2.3.46-52). We prefer the former since the share of the sector of households concur with the share of the share of unobserved economic operations until 2009. For succeeding years the latter falls much faster than the former, which unveils some unreported changes in methodology. We thank Rostislav Kapeliushnikov, who attracted our attention to this issue.

4. Two decades of labour productivity growth and structural change

The Russian economy has passed two decades of turbulent growth (figure 1). After a long post-transitional recession, which came to the end with the crisis of 1998, it reached the stage of growth. In 1999-2008 the Russian economy grew with annual growth rates 6.7% (Rosstat 2013b), which made it one of the most dynamic economies in the world, along with the other BRIC countries. However, the global crisis of 2008 hit Russia more than many other economies. As a result, the following years, 2009-2012 can be characterized as stagnation with more modest 4.0% growth rates (Rosstat 2013b).

[Fig. 1 is somewhere here]

Economic growth, which refers to yearly average growth rates of real value added, can be represented as the sum of growth rates of hours worked and labour productivity. In case of Russia, as well as of many post-industrialized economies with weak labour inflow, it is labour productivity which fuels growth. Indeed, comparing patterns of hours worked and labour productivity with real value added in Figure 1, we see that output variations are much more in line with labour productivity than employment. In terms of numbers, of 3.9% real value added growth rates in 1995-2012 2.9 p.p., or almost three quarter were contributed by labour productivity. That is why variations in economic performance are mostly ups and downs of aggregated labour productivity.

What does this aggregate labour productivity pattern originate from? It is driven by two types of sources, which are changes in performance industries and labour reallocation across industries. Timmer and Voskoboynikov (2014) provide evidences that the former is driven by capital intensity in low skills intensive services and extended mining, and by technology catching up in manufacturing, financial intermediation and business services. In turn, it is labour reallocation, which is in focus of the present study. It reflects fluctuations in the industrial structure of the economy. The impact of labour reallocation is the more the more the structure changes and industries differ in labour productivity.

Dealing with 30 industries of market economy, for descriptive reasons we combine them six aggregate sectors, which are agriculture, manufacturing, extended mining, market services (e.g. construction, retail and telecommunications), transport, and, finally, finance and business services[19]. Suggesting these sectors we follow the take into account the following

[19] The composition of these sectors is represented in Appendix 1.

considerations Agriculture and manufacturing are sectors, which are conventional within the three-sectoral analysis in development economics. One more reason of our interest to agriculture in the context of Russia is its high share in comparison of other post-industrialized and post-transition economies of a similar level of development. Extended mining is considered separately because of its size and a specific role in the Russian economic performance. It includes not only mining, but also wholesale trade and fuel, because the lion's share of oil and gas revenues falls at them (Timmer and Voskoboynikov 2014). At the same time, taking into account high share of services in modern economies and their heterogeneous performance (Jorgenson and Timmer 2011), we split services into three additional sectors. Transport is specific in a sense of its high capital intensity. Workers engaged in finance and business services differ from the rest of market servicers activities with the average level of skills and education (O'Mahony and van Ark 2003), which make these industries specific in terms of labour productivity performance. Finally, we exclude public administration, education and healthcare, because of low quality of productivity measures in non-market services (Timmer et al. 2010).

[Table 1 is somewhere here]

In recent decades the Russian economy went through intensive structural changes. The structure of the economy in 1995, three years after transition, carried some rudiments of planned economy and early transition distortions. In terms of hours worked the share of goods (agriculture and manufacturing) was almost 60%. Surprisingly, more than two thirds of all labour fall at agriculture, which is enormous for the post-industrialized economy. This was caused with labour intensive non-market households, which produce agricultural products for own consumption (Kapeliushnikov 2006). Being labour intensive and low productive in comparison with agricultural firms, these households use around 12% of total hours worked or more than half in Agriculture (Rosstat 2009, tab. 3.5). As it might be expected, the share of extended mining was small.

In the following years we observe forcing out of goods by services, which was the outcome of different forces, which acted in one direction. These are the shift of demand from goods to services because of growing income; overcoming of the planned economy over-industrialization; competition with Asia in manufactured goods; expansion of Extended Mining in years of soaring global oil prices, starting from 1999. The share of Agriculture in total hours worked reduced from 35% to 26% and the share of Manufacturing decreased from

23% to 19%. This contrasts sharply with expansion of Retail Trade, Construction and Services from 24% to about 35% of total hours worked. Not less impressive was the structural change in value added. The share of Agriculture almost halved, the share of Manufacturing reduced from 26% to about 19%, that of Transportation - from 14% to 8%. At the same time, Mining, Finance and Business Services increased the shares in GDP, while the aggregate share of Retail, Construction and Services changed little.

Comparison of shares of value added and hours worked in Table 1 also provides some insight about variations in labour productivity levels and growth across sectors. For example, Agriculture seems the least productive, because its share of hour worked, say, in 1995, is almost four times as much as of value added. At the same time, it is not surprising that the share of value added of capital intensive extended mining is more than five times higher than of hours worked. We expect a remarkable growth of labour productivity in Financial and Business Services, because by 2012 its share of value added raised by 7.3 p.p., while the share of hours worked – only by 0.8 p.p. It is also worth mentioning the fall of labour productivity in CRT with its constant share of value added and the expanding labour share by 10.3 p.p.

[Fig. 2. is somewhere here]

[Fig. 3. is somewhere here]

A more detailed picture of distributions of industries by labour productivity levels and growth rates is presented in figures 2A and 3A. Industries vary across the aggregate labour productivity level from the least productive Agriculture, Textile, and Leather and Retail (0.2 – 0.4 of the aggregate level) to the most productive Fuel and Mining (7-15 times as much as the aggregate). In comparison with levels the distribution of labour productivity growth rates looks more symmetric and close to normal. Its mean is 3.1 per cent, which reflects total labour productivity growth. Heterogeneity appears in the high value of standard deviation, which is 11.1 per cent. This means the substantial number of industries with very high, and also low and negative productivity growth. The negative tail consists mostly of growth rates after the crisis of 2008. At the same time, even before the crisis labour productivity fall in Textile and Leathers. Before the crisis the leaders were Financial Intermediation, Business services and Transport, while after the crisis in certain years growth rates of Transport Equipment (2010-11), Rubber and Plastics (2010) and Leather (2010) were also high.

[Table 2 is somewhere here]

The additional source of variations in productivity both across industries and in time is labour reallocation between formal and informal segments of the economy. Table 2 reports, that its share in hours worked is almost half and expanding. The share of informality varies across industries from modest one tenth (2012) in Financial and Business Services to enormous four fifth in Agriculture.

Taking into account informal split shifts the distribution of productivity levels to the left, which can be noticed by comparison of figures 2A and 2B. Quantitatively this effect is reported by table 3, which presents the parameters of this distribution for total industries and with the informal split. In comparison with the no split case the skewness of the distribution with the informal split raises by one quarter. At that the increasing number of low productive industries shifts the average productivity down from 1.8 to 1.3 of the total economy level. The growing spike appears also in the form of increasing kurtosis. All this indicates that the probability of finding a new job for a worker with the lower *level* of productivity than the previous one is higher if the informal split is taken into consideration.

[Table 3is somewhere here]

[Table 4 is somewhere here]

Informal split can also impact the distribution of productivity growth rates. Figures 3A and 3B show that it does, but the influence is different. In contrast with the distribution of levels, the asymmetry of growth rates distribution decreases. Indeed the corresponding skewness (table 4) becomes closer to nil, changing from -1.7 to -0.8, which indicates that the tales on both sides balance out. Interestingly, the informal split has no impact on the mean growth rates, which remain 3.1 per cent per year. At the same time, higher standard deviation (15.3 instead of 11.1) is caused by increasing infrequent extreme deviations, as it follows from the decreasing value of kurtosis. In other words, the number of industries with extreme productivity growth, both positive and negative, increases. All in all, there is no evidence that because of taking into account informality labour reallocation leads to the increasing role of industries with growing of falling productivity.

The results reported in this section have shown that structural change can be the substantial source of variations in aggregate labour productivity. This follows from the fact, that the shifts in the structure of the economy in recent decades ware substantial and variations in productivity across industries were high. In addition, we provide evidences that labour reallocation between formal and informal segments of the economy can contribute to productivity variations. Moreover, the impact of informality is shown as the increasing role of industries with low productivity levels. However, these preliminary results do not answer the question, what are relative impacts of all these reallocation effects to aggregate productivity growth. Such estimations need the more accurate shift share analysis technique, which will be implemented in the following section.

5. The role of labour reallocation in aggregate productivity growth

In this section we depart from the traditional (TRAD) approach to the shift-share analysis, decomposing aggregate labour productivity growth into within and between components, and also splitting the latter into level (Denison) and growth rates (Baumol) effects. Then we look at the change of this decomposition, introducing the formal/informal split. Next, we apply alternative and superior decomposition techniques, improving accuracy and interpretation of our estimations.

[Table 5 is somewhere here]

Table 5 presents TRAD estimates for 30 industries for the period of 1995-2012 and grouped in six aggregated sectors. Over the period, the LP level increased by 93% or almost doubled. Extended Mining provided about one third of this growth. The contribution of Construction, Retail and Telecommunications (Market Services) is also very large (25 p.p.). Finance and Business services added 22 p.p. and Manufacturing gave 10 pp, while contributions from Transportation (5 p.p.) and Agriculture (2 p.p.) are marginal.

However, each sector contributes to the aggregate labour productivity growth comes not only because of intra-industry sources, but also due to labor flows across industries. Indeed, one fourth of the aggregate LP growth comes from labor reallocation.

Column 2 of Table 5 presents within and between components of the aggregate labour productivity growth. Extended Mining leads in the within sector productivity growth providing a quarter of it. This is hardly surprising since this sector accounts for the lion share of capital services in the total economy (Timmer and Voskoboynikov 2014). It is followed by

Manufacturing and Market Services which lag by 5-6 p.p. Meanwhile, Manufacturing contracts having reduced its employment share from 26% in 1995 to almost 19% in 2012 (Table 1). On the contrary, Market Services expand having increased its labor input from 24 to almost 35%. Therefore, the productivity growth in the sector is driven by capital inflow, as it is in Extended Mining (Timmer and Voskoboynikov 2014). Transportation and Agriculture are laggards in the process of the within LP growth. The within contribution of the latter is three times larger than its total contribution.

Now we can look at reallocation effects for the whole period from 1995 and on (column 3 of table 5). Market Services (12 p.p.) and Extended Mining (10 p.p.) play the key role though major properties of reallocation in these sectors differ, as Table 1 suggests. The share of value added attributed to Extended Mining rose from 23% in 1995 to 33% in 2012, while its employment share gained less than 2 p.p. and reached 5.7% in 2012. The value added share of Market Services remained almost constant hovering around 22%, while the employment share increased by 10 p.p. making almost 35% at the end of the period. Therefore, the contribution of Mining into labour productivity growth can be generated by large productivity handicap this sector enjoys compared to others, while its labor in- and outflows are relatively small.[20] On the contrary, contribution of Market Services into the reallocation effect comes from labour flows across industries. In fact, Construction and Retail have better absorptive capacity for heterogeneous and often low-skilled labor (that inflowing from other industries) but enjoy relatively limited (compared to Mining) possibilities for within productivity growth.

The contribution of the other sectors to the aggregate is relatively small. Highly productive and expanding Financial and Business Services add 6 p.p. through the reallocation effect. Outflow from low productive Agriculture and relatively high productive Manufacturing almost neutralize this growth. These two industries provide modestly negative contributions of about 3 and 4 pp, correspondingly. Intuitively clear that employment loss in an industry with labour productivity level higher than the average should result in the slowdown of labour productivity growth. Outflow from Manufacturing fits these expectations well and adds 3.8 p.p. On the contrary, if the low productive industry loses workers, we should also expect a positive contribution to aggregate growth. However, the least productive sector – Agriculture - reduces its labour share from 35% in 1995 to 26% in 2012 (Table 1)

[20] In what follows we show that the contribution of Extended Mining to the total reallocation effect is explained mostly by shifts in relative output prices rather than by labor reallocation per se (see Table 7 and related discussion).

but contributes negatively with -3 p.p.(Table 5). This counterintuitive outcome demonstrates potential drawbacks of TRAD interpretation.

Taking into account substantial changes in distributions of productivity levels and growth rates, reported in the previous section, introduction of the informal split increases heterogeneity in labour productivity levels and, therefore, is expected to affect components of productivity growth. A fraction of the aggregate labour productivity growth which was initially attributed to the within effect becomes now the part of the between effect. This shift reflects implications of flows across formal-informal divide. Table 6 presents the estimates for this effect for 2005-2012.

[Table 6 is somewhere here]

Table 6 presents estimates for sectors for total industries (columns 2 and 3) and for the case of the informal split (columns 4 and 5). For the total economy with no informal split labor reallocation provides 4.5 p.p. of 28 per cent of aggregate growth. Accounting for informality takes away one fifth of the total reallocation effect (4.47-3.61=0.86 p.p.). Equation (4) suggests the following interpretation: the productivity enhancing effect of labor reallocation across industries was partially offset by the negative effects of de-formalization.

Manufacturing is affected by formal to informal reallocation the most. Outflow of labor to the informal segment reduces the sectoral contribution into the aggregate labour productivity growth by 0.9 p.p. (0.9 = -2.10 – (-1.18)). The within growth seems to be even higher than it was thought earlier (3.4 p.p. instead of 2.9) but was partially cancelled by the displacement of workers to less productive non-corporate jobs.

A similar story is observed in Transportation where cross-segment flows reduce the reallocation effect by 0.6 p.p. The same, though to a lesser extent, is seen in Agriculture. In Market Services, if informality is taken into account, the reallocation effect does not change. In this complex sector, the de-formalization of Construction could be counteracted by formalization of retail through expansion of supermarkets and other modern retail formats. In fact, the fraction of informal labor input (in hours) in Construction rose from 40% in 2005 to 43% in 2012, while in Retail it was reduced from 72% to 64%.

[Table 7 is somewhere here]

As we have already noted, the CSLS approach (7) suggests a modified interpretation of the decomposition. The reallocation effect is the more the higher inter-industry variations in productivity levels and growth rates. The decomposition results, taking into account informal split, are shown in Table 7. Comparing TRAD (5) and CSLS (7) decompositions one can be noticed that only the between of these decompositions differ. Now the outflow from low productive Agriculture adds more than 1.4 p.p. to the aggregate growth, so that this effect exceeds the corresponding within contribution. Meanwhile, relatively more productive Manufacturing loses jobs and thus diminishes total reallocation.

The shift from TRAD (Table 5) to CLMS (Table 6) changed ranking of sectors. Reallocation effects associated with Finance and Business Services remained the largest. The second largest contribution came now from Agriculture, while Market Services and Manufacturing closed the ranking. Market Services expanded and absorbed low productive activities (employing low skilled labor), while Manufacturing experienced contraction of more productive jobs.

So far our discussion has been focused on TRAD and CSLS decompositions, that treat components of output as fixed weighted with relative prices fixed at the base year level of 2005.[21] If, in the 1990-s, relative prices changed, being driven by high inflation, in 2003-2012, they were strongly affected by the world commodity boom. In any case, volatility in relative prises could bias the decomposition outcomes (Bessonov 2005), confusing reallocation effects with those of relative price dynamics. The GEAD approach which is better suited to account for changes in relative prices provides more precise estimates of the reallocation.

[Table 8 is somewhere here]

GEAD (Table 8) reduces the aggregate LP growth from 28% to 26% and this is due to smaller reallocation effect. Between labour flows accelerate annual average productivity growth rates by 1.7 p.p. or by 6.5% of the total growth. This contribution is markedly smaller than that of 12.9% produced by the TRAD/CSLS methodology.

Only two sectors - Mining and Finance and Business Services - contribute positively into the reallocation effect having added 3.5 p.p. and 1.3 p.p., correspondingly. Being leaders in productivity levels they increased their employment shares. During the period under study,

[21] This year was chosen since it was close to the midpoint of the period 1995-2012. This minimizes fixed weights bias.

Mining benefited from commodity rent generated by relative price increase. A fraction of the rent spilled over into the sectors that produced non-tradables and drove up the within productivity growth. The negative structural (reallocation) effect associated with Agriculture seems surprising but can be explained by significant fall in sectoral relative prices[22].

[Table 9 is somewhere here]

However, the GEAD methodology does not separate total reallocation effect into components associated with changing relative prices and with changing employment composition. This can be done by applying the GEAD 3f decomposition (14). Its outcomes are presented in Table 9. They have the same sign and similar scale as the GEAD results have, but GEAD 3f weights the within industry growth more heavily. These differences come from the corrections the Diewert (2014) approach introduces providing additivity of output (components within the parentheses in formulas (14) that are added to unity). Both GEAD versions suggest that the main positive contribution into the reallocation effect contribution of Extended Mining and Finance and Business Services. However, the nature of this effect differs between these two sectors (Tab. 9). In Mining, the between component explains one third of the intra-sectoral productivity growth (almost 14% of the aggregate growth), but two thirds of the between contribution is associated with changes in relative prices. Reallocation between Mining and the rest of the economy explains 1.1 p.p. of the LP growth or about 11% of the total growth in the sector. In its turn, the between effect in Finance and Business Services (1.3 p.p.) is generated by the reallocation while falling relative prices in the sector affected the aggregate growth negatively.

The productivity effect induced by changing employment shares is a more precise indicator of inter-industry labor flows since it is not affected by changing relative prices. The role of labour input-driven reallocation in industries (column 5) is much different from total reallocation (column 3). Three labor receiving sectors contribute to the reallocation positively, these are Finance and Business Services, Constructions, Retail and Telecom, as well as Extended Mining (see Table 1). In turn, the reduced employment share of Manufacturing (by 1.9 p.p.) speeds down the LP growth, despite the compensating effect of growing relative prices.

[22] Evidence on this is provided by the official price statistics. Indeed, the official GDP deflator for industry "11. Extraction of crude petroleum and natural gas; service activities incidental to oil and gas extraction, excluding surveying" was 2.7 times as much as in 2005. At the same time, the same multiplier for industry "A. Agriculture, Hunting and Forestry" was just 2.1 (Rosstat 2013a; tab. 2.5.14-2.5.15).

[Table 10 is somewhere here]

As Table 10 suggests, than deceleration in the aggregated growth rates driven by the Denison effect is stronger than that by the Baumol effect. The Denison effect decreased by 0.6 p.p. in the TRAD/CSLS decompositions and by 0.7 p.p. in GEAD, while the Baumol effect did by 0.27 and 0.15 p.p., correspondingly. In other words, reallocation of labour between industries with different productivity levels has a larger effect on aggregate growth than with different growth rates.

Why is that? The Denison effect captures shifts of labour between industries with different levels of labour productivity, while the Baumol effect deals with growth rates. As can be seen, comparing figures 2 and 3, the informal split impacts the distribution of levels stronger than of growth rates. Since the distribution of levels became more asymmetrical, being biased in the direction of the left tale, one can conclude that the probability of a reallocation to a position with the lower level of productivity in comparison with the previous one is much higher than to a more productive one. On the contrary, with the informal split the distribution of growth rates becomes more symmetrical. So, we can expect that the extension of informality leaded to employment growth in industries with the below average productivity levels.

[Figure 4 is somewhere here]

Indeed, as can be seen in figure 4A, labour share of the least productive decile of industries, which consists of informal segments of some manufacturing industries, expands from 1.4% in 2005 to more than 1.5% in 2012 with a remarkable jump in years of the global crisis in 2008-2010. A similar picture is observed in a wider group of industries, shown in Figure 4B. Expectedly, all industries in the least productive one quarter group also belong to the informal segment. Along with the industries mentioned this group includes informal segments of agriculture, inland transport, construction and social and personal services. Taking into account, that the total share of the informal segment is about 44% (Table 2), this least productive 25% group includes more than two thirds of the informal employment. Consequently, data on Figure 4 confirms that *the expansion of informality leads to growth of labour shares of the least productive industries*.

In addition, Figure 4 demonstrates that this effect can be easily overlooked if one neglects the informal split. Indeed, considering total industries only we come up with the opposite conclusion concerning the employment share trend in the least productive group of industries. According to the figure, this group loses employee starting from 1999.

Though the estimates produced by alternative decomposition methodologies differ, they paint largely the similar picture. The core is that the reallocation in the Russian economy in 2005-12 was not growth neutral. Its contribution into the aggregate labour productivity growth was positive. This finding matches evidences of other studies that suggest consistent upgrade in job quality in 2000-2012 (Gimpelson and Kapeliushnikov 2014b). However, the more precise account of the informality composition and associated trends discounts positive contribution of labour reallocation by 20%. Reallocation remained progressive but the trend towards the expansion of informality worked in opposite direction. Workers who moved from the formal segment into the informal one got jobs in industries where the productivity levels were lower than in industries they exited. A worker leaving large industrial plant could become a cab driver or a sales person (formal or informal), or could earn his/her living transforming his/her garage or basement into a small workshop. The latter option allows staying in the same industry but working informally. In any case, in this new job one hour of work produces much less value added than in the previous one. This conclusion hardly depends on whether the worker is formally registered and pays taxes or not.

6. Conclusion

Labor reallocation caused by structural change in the economy can be both growth enhancing and growth reducing (McMillan and Rodrik 2011). Labor can move between economic activities as well as between formal and informal segments. There is large literature that explores how structural change and productivity growth are linked. Another strand of literature focuses on informality and its social and economic implications. The latter issue is of special importance for all developing and transition economies. However, these two strands do not cross and the link between structural change, productivity growth, and informality is discussed very loosely. The recent paper of de Vries et al (2012) is a rare exception.

The present study was designed to extend our knowledge concerning the contribution of structural change to aggregate labour productivity growth, taking into account large and growing informality. According to de Vries et al (2012) when informality split is taken into account, in India the growth enhancing reallocation effect disappears, and in Brazil it rises from 0.2 to 1.2 p.p. The scale of these estimates suggests that accounting for informality in countries with large informal economies can change our understanding on the link between structural change and aggregate labour productivity growth.

The present study aims to contribute to the field in both aspects. In this paper, we explore how the structural change can affect the aggregate labour productivity growth in the Russian economy if trends and structure of informality is accounted for. We apply a set of alternative analytical tools to decompose the aggregate labour productivity growth into the between and within components. Three main findings are worth to be mentioned. We show that labour reallocation was growth enhancing. In 1995-2012 it provided more than one fifth of aggregated labour productivity growth rates. Considering 2005-2012 we report that the expansion of the informal employment acted in the opposite direction. As our study documents, it was caused mostly by the expanding employment share of informal activities with low labour productivity levels.

In sum, the set of evidence presented in the paper shows how expansion of the informal economy reduces growth and makes reallocation less productive. Informality is a big problem in all countries with imperfect institutions. In most of developing economies one of the major sources of informality is the lack of human capital. In Russia, the main reason is in limited labor demand in the formal segment. This demand is “successfully” suppressed by excessive and unpredictable regulation. The formal employment tends to shrink pushing workers into

informal activity where there are no entry barriers but productivity is low. In the end, existing human capital is wasted and degrades.

Politicians often see a solution to informality in further tightening of regulations. this has exactly the opposite outcome. Additional regulatory burden leads to mutual reduction on the demand side and feeds informality expansion. Decrease in the LP growth follows.

Tables and figures

Table 1. Shares of value added and hours worked by sectors in 1995 and 2012 (%)

Sectors	Value added			Hours worked		
	1995	2005	2012	1995	2005	2012
Total market economy	100.0	100.0	100.0	100.0	100.0	100.0
Agriculture	8.8	5.8	4.8	34.6	28.6	26.3
Manufacturing	26.0	20.7	18.6	23.3	20.5	19.0
Extended Mining	23.4	31.3	33.2	4.3	5.6	5.7
Construction, Retail and Telecom	22.2	21.8	22.4	24.3	32.1	34.5
Transport	13.6	9.0	7.8	7.1	7.1	7.4
Finance and Business Services	5.9	11.4	13.2	6.4	6.1	7.2

Source: Russia KLEMS.

Table 2. Shares of hours worked in informal segments of market economy (%)

	2005	2012
Total market economy	43.84	44.81
Agriculture	79.71	82.68
Manufacturing	12.12	15.41
Extended Mining	38.20	35.35
Construction, Retail and Telecom	44.83	44.77
Transport	21.43	27.17
Finance and Business Services	8.06	9.74

Note: Relatively high shares of informal segment in Extended Mining are caused by high informality in some organizations of Wholesale Trade. However, it is unclear if these organizations provide some specific energy-export oriented services or other wholesale trade activities.

Table 3. Measures of labour productivity *level* distribution in industries in 2005-2012

	NO Split	Informal Split
Mean	1.79	1.32
Standard deviation	2.33	2.20
Skewness	3.05	3.82
Kurtosis	12.46	20.20

Note. Labour productivity in industries refers to nominal value added over hours worked. Industry productivity levels are normalized to the level of total economy of a corresponding year.

Table 4. Measures of labour productivity *growth rates* distribution in industries in 2005-2012

	NO Split	Informal Split
Mean	3.09	3.09
Standard deviation	11.10	15.26
Skewness	-1.72	-0.79
Kurtosis	9.51	4.95

Note. Labour productivity growth rates are measured in yearly average growth rates.

Table 5. Sectoral, within and between contributions to aggregate labour productivity growth, obtained with TRAD decomposition, in 1995-2012 (p.p.)

	Total	Within	Between
	1 = 2 + 3	2	3
Total market economy	92.5	71.3	21.2
Agriculture	1.6	4.6	-3.0
Manufacturing	9.8	13.6	-3.8
Extended Mining	29.1	19.0	10.1
Construction, Retail and Telecommunications	24.8	13.2	11.6
Transport	5.1	4.7	0.4
Finance and Business Services	22.2	16.2	6.0

Note: In this decomposition informal split is *not* taken into account. Constant prices of 2005 are used. An example of interpretation of this table is following. By 2012 labour productivity level of market economy grew by 92.5 % relative to the level of 1995. These growth rates can be split into contributions of the sex sectors, as well as of aggregated within (71.3 p.p.) and between (21.2 p.p.) effects. In turn, the contribution of each sector can be represented as the sum of corresponding within and between components. For example, the contribution of Manufacturing, 9.8 p.p., is the sum of corresponding within (13.6 p.p.) and between (-3.8 p.p.) components.
Source: authors' calculations on the basis of Russia KLEMS dataset.

Table 6. Sectoral, within and between contributions to aggregate labour productivity growth, obtained with TRAD decomposition, in 2005-2012 (p.p.)

	Total	NO informal split		Informal split	
		Within	Between	Within	Between
	1 = 2+3 = 4+ 5	2	3	4	5
Total market economy	28.01	23.54	4.47	24.40	3.61
Agriculture	0.40	0.96	-0.56	1.34	-0.94
Manufacturing	1.36	2.54	-1.18	3.46	-2.10
Extended Mining	8.28	8.02	0.27	7.09	1.19
Construction, Retail and Telecom	8.91	6.94	1.96	7.01	1.90
Transport	1.26	0.94	0.32	1.53	-0.27
Finance and Business Services	7.80	4.13	3.67	3.97	3.83

Note: Constant prices of 2005 are used. An example of interpretation of this table is following. By 2012 labour productivity level of market economy grew by 28.01 % relative to the level of 2005. These growth rates can be split into contributions of the six sectors, as well as of aggregated within (23.54 p.p.) and between (4.47 p.p.) effects. In turn, the contribution of each sector can be represented as the sum of corresponding within and between components. For example, the contribution of Manufacturing, 1.36 p.p., is the sum of corresponding within (2.54 p.p.) and between (-1.18 p.p.) components with *no* informal split or within (3.46 p.p.) and between (-2.10 p.p.) components with the presence of informal split.
Source: authors' calculations on the basis of Russia KLEMS dataset.

Table 7. Sectoral, within and between contributions to aggregate labour productivity growth, obtained with CSLS decomposition, with informal split in 2005-2012 (p.p.)

	Total	Within	Between total
	1 = 2 + 3	**2**	**3**
Total market economy	28.01	24.40	3.61
Agriculture	2.76	1.34	1.42
Manufacturing	2.87	3.46	-0.59
Extended Mining	8.21	7.09	1.12
Construction, Retail and Telecom	6.45	7.01	-0.56
Transport	1.01	1.53	-0.53
Finance and Business Services	6.71	3.97	2.74

Note: Constant prices of 2005 are used.
Source: authors' calculations on the basis of Russia KLEMS dataset.

Table 8. Sectoral within and between contributions to the aggregate labour productivity growth, obtained with GEAD decomposition, in 2005-2012 with the informal split (p.p.)

	Total	Within	Between total
	1 = 2 + 3	**2**	**3**
Total market economy	26.10	24.40	1.69
Agriculture	0.18	1.34	-1.16
Manufacturing	2.82	3.46	-0.64
Extended Mining	10.56	7.09	3.47
Construction, Retail and Telecom	6.47	7.01	-0.54
Transport	0.78	1.53	-0.75
Finance and Business Services	5.28	3.97	1.31

Source: authors' calculations on the basis of Russia KLEMS dataset.

Table 9. Sectoral contributions to the aggregate labour productivity growth, obtained with the GEAD-3f decomposition, in 2005-2012 with the informal split (p.p.)

	Total	Within	Between total	Relative prices effect	Labour reallocation effect
	1 = 2 + 3	**2**	**3 = 4 + 5**	**4**	**5**
Total market economy	26.10	23.46	2.63	-0.35	2.98
Agriculture	0.18	1.21	-1.03	-0.21	-0.82
Manufacturing	2.82	3.20	-0.38	1.54	-1.92
Extended Mining	10.56	6.97	3.59	2.44	1.14
Construction, Retail and Telecom	6.47	6.46	0.01	-1.80	1.81
Transport	0.78	1.59	-0.81	-0.59	-0.22
Finance and Business Services	5.28	4.03	1.26	-1.73	2.99

Source: authors' calculations on the basis of Russia KLEMS dataset.

Table 10. Total reallocation, Denison and Baumol effects for total market economy in 2005-2012 (p.p.)

	Total Reallocation effect	Denison effect	Baumol effect
	1 = 2 + 3	**2**	**3**
TRAD/CSLS, NO informal split	4.47	3.44	1.03
TRAD/CSLS, informal split	3.61	2.85	0.76
GEAD, NO informal split	2.56	4.38	-1.82
GEAD, informal split	1.69	3.66	-1.97

Note: the TRAD and CSLS decompositions are the constant prices of 2005

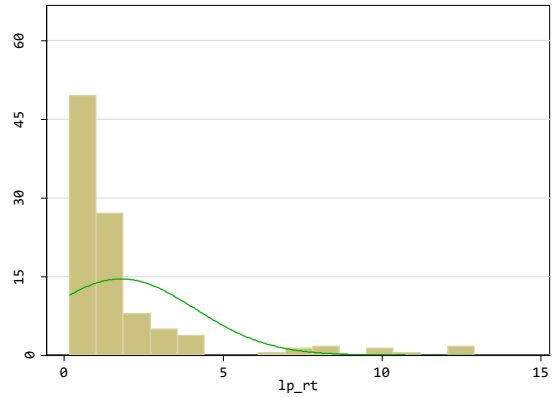
Source: authors' calculations on the basis of Russia KLEMS dataset.

Fig. 1. Trends of real value added, hours worked and labour productivity in 1995-2012 in total market economy (1995=100)

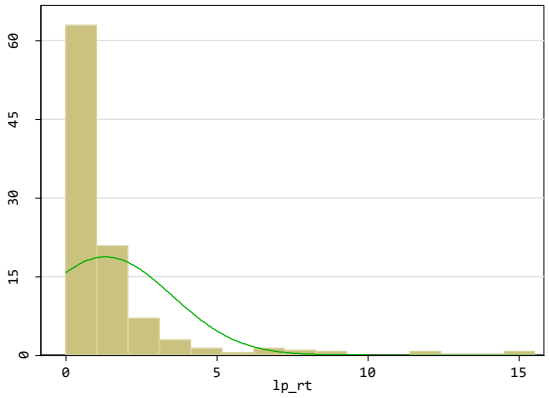
Note: Market economy includes all industries except those, where non-market services dominate, such as Public Administration, Education, Healthcare and Real Estate.
Sources: authors' calculations on the basis of Russia KLEMS.

Figure 2. Distributions of labour productivity levels across industries in 2005-2012

A. Total industries with no informal split.



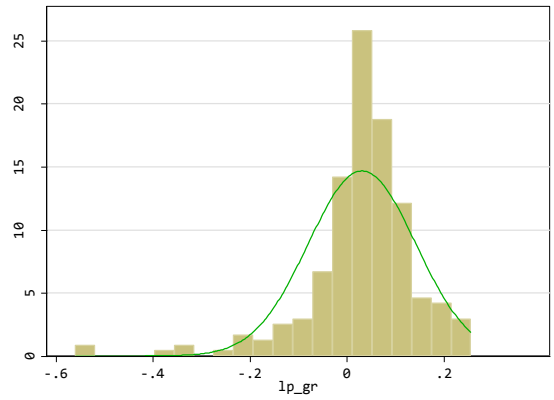
B. Industries with the informal split



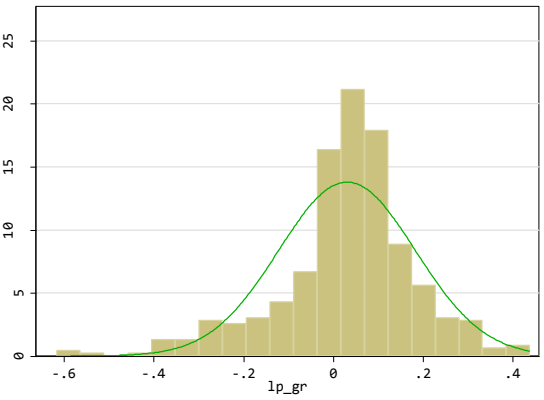
Note. Labour productivity level in an industry refers to the nominal value added per hour worked, normalized to the aggregate labour productivity level of a corresponding year.
Sources: authors' calculations on the basis of Russia KLEMS. See main text.

Figure 3. Distributions of labour productivity growth rates across industries in 2005-2012

A. Total industries with no informal split.

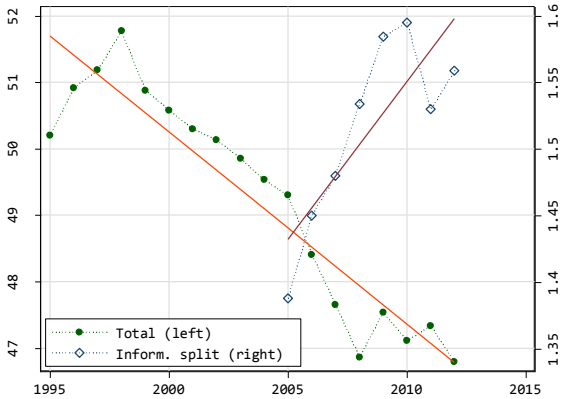


B. Industries with the informal split

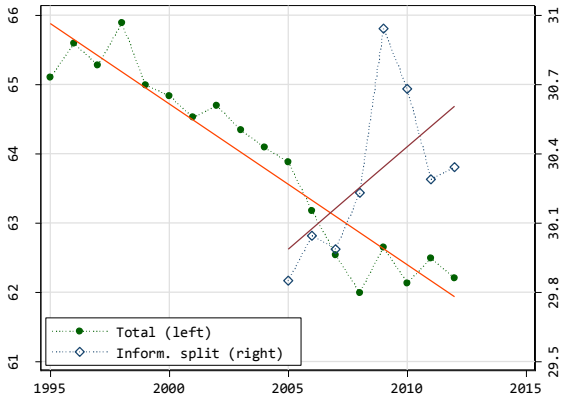


Note. Labour productivity growth rate in an industry relative to the previous year is defined as the difference in growth rates of the real value added of this industry and its hours worked.
Sources: authors' calculations on the basis of Russia KLEMS. See main text.

Figure 4. Labour share trends of the lowest labour productivity level groups of industries



A. The lowest 10% group



B. The lowest 25% group

*Note***:** See Appendix 2 for the content of the groups

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Appendix 1. The list of industries and sectors

#	**Industry**	**Aggregated sector**
AtB	Agriculture, Hunting, Forestry and Fishing	Agriculture
15t16	Food, Beverages and Tobacco	Manufacturing
17t18	Textiles and Textile Products	Manufacturing
19	Leather, Leather and Footwear	Manufacturing
20	Wood and Products of Wood and Cork	Manufacturing
21t22	Pulp, Paper, Paper , Printing and Publishing	Manufacturing
25	Rubber and Plastics	Manufacturing
26	Other Non-Metallic Mineral	Manufacturing
27t28	Basic Metals and Fabricated Metal	Manufacturing
34t35	Transport Equipment	Manufacturing
36t37	Manufacturing, Nec; Recycling	Manufacturing
23	Fuel	Extended Mining
C	Mining and quarrying	Extended Mining
51	Wholesale trade	Extended Mining
F	Construction	Construction, Retail and Telecom
H	Hotels and Restaurants	Construction, Retail and Telecom
50	Sale, Maintenance and Repair of Motor Vehicles and Motorcycles	Construction, Retail and Telecom
52	Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods	Construction, Retail and Telecom
64	Post and Telecommunications	Construction, Retail and Telecom
O	Other Community, Social and Personal Services	Construction, Retail and Telecom
60	Inland Transport	Transport
61	Water Transport	Transport
62	Air Transport	Transport
63	Other Transport Services	Transport
J	Financial intermediation	Finance and Business Services
71t74	Renting of Machinery and Equipment and Other Business Activities	Finance and Business Services

Appendix 2. The least productive group of industries

INDUSTRIES, 10% group, Informal split = 0

BROAD DEF: 17t18 19 20 29 52 AtB

NARROW DEF: AtB

INDUSTRIES, 25% group, Informal split = 0

BROAD DEF: 17t18 19 20 29 30t33 34t35 52 61 71t74 AtB H O

NARROW DEF: 17t18 19 AtB O

INDUSTRIES, 10% group, Informal split = 1

BROAD DEF: 17t182 192 202 262 292 30t332 34t352

NARROW DEF: 17t182 192 202 292 34t352

INDUSTRIES, 25% group, Informal split = 1

BROAD DEF: **15t162** 17t182 192 202 21t222 242 252 262 27t282 292 30t332 34t352 36t372 612 632 AtB2 **F2 O2**

NARROW DEF: 15t162 17t182 192 202 21t222 252 262 292 30t332 34t352 36t372