BOFIT Discussion Papers
18 • 2017

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BOFIT Discussion Papers
Editor-in-Chief Zuzana Fungáčová

BOFIT Discussion Papers 18/2017
28.11.2017

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ISBN 978-952-323-198-6, online
ISSN 1456-5889, online

Suomen Pankki
Helsinki 2017

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Abstract

Intensive growth, structural change and expanding informality has characterized many developing and emerging economies in recent decades. Yet most empirical investigations into the relationship between structural change and productivity growth overlook informality. This paper includes the informal sector in an analysis of the effects of structural changes in the Russian economy on aggregate labour productivity growth. Using a newly developed dataset for 34 industries covering the period 1995–2012 and applying three alternative approaches, aggregate labour productivity growth is decomposed into intra-industry and inter-industry contributions. All three approaches show that the overall contribution of structural change is growth-enhancing, significant and attenuating over time. Labour reallocation from the formal sector to the informal sector tends to reduce growth through the extension of informal activities with low productivity levels. Sectoral labour reallocation effects are found to be highly sensitive to the methods applied.

Keywords: labour productivity, structural change, informal economy, Russia.
JEL Codes: O11, O17, C82, N14.

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Acknowledgements
I acknowledge support from the HSE Basic Research Program, and thank Vladimir Bessonov, Rostislav Kapelyushnikov and Boris Kuznetsov for their valuable comments and suggestions. I owe a special thanks to Vladimir Gimpelson, who helped me in early stages of this project. I thank Greg Moore for excellent proofreading, which improved the draft substantially. Various versions of this paper have been presented in the research seminar of the department of economics at Higher School of Economics (20 May 2015), the research seminar at the Bank of Finland's Institute for Economies in Transition (13 October 2015), the 34th General IARIW Conference in Dresden (25 August 2016) and at a conference in honour of Elinor Ostrom "Informality and Development" at the Indiana University, Bloomington (23 October 2016). The participants and discussants in these events provided many valuable comments. The usual disclaimer on errors and omissions applies.

1 Introduction

The past two decades witnessed intensive growth and structural change in emerging and developing economies (Diao, McMillan and Rodrik, 2017). Many such economies are characterized by sizable informal sectors that account for the substantial share of employment and value-added production (Hassan and Schneider, 2016).

Vries et al. (2012, p. 219) observe that when formal and informal activities within industries are not distinguished, estimation of the impact of structural change on growth may be biased. Researchers have also begun to explore the link between informality and productivity. Restuccia (2013, 93), for example, asserts that informality is the response of less productive entrepreneurs to tightened regulations.

Indeed, informality itself can create economy-wide distortions that are harmful to productivity. McKinsey (2006), for instance, singles out informality as a major reason for the productivity gap between Brazil and the US.[1] Marcouiller et al. (1997) identifies informality as the cause of low productivity growth in construction, manufacturing and retailing in Latin America. Using Mexico as his subject, Leal-Ordóñez (2014) specifies three types of distortions induced by the informal sector: misallocation of resources to small, stagnant plants; distortions in occupational choices; and distortions in capital use in informal establishments. Such distortions were earlier found to lower Mexican productivity in manufacturing, retail, wholesale and services (Busso, Fazio and Levy, 2012).

Even with new research, few empirical studies deepen our understanding of the impact of structural change on productivity growth when labour outflow to the informal sector is explicitly included. The exception is Vries et al. (2012), which shows that expanding informality generated a growth-reducing reallocation effect in India, while a shrinking informal sector in Brazil produced a growth-enhancing labour reallocation. Vries et al. (2012) apply a conventional shift-share analysis to a decomposition of aggregate labour productivity growth into inter-industry and intra-industry components. Their approach is in line with the pioneering works of Fabricant (1942) and Denison (1962), but still suffers from basic shortcomings. In particular, De Avillez (2012) points to the possible counter-intuitive interpretation of the contributions of labour reallocation in industries to aggregate labour productivity growth. Dumagan (2013) also highlights the problem of fixed weights in this approach, as well as its dependence on aggregation formulae.

[1] See also Üngör (2017).

The case of the post-transition Russia is remarkable in this context. Kapelyushnikov et al. (2012) consider informality as a significant outcome of the shock therapy approaches applied in the early 1990s to speed up the transition from planned economy to market economy. Not only does this historical episode well illustrate the concept of "second-best institutions" suggested by Rodrik (2008), but highlights the struggle to adapt to labour market legislation based on first-best practices of developed economies. Informality emerges as an obvious solution in a weak institutional environment with poor state enforcement that forces firms and workers to adapt. Thus, Russia's transition created the pre-conditions for expansion of its informal economy.

This shift of labour into the informal sector has continued for a quarter of a century, even during the boom years of the Russian economy (1999–2008). Although the informal sector smoothed the negative consequences of the shock therapy in Russia, absorbing excessive labour, its consequences for productivity growth, as Kapelyushnikov et al. (2012) point out, was harmful in two respects.[2] First, employment contracts were poorly enforced, so employees had little incentive to invest in improving their skills (i.e. increase human capital). Second, the persistence of obsolete jobs hindered the emergence of jobs relevant to changed economic circumstances.

The present paper has two key aims. First, it considers the impact of expanding informality on labour productivity growth in Russia. For this, I develop a new industry-level data set that includes variables for output and labour input for the period 1995 to 2012. It draws upon industry-level series from the Russia KLEMS database (Timmer and Voskoboynikov, 2016) and splits them into formal and informal segments.[3] Second, in addition to the traditional approach, I apply two newer methods to the shift-share analysis. These newer methods are better tailored for strong volatility of domestic relative prices than the traditional approach (Tang and Wang 2004; Sharpe 2010).

This study is a novel attempt to assess the impact of structural change on growth of the Russian economy.[4] I decompose aggregate labour productivity growth into intra-industry and inter-industry contributions. All three approaches (traditional plus the two new methods) provide consistent evidence of a link between structural change and productivity. *Overall*, structural change in Russia has been growth-enhancing, significant and attenuating over time. Explicit estimation of labour reallocation between formal and informal sectors of the economy, something new in the case

[2] In this context, Kapelyushnikov et al. (2012) also mentions informal relations within firms and assumes that such relations help inefficient firms to survive. Here, I do not deal with the effect of informality *within* firms, focusing on producers formally associated with some legal entity such as a registered company (formal segment) and all other organizational forms of production (informal segment).
[3] See Appendix A on the usage of terms formal/informal sectors and segments through the text.
[4] Vries et al. (2012) apply a conventional shift-share analysis to the Russian economy in 1995–2009. They use an earlier release of the Russia KLEMS dataset (1995–2009) with no informal split.

of Russia, leads to a reduction in the overall contribution effect due to expansion of the informal segments of industries with low productivity levels. At the same time, *sectoral* labour input reallocation effects, which are discussed in the literature,[5] are found to be highly sensitive to the assumptions of the methods and to the presence of the informal split.

Following the official definition of the Russian statistics office (Rosstat), a worker is considered informal if they are not employed by a corporation or some other legally recognized entity.[6] Because our focus is on labour reallocation between formal and informal segments, I also disaggregate data for each industry by informal and formal segments. While there is a long discussion in the literature on how to define informality, I rely here on a simple definition that associates informality with properties of the firm or enterprise, rather than the worker.[7]

Finally, the limitations to the present study should be mentioned. Consideration of informality problem at the industry level ignores the contribution of labour reallocation between firms within an industry, which can be significant.[8] I am also limited to the definition of informality used in the Russian system of national accounts, which, while not entirely satisfactory, is at least consistent. Of course, the share of informality depends on its definition as we see in the household survey data.[9] However, from a macro perspective, it is the only definition that considers the economy as a whole, rather than the corporate sector for firm-level surveys. Moreover, it is consistent with the total economy measure of economic growth.

The paper has the following structure. Section 2 presents alternative approaches to the shift-share analysis that are used in the following sections. Section 3 describes the process of data construction and sources. Section 4 overviews major industry-level productivity and employment trends and points out productivity gaps between formal and informal segments of the economy that are essential for the analysis. Section 5 discusses the outcomes of decomposing labour productivity growth rates into *intra*- and *inter*-industry effects. Section 6 concludes.

[5] See e.g. Diao, McMillan and Rodrik (2017).
[6] Formally, Rosstat classifies a worker as informal, if he or she is a non-incorporated entrepreneur or an employee of such an entrepreneur, if he or she is engaged in a farm enterprise or works in his or her own household and produces goods and services for own consumption (Kapelyushnikov 2012, 21). This definition is not entirely satisfactory, but it is the only one that is consistent with Russian national accounts.
[7] Alternative definitions of informality and their application to the Russian employment are discussed by Lehman and Zaiceva (2013), Gimpelson and Kapelyushnikov (2015) and Lehman (2015).
[8] See e.g. Brown and Earle (2008).
[9] Surveys of Lehmann and Zaiceva (2013) and Gimpelson and Kapelyushnikov (2015).

2 Approach to structural decomposition

Reallocation of workers across industries contributes to aggregate labour productivity growth. Many studies have described this phenomenon,[10] but the strand originates from the study of Fabricant (1942), which decomposes the increment of aggregate labour productivity growth into intra-industry and inter-industry components. The former is caused by accumulation of human and physical capital, intangible assets and technological progress.[11] The latter depends on structural changes in the economy. Assuming the additivity of output in constant prices

$$\bar{\bar{Y}}^t = \sum_n^N \bar{\bar{Y}}_n^t,^{12} \tag{1}$$

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

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

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.[13]

Vries et al. (2012, sec. 4) show 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

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

[10] See the review in (G. de Vries, Timmer, and Vries 2015).
[11] The contribution of multifactor productivity growth, which is usually interpreted as the outcome of technological change, may also be explained in terms of a temporary disequilibrium that is caused by a delayed reaction to technological changes in previous periods, terms of trade, low mobility of labour and capital, as well as various competitive barriers. (Reinsdorf, 2015).
[12] For brevity's sake, we skip summation indices. A variable is marked with a double bar if it depends on output in constant prices with fixed weights (Laspeyres index formula).
[13] Diewert (2014) notes that interpreting sectoral contributions to structural change may be difficult. Say an increase of labour share of one industry is offset by changes in labour shares of other industries. If the number of industries involved is greater than two, there is no way to determine how the increase of the labour share of a certain industry is offset by decreases in labour shares of the other industries. The same logic applies to changes in relative prices. The *total reallocation effect*, of course, remains correct. Thus, sectoral contributions should be considered as the labour input reallocation effect rather than sectoral contributions to structural change.

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

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

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

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

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

Here $\gamma \equiv \Delta X/X_0$ represents 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 Denison (1962) and, following Dumagan (2013), we refer to it as TRAD. 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 the "between" effect. Nordhaus (2002) labels these the "Denison" and "Baumol" effects.

The *Denison effect* is the contribution of labour reallocation between industries with different productivity levels. It explains why labour productivity acceleration in a certain industry can be harmful for the economy by slowing aggregate productivity growth. To illustrate, consider two industries in the economy, with industry A more productive than B $\left(\bar{\bar{X}}^0_A > \bar{\bar{X}}^0_B\right)$. Because of, say, technology improvements in industry A its labour productivity level goes up, while the rest of the economy remains unchanged. Under the condition of constant demand for their product, industry A starts releasing workers, who find new jobs in B. As a result, the labour share shrinks in industry A $\left(\Delta s_{L,A} < 0\right)$ and expands in industry B $\left(\Delta s_{L,B} > 0\right)$, being both equal in absolute magnitude, or $\Delta s_{L,B} = -\Delta s_{L,A}$. At this point, the terms of industries A and B in the Denison effect component of (5) are

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

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 the *initial* productivity of A is higher than B. It also follows from (6) that 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 (1962) even mentions that the aggregate labour productivity growth can be negative even if productivity growth in all industries is nil.

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 industries with low growth (Baumol, 1967).

The literature mentions a counterintuitive interpretation of reallocation in certain cases of TRAD.[14] For example, consider industry *n* with a below-average productivity level. Intuitively, if *n* 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. Similarly, when the employment share of an industry with below-average productivity shrinks ($\sigma_n < 0$), 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 is also positive.

To resolving this, an alternative approach was developed at the Centre for the Study of Living Standards (CSLS) and implemented in the series of publications (De Avillez, 2012) that account for the difference between productivity levels in an industry and the economy as a whole. With some algebra, we get the explicit expression for the CSLS decomposition:

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

Compared against each other, we see that the first term is the same in both the TRAD and CSLS equations, (5) and (7) respectively. However, industry-level components of the second term in (7), the Denison effect, become negative if employment increases in an industry with a below-average level of labour productivity. In this case, $\sigma_n\left(s^0_{\bar{\bar{Y}},n} - s^0_{L,n}\right) = \Delta s_{L,n}\left(\frac{\bar{\bar{X}}^0_n}{\bar{\bar{X}}^0} - 1\right) < 0$. By analogy, the Baumol effect in the case of a low-productivity shrinking industry is positive.

A major source of uncertainty of TRAD and CSLS is the assumption in (1) of additivity of output in constant prices. Since (1) holds if aggregated output is calculated with fixed weights in constant prices for a certain base year, the output series are sensitive to the choice of year. This measurement uncertainty increases with larger changes in relative prices of the current year relative to the base year. Such dramatic changes are not limited to transition economies. Indeed, large changes in prices in developed economies typically have come from rapid development of information and communications technologies (Nordhaus, 2002), while transition economies experienced smoothing of multiple distortions of the planned economy period (Campos and Coricelli,

[14] See e.g. De Avillez (2012) and Reinsdorf (2015).

2002). Global oil prices are a source of large variations in relative prices specific to the Russian economy.

As recommended by the System National Accounts, the conventional solution for this mis-measurement problem is the substitution of volume indices in constant prices with chained volume indices.[15] In such case, the exact additivity assumption (1) no longer holds and requires some other approach to the shift-share analysis that is consistent with the chained volume indices system. The suggestion of Tang and Wang (2004) is the Generalized Exactly Additive Decomposition (GEAD).[16] The counterpart of (1) in GEAD is the additivity of output V in current, rather than constant, prices, so

$$V = \sum V_n. \tag{8}$$

Here, 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

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

where $p_n \equiv (P_n/P)$ 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

$$X = \sum s_n X_n, \tag{10}$$

and, with small manipulations, aggregated labour productivity growth as

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

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 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, along with the superiority in terms of the fixed weights problem, GEAD has two additional advantages over TRAD. First, the "within" component in GEAD, i.e. the first term in (11), depends only on industry price deflators. In TRAD, i.e. the first term in

[15] (System of National Accounts, 1993: 1.17, System of National Accounts 2008: 15.21). For more on chain volume output indices in Russian statistics see Rosstat (2014, section 3).
[16] See also the literature reviews in Balk (2014) and Reinsdorf (2015).

(5), it also rests on the price deflator for the total economy.[17] In other words, the TRAD decomposition is sensitive to the relationship between industry-level deflators and the aggregated deflator. Second, unlike TRAD, GEAD recognizes changes in aggregate productivity growth that are 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.

All three methods are implemented in the present study. The TRAD method assumes fixed relative prices for industry products. It is widely used in the literature for the analysis of structural changes and the literature provides a rich context for comparisons across time and space. In addition, it provides an opportunity for interpretation of the reallocation effect as the sum of two effects, i.e. labour reallocation between industries with different productivity levels (Denison effect) and growth rates (Baumol effect). The second method, CSLS, uses the same assumption of fixed product weights as TRAD, but provides a better intuitive interpretation than TRAD for sectoral contributions to structural change. Finally, weakening the limitation of fixed relative prices leads to GEAD. This approach allows us to explore splits of the reallocation effect into Denison and Baumol components.

There is a peculiarity in the interpretation of sectoral contributions to structural change. As noted in footnote 14, Diewert (2014) raises the point difficulty of interpretation if we treat a term like $\sum s_{X,n}^{0}\,(s_n^1 - s_n^0)$ in (11) as independent. The increase of labour share of the industry is offset by changes in labour shares of other industries. If the number of industries is greater than two, however, there is no way to determine how the increase of the labour share of a certain industry is offset by decreases in labour shares of the other industries. At the same time the total reallocation effect remains correct. Thus, each member of sum $\sum s_{X,n}^{0}\,(s_n^1 - s_n^0)$ should be considered as sectoral the effect of the change in the sectoral labour share, rather than the sectoral contribution to structural change.

Considering the rich literature on structural change and labour productivity growth,[18] the list of these three decompositions is hardly comprehensive or perfect.[19] At the same time, the discussed framework amounts to the coherent system of methods with the well-developed economic interpretation. The following sections show how these methods work for the case of Russia.

[17] See equations (4.1) and (4.2) in (Dumagan, 2013) for an explicit exposition.
[18] See, for example, the alternatives in the following studies (G. J. de Vries et al., 2012; Diewert, 2014; Reinsdorf, 2015).
[19] See more about shortages and limitations in (Timmer and Szirmai, 2000; G. J. de Vries et al., 2012; and Reinsdorf, 2015)

3 Data

Shift-share analysis methods require industry-level time series data on nominal value added, real value added and labour input. To account for informality, we need to split these series into formal and informal segments for each industry.

The first best option of the data source is the official National Accounts series. However, in case of Russia, Rosstat provides consistent industry-level series only from 2003. The only alternative data source with a time series back to 1995 is Russia KLEMS (Timmer and Voskoboynikov, 2016; Russia KLEMS 2017). This dataset includes backcast estimations of output and inputs back to 1995 that are consistent with the total economy level official SNA series in 1995–2002 and the official industry-level SNA series thereafter.

Next step, we break down the industry-level series into formal and informal segments. As mentioned in the introduction, a worker is considered informal if they are *not* working for a corporation or other recognized legal entity. 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 through various indirect estimates in accordance with international guidelines.[20] The share of the informal segment in value added is assumed to be the share of household's sector in total value added of a particular industry.[21] Unfortunately, this subset of data is available at the one-digit level only. For example, manufacturing includes thirteen industries, among which the informal segment in 2005 varied from 3% of hours worked in "Electrical and optical equipment" (code 30t33 in Appendix B) 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.

The share of hours worked in the informal segment of each industry is calculated with data on hours worked in total and in the corporate sector (available starting from 2005).

[20] The methodology description for assessing output and value added of the economy, including the informal segment, is available from Rosstat (1998). OECD (2002) provides a general international overview of practices.

[21] Rosstat publishes this data. See, for example, (Rosstat, 2014, Table 2.3.44), as well as similar publications for previous years. Since 2002, Rosstat has also released shares of value added adjusted for unobserved economic operations (e.g. Rosstat, 2010, Table 2.3.46-52). The former datasets have the advantage that the share of the sector of households agrees with the share of unobserved economic operations up to 2009. In the succeeding years, the latter falls much faster than the former, which suggest some unreported changes in methodology. I thank Rostislav Kapelyushnikov for enlightening me on this issue.

There are two exceptions in application of this general approach. First, we set informal share in mining (C) and financial intermediation (J) to zero. Official data estimates for value added in these industries produced by SMEs are less than 0.2% and 1%, respectively.

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

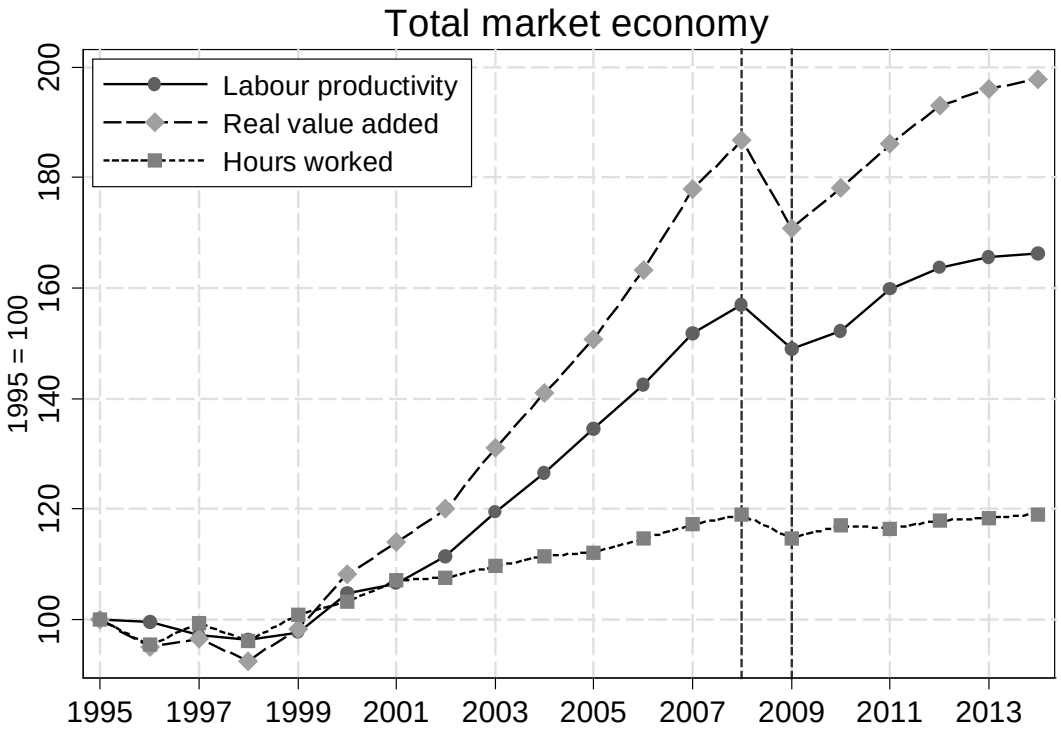
4 Trends of productivity growth in Russia: shocks and adaptation

A peculiarity of the Russian growth pattern in recent decades has been relatively stable employment amidst highly volatile output. This characterized the transformational recession in 1991–1998, the post-transition recovery in 1999–2008 and the stagnation that followed the global financial crisis in 2009 (Kapelyushnikov, Kuznetsov and Kuznetsova, 2012). Figure 1 shows that real value added of the total market economy doubled during 1999–2008, yet employment grew by less than 24%. Another example of this is the reaction of the economy on the global crisis of 2009. While output plummeted by 8.9% in 2009 relative to 2008, the fall of employment was just 3.6%. Although all transition economies passed through the stages of the transformational recession and a subsequent post-transition recovery, albeit with varying depth and duration,[22] the employment trends of most economies of Central and Eastern Europe followed GDP growth rather closely. Market reforms in CEEs triggered unemployment rates that kicked up above 10% almost immediately. In contrast, the Russian unemployment level only reached 10% in the sixth year of reforms and peaked at 13.3% in 1998.

This phenomenon highlight a distinctly Russian approach to labour market adjustment to external shocks. It is apparent from the shock therapy episodes in early transition (Layard and Richter, 1995), which saw the emergence of a wide range of informal arrangements between employers and employees to help absorb the impacts of external shocks. In additions to appropriate adjustments in wages and hours worked, Russians could turn to job opportunities in the informal segment (Kapelyushnikov, Kuznetsov and Kuznetsova, 2012).[23] Workers who lost their jobs at registered firms workers could find work in the informal sector.

[22] See (Campos and Coricelli, 2002) for a comprehensive review.
[23] Gimpelson and Kapelyushnikov (2013) also provide an excellent literature review.

Figure 1 Trends of real value added, hours worked and labour productivity in total market economy, 1995–2014 (1995=100)



Sources: (Timmer and Voskoboynikov, 2016; Russia KLEMS, 2017).

Note: Market economy includes all industries where non-market services do not dominate. I follow the industry growth accounting literature (e.g. Timmer et al., 2010), in which public administration, education, healthcare and real estate are considered non-market services and excluded from market economy.

Such reallocation does not significantly alter total hours worked in the economy, but it does influence the structure of the economy and increases the share of the informal segment.

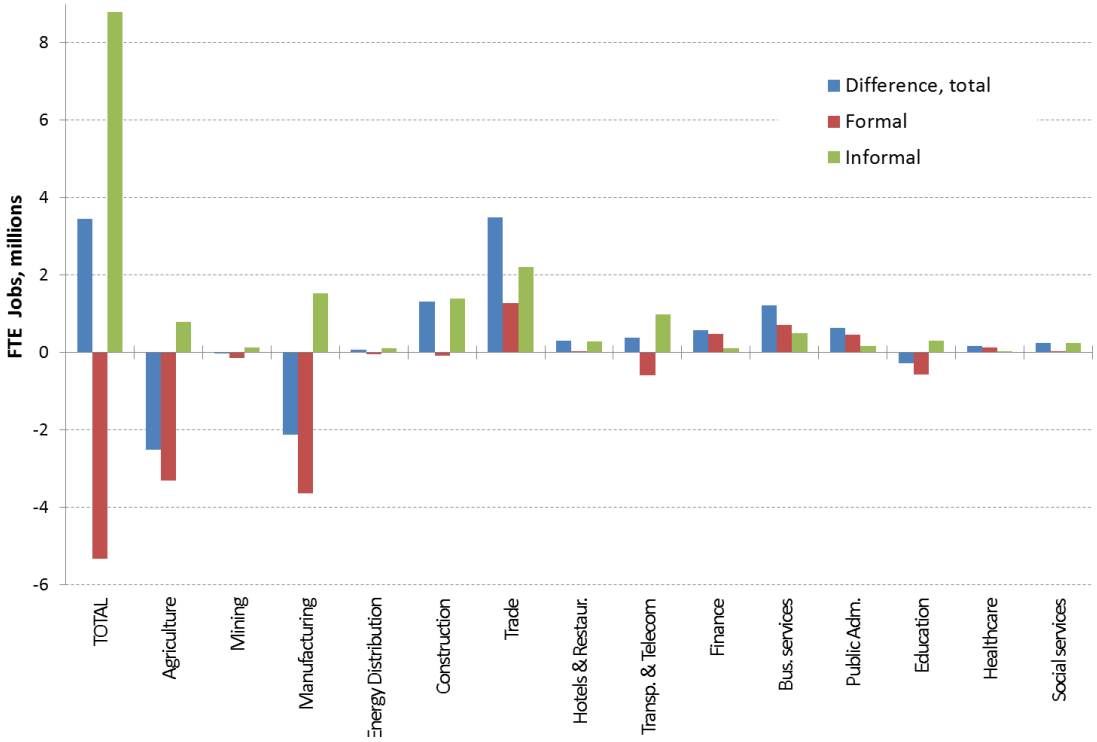
The corresponding changes in the employment structure in 2000–2013 are presented in Figure 2. The small net change in jobs of nearly 3.5 million over thirteen years (mostly in years of high growth),[24] masks the huge inflow of 8.8 million jobs to the informal segment and the significant outflow of 5.3 million jobs from formal organizations. The most significant losses of formal jobs were in manufacturing (3.7 million) and agricultural firms (3.3 million), while new informal jobs were created gained in construction (1.4 million), trade (1.3 million), transport (1.0 million) and business services (0.5 million). This is more or less in line with expectations about traditional sectors with the significant labour shares of informal workers.

What stands out is the remarkable cross-flow of jobs between formal and informal segments within manufacturing and transport. This seems to indicate that some manufacturing workers

[24] Some similarities of the countercyclical expansion of informality in Russia may be found in Mexico. See Fernández and Meza (2015).

preferred staying in profession, but are willing to leave large corporate enterprises for small workshops.

Figure 2 Change in number of workers in total economy and major sectors, 2000–2013



Sources: Labour Force Survey, Rosstat.

The overall the impact of the Russian approach to labour market adjustment to the initial shock therapy of plan-market transition, as well as the shocks of 1998 and 2008, is ambiguous. On the one hand, this approach provides a level of social stability through the relatively low level of unemployment due to the absorption of the formal segment's shed labour by the informal segment. On the other hand, such labour reallocation to low productive informality influences aggregate labour productivity growth, resulting in drastic changes in the structure of employment. Figure 2 illustrates the rise in the number of workers in informal segment in the economy.

The other proximate factors that contribute to aggregate labour productivity growth come from two sources: changes in the performance of industries, which fuelled mostly by investments to physical and human capital and innovations, and labour reallocation across industries. Timmer and Voskoboynikov (2016) note that the first source of labour productivity growth is driven by capital intensity in low-skill-intensive services and extended mining, and by technology the global frontier catching-up in manufacturing, financial intermediation and business services. Labour reallocation, the focus of this study, reflects fluctuations in the industrial structure of the economy. The

impact of labour reallocation increases with greater structural changes and differences in productivity across industries.

Before tackling the reallocation effects among 30 industries of Russia's market economy, I combine them into six sectors: agriculture, manufacturing, extended mining, market services (e.g. construction, retail and telecommunications), transport, and finance and business services.[25] These broader sector descriptions present their own challenges. Agriculture and manufacturing are conventional sectors within the three-sectoral analysis in development economics, but the role of agriculture in Russia is still fairly large. Specifically, farm work occupies a larger share of the labour force than in other post-industrialized and post-transition economies at similar levels of development. Extended mining is considered separately because of its size and the specific role in the Russian economic performance. It includes mining, wholesale trade and fuel. It also accounts for the lion's share of Russia's oil and gas (Timmer and Voskoboynikov, 2016).

Services employ a large share of workers in developed economies and their roles are quite diverse (Jorgenson and Timmer, 2011). For this reason, I split services into three sectors. Transport is notable for its high capital intensity. Workers engaged in finance and business services are different from the rest of market services activities as they have fairly high of average level of skills and education (O'Mahony and Ark, 2003). This makes these industries distinct in terms of labour productivity performance.

I exclude public administration, education and healthcare altogether due to the poor quality of productivity measures in non-market services in National Accounts (Timmer et al., 2010).

The Russian economy has experienced intensive structural changes over the past two decades. The structure of the economy in 1995, three years after transition, still incorporated elements of the planned economy and early transition distortions. Almost 60% of hours worked went to producing goods (agriculture and manufacturing). Surprisingly, over one-third of labour in market economy fall at agriculture in the early days of transition. This proportion, enormous for a post-industrial economy, mainly reflects labour- intensive non-market households producing agricultural products for their own consumption (Gimpelson and Kapelyushnikov, 2015). These household arrangements are labour intensive and low productivity relative to agricultural firms, accounting for around 12% of total hours worked and more than half of hours worked 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 services gradually crowding out goods as the focus of labour activity. The shift in demand from goods to services reflects rising incomes, an overcoming

[25] The composition of these sectors is represented in Appendix B.

of the planned economy over-industrialization, competition with Asia in manufactured goods and, starting in 1999, an expansion of extended mining during a period of soaring global oil prices. Table 1 shows shares of sectoral hours worked and value added in 1995 and 2012. The share of agriculture in total hours worked falls from 28% to 21%, while the share of manufacturing decreases from 19% to 15%. These figures contrast sharply with the expansion of the construction, retail and telecom sector (CRT) from 20% to about 28% of total hours worked.

No less impressive is the structural change in value added. The share of agriculture almost halves, the share of manufacturing decreases from 7.6% to about 4%. Transportation sinks from 11.7% to 6.8%. At the same time, mining, finance and business services increase their relative shares of GDP. The aggregate shares of retail, construction and services are largely unchanged.

Table 1 Sectoral shares in 1995 and 2012, %

Sectors	Value added		Hours worked	
	1995	2012	1995	2012
Total economy	100.0	100.0	100.0	100.0
Market economy	86.1	81.7	80.9	79.6
Agriculture	7.6	3.9	27.9	20.9
Manufacturing	22.4	14.9	18.8	15.1
Extended mining	20.1	25.0	3.5	4.5
Construction, retail and telecom	19.2	20.1	19.7	27.5
Transport	11.7	6.8	5.7	5.9
Finance and business services	5.1	10.9	5.2	5.7
Non-market economy	13.9	18.3	19.1	20.4

Source: (Timmer and Voskoboynikov 2016; Russia KLEMS, 2017)

Comparison of shares of value added and hours worked in Table 1 provides insight about variations in labour productivity levels and growth across sectors. For example, agriculture seems the least productive. Its share of hours worked in 1995 is nearly four times as its value-added share. 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. Given that Russia is moving to a market economy, we expect to see high growth of labour productivity in financial and business services. By 2012, its share of value added was up 5.8 percentage points, while the share of hours worked only rose by half of a percentage point. 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 percentage points.

The substantial changes in jobs in the formal and informal segments of the economy, as shown in Figure 2, may also be an additional source of variations in productivity. Table 2 reports that the share in hours worked by informal workers in 2005 was almost 44% and continued expanding. The share of informality varies across sectors from a modest one-tenth (2012) in financial and business services to a hefty four-fifths in agriculture. Equally important, the substantial gap in labour productivity levels between formal and informal segments of the economy *widens*. While the level of total market economy was 17% of the formal one in 2005 and fall to 14% by 2012, the picture in sectors is heterogeneous. Informal manufacturing is very unproductive and continues degradation from 11% in 2005 to 5% in 2012. On the other extreme, informal workers in financial and business services seem to be much more productive than their formal colleagues. This is the area where high-quality freelancers outperform traditional corporate forms of activity.

Table 2 Shares of hours worked for informal segment and relative labour productivity levels

	Labour shares of informal segments (% of hours worked)		LP levels of informal segments relative to formal ones	
	2005	2012	2005	2012
Total market economy	43.8	44.8	0.17	0.14
Agriculture	79.7	82.7	0.31	0.27
Manufacturing	12.1	15.4	0.11	0.05
Extended mining	38.2	35.4	0.19	0.15
Construction, retail and telecommunications	44.8	44.8	0.22	0.16
Transport	21.4	27.2	0.14	0.19
Finance and business services	8.1	9.7	1.74	1.29

Source: Author's calculations.

Notes: 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. Numbers may not sum exactly due to rounding.

The results reported in this section show 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 were substantial and variations in productivity across industries were high. In addition, we provide evidence that labour reallocation between formal and informal sectors of the economy can contribute to productivity variations. These preliminary results do not answer the big question: What are relative impacts of all these reallocation effects on aggregate

productivity growth? Such estimations demand the more accurate shift-share analysis techniques implemented in the following section.

5 Contribution of labour reallocation and informality

In this section, I attempt assessment of the impact of structural change and labour reallocation on aggregate labour productivity growth in two cases. The first, in line with conventional literature, deals with industries without splitting into informal and formal segments. Applying the three alternative methods of the shift-share analysis discussed in section 2, I tease out the effects where consistent results are available. I then address the drawback of the "no-split" approach, which wrongly assesses the impact of job flows between formal and informal segments within industries on aggregate productivity as part of the intra-industry contribution, taking the informal split explicitly into account. Comparing the results, I discuss the bias of the no-split approach and the impact of informality expansion on labour productivity growth.

Table 3 presents the decomposition of aggregate labour productivity growth into intra-industry contributions and the impact of labour reallocation for 30 industries of the market economy in 1995–2012 after they have been grouped into six aggregated sectors. The table also reports the results obtained by alternative methods.[26] Over the period, all approaches are consistent in revealing main trends of this decomposition. First, aggregate productivity growth decelerates in 2005–2012 from the previous decade. Next, main drivers of aggregate productivity growth in the first decade were extended mining, manufacturing and finance and business services, while in the following years manufacturing and business services give way to the consumption-oriented sector, i.e. construction, retail and telecom. Finally, the contribution of labour reallocation declines. For example, the TRAD/CSLS estimations show the reallocation component fell by almost one-fifths of a percentage point (from 0.83 p.p. in 1995–2005 to 0.64 p.p. in 2005–2012). The fall of reallocation explains from one fifth of the total for TRAD/CSLS.[27] It declines by almost two-thirds for GEAD. A possible explanation of this decline is the slow evaporation of the planned economy distortions in late stages of transition. Summing up, comparing with intra-industry sources, the role of labour reallocation in total growth seems modest. From this perspective, Russia seems similar to the Latin America region, rather than East Asia or Africa (Diao et al., 2017).

[26] Note that that sectoral contributions and the total reallocation effect in TRAD and CSLS are the same for equations (5) and (7).
[27] Aggregate productivity growth dropped by 1.04 p.p. and reallocation by 0.19 p.p. (almost 19% of 1.04).

Table 3 Alternative decompositions of labour productivity growth

Contributions to yearly average growth rates (p.p.)

	TRAD, CSLS		GEAD	
	1995–2005	2005–2012	1995–2005	2005–2012
Total market economy	5.04	4.00	4.98	3.71
Total intra-industry	4.21	3.36	3.81	3.36
Agriculture	0.28	0.14	0.32	0.14
Manufacturing	0.93	0.43	1.09	0.43
Extended mining	1.10	0.98	0.55	0.98
Construction, retail and telecommunications	0.52	1.06	0.61	1.06
Transport	0.33	0.16	0.32	0.16
Finance and business services	1.05	0.60	0.93	0.60
Reallocation	0.83	0.64	1.17	0.36

Source: Author's calculations.

Notes: In this decomposition, the informal split is not considered. TRAD, CSLS: constant prices of 2005 are used. Numbers may not sum exactly due to rounding.

In any case, the overall reallocation component deserves more attention, both because its contribution is crucial in understanding the Russian economy and because of the role of labour input reallocation contributions to structural change in different patterns of structural transformation as discussed in Diao et al. (2017) and calculated with the TRAD approach.

Section 2 elaborates differences in initial assumptions of the three methods of structural decomposition. These are shown as different approaches to the calculation of the reallocation term. It is hardly surprising that the sectoral contributions to structural change represented in Tables 4 and 5 are mostly sensitive to the method used. For example, the negative contribution of agriculture provided by TRAD in 1995–2005 (-0.18 p.p., Table 4) and in 2005–2012 (-0.08 p.p., Table 5) becomes positive with CSLS (0.41 p.p. and 0.26 p.p., respectively). This is expected as CSLS is a modification of TRAD, which provides a positive contribution to structural change in the case of a sectoral labour outflow from a low-productivity industry such as agriculture. In turn, the GEAD-based contribution of extended mining in 1995–2005 is at least three times higher than for TRAD and CSLS. This is explained by the drastic changes of relative prices in 2005 in comparison with 1995 against soaring oil prices. Interestingly, the variation of GEAD-based structural change contributions are higher in comparison with TRAD in 1995–2005 (Table 4) than in the following years (Table 5). This can also be interpreted as an effect of soaring oil prices. These findings clearly

indicate that sectoral contributions to structural change are sensitive to the way the shift-share analysis is implemented.

In addition to the variety of methods, another more source of uncertainty in this type of the analysis is the option of taking informality into account. After all, the reality is that a substantial share of labour takes place in the informal segment in most developing economies. While widely discussed in the context of its influence to the overall productivity growth, this fairly significant aspect of labour activity is largely overlooked in quantitative decompositions of aggregate labour productivity growth.

Table 4 Sectoral labour reallocation effects, 1995–2005

Contributions to yearly average growth rates (p.p.)

	TRAD	CSLS	GEAD
Reallocation, total market economy	0.83	0.83	1.17
Agriculture	-0.18	0.41	-0.33
Manufacturing	-0.16	0.12	-0.59
Extended mining	0.57	0.44	1.81
Construction, retail and telecommunications	0.62	-0.16	0.43
Transport	-0.02	-0.02	-0.33
Finance and business services	0.00	0.03	0.18

Source: Author's calculations.

Notes: In this decomposition, the informal split is not considered. TRAD, CSLS: constant prices of 2005 are used. TRAD, CSLS, GEAD: references to methods. Due to rounding, numbers may not sum exactly.

Given the substantial heterogeneity of productivity levels reported in Table 2, introduction of the informal split increases heterogeneity in labour productivity levels should affect components of productivity growth. As follows from equations (3) and (4), the fraction $\sum(s_{L,n}^{0}R_n)$ of the aggregate labour productivity growth, which in (2) was attributed to the intra-industry effect, now becomes the part of the inter-industry effect. This fraction reflects implications of flows across formal-informal divide and can be calculated as the difference between the reallocation components of the "split" (4) and "no-split" (2) decompositions. As follows from Tables 5 and 3, the corresponding reallocation components equal 0.51 and 0.64 p.p., or -0.13 p.p. Thus, if the informal split is ignored, the overall "within" effect is underestimated by -0.13 p.p., and amounts to 3.36 p.p. (reported in Table 3). This negative fraction reflects the expansion of the low-productivity informal segment. Indeed, revisiting Table 2, we see that its share grew by 1 p.p. in 2005–2012, while its labour productivity level was less than one-fifth that of the formal segment.

Table 5 Sectoral reallocation effects, 2005–2012

Contributions to yearly average growth rates (p.p.)

	TRAD		CSLS		GEAD	
	Informal split:		Informal split:		Informal split:	
	No	Yes	No	Yes	No	Yes
Reallocation, total market economy	0.64	0.51	0.64	0.51	0.36	0.22
Agriculture	-0.08	-0.13	0.26	0.20	-0.11	-0.16
Manufacturing	-0.17	-0.31	0.04	-0.09	-0.09	-0.22
Extended mining	0.04	0.17	0.03	0.16	0.05	0.17
Construction, retail and telecommunications	0.28	0.26	-0.07	-0.09	0.26	0.25
Transport	0.04	-0.04	0.01	-0.08	0.06	-0.02
Finance and business services	0.53	0.56	0.38	0.40	0.18	0.20

Notes: TRAD, CSLS: constant prices of 2005 are used. Numbers may not sum exactly due to rounding.

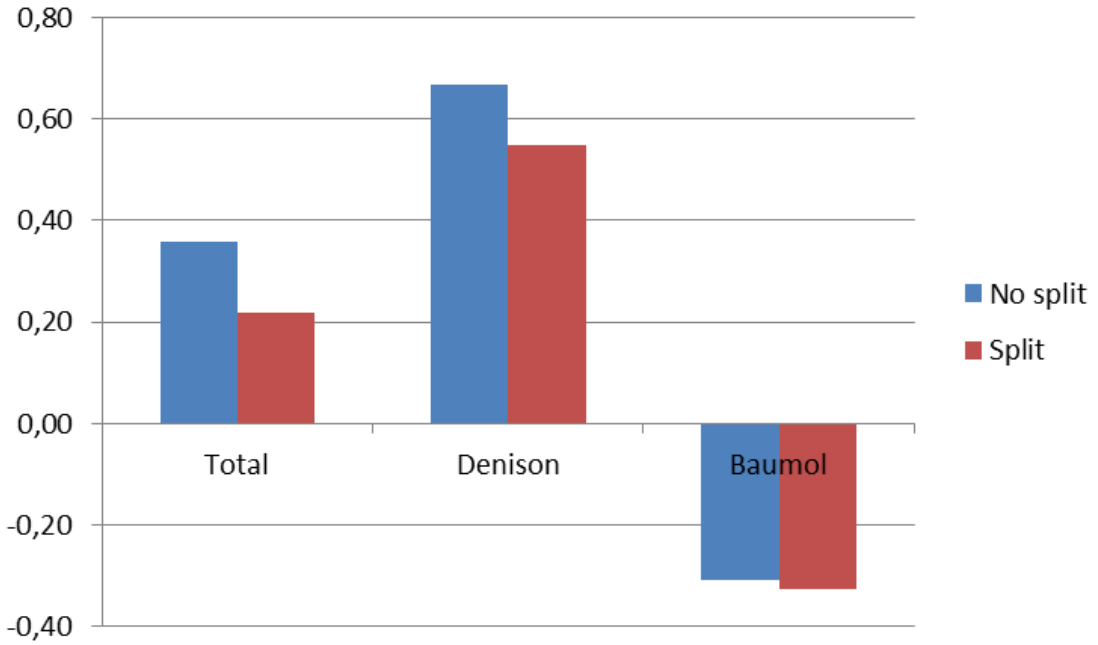
Source: Authors' calculations.

Consequently, the effect of labour reallocation between formal and informal segments within a sector (difference between the second and the first columns of Table 5) equals the sectoral contributions of this reallocation between formal and informal segments. As can be seen from the table, this reallocation is negative for all sectors with two exceptions. In case of finance and business services, the informal segment is more productive. Looking at Table 2, it is hardly surprising that the expansion of its informal segment by 1.6 p.p. leads to the positive contribution. The shift likely reflects professionals outsourcing themselves. For example, a talented lawyer could abandon his or her firm to engage in a solo or free-lance practice.[28] Another exception is extended mining. Referring again to Table 2, we see this is the only sector where the informal sector contracts by 2.8 p.p. This effect is also evident as the gross flow of jobs in Figure 2. The most substantial intra-sectoral reallocation of jobs between formal and informal segments in manufacturing, agriculture and construction corresponds to the largest values of the effect (in absolute values).

[28] We see this group of highly qualified self-employed at the micro level (Gimpelson and Kapelyushnikov, 2015).

Figure 3 Contribution of labour reallocation on aggregate labour productivity growth of the Russian economy, 2005–2012

Contributions to yearly average growth rates (p.p.)

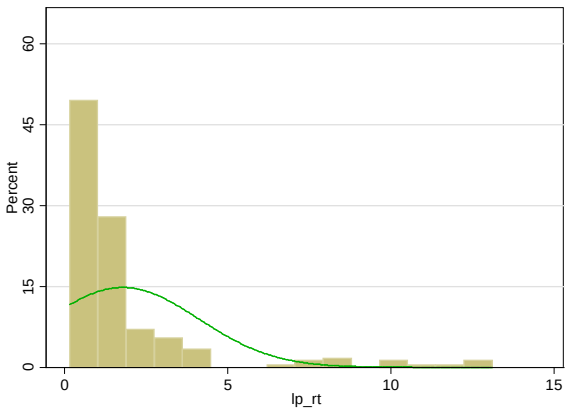


Source: Author's calculations.

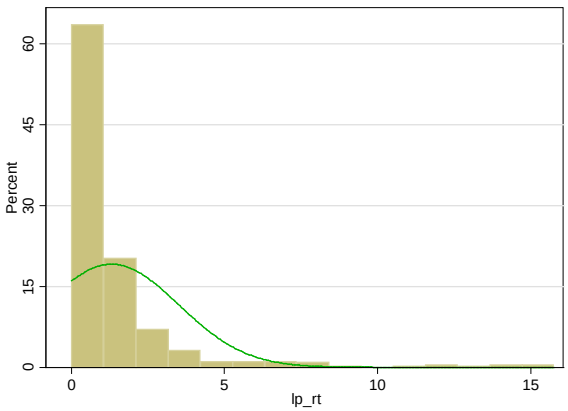
Note: GEAD approach for the shift-share analysis follows Tang and Wang (2004).

Figure 4 Distributions of labour productivity levels across industries, 2005–2012

A. Total industries with no informal split.



B. Industries with informal split

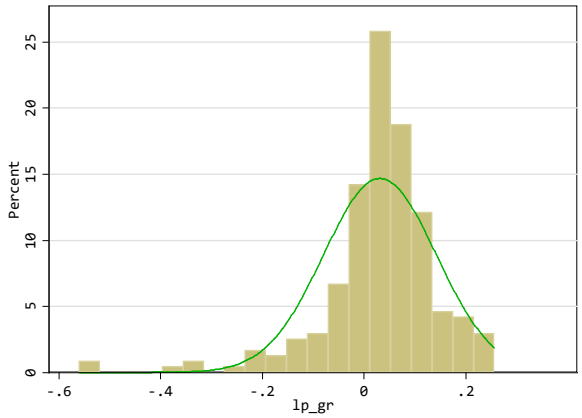


Sources: Authors' calculations.

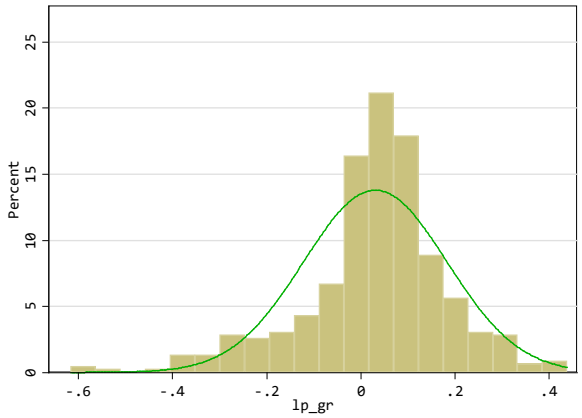
Notes: Labour productivity level in an industry refers to the nominal value added per hour worked, normalized to the aggregate labour productivity level of a corresponding year. Descriptive statistics of the distributions are available in Appendix C.

Figure 5 Distributions of labour productivity growth rates across industries, 2005–2012

A. Total industries with no informal split.



B. Industries with informal split



Sources: authors' calculations. See main text.

Notes: 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. Descriptive statistics of the distributions are available in Appendix C.

As an overarching observation, we can say that expanding informality reduces growth-enhancing structural change through labour reallocation to the less-productive informal segments of most industries. But can we refine this a bit further and determine whether the nature of this aggregate productivity slowdown is driven by expansion of industries with lower productivity levels (Denison effect) or growth rates (Baumol effect)?

The results of the corresponding decomposition for GEAD (11) are given in Figure 3. They show the contribution of the reallocation effect and its components to aggregate labour productivity growth in 2005–2012 in both the "no split" (blue) and "split" (red) assessments. As can be seen, the total reallocation effect contributes a net of 0.36 p.p. (Table 5), with the Denison effect providing 0.67 p.p. and Baumol effect reducing by 0.31 p.p. The corresponding decomposition of the "split" case is 0.22 p.p. = 0.55 p.p. – 0.33 p.p. Accordingly, of total decrease of the split case in comparison of the no-split case is 0.14 p.p. (0.22 p.p. – 0.36 p.p.). The Denison effect shows a fall of 0.12 p.p., while the Baumol effect only goes down by 0.02 p.p. In other words, *reallocation of labour between industries with different productivity levels has a larger effect on aggregate growth than differences growth rates*.

The explanation seems to be that the Denison effect captures shifts of labour between industries with different levels of labour productivity, while the Baumol effect deals with growth rates. The informal split impacts the distribution of levels stronger than distribution of growth rates. Since the distribution of levels is more asymmetrical (i.e. biased in the direction of the left tail), 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 higher productivity level. In contrast, the distribution of growth rates with the informal split becomes more symmetrical. Thus, we can expect that a trend to informality leads to employment growth in industries with below-average productivity levels.

The same effect can be represented in the form of distributions of industries by labour productivity levels (Figure 4) and growth rates (Figure 5). Regarding informal split shifts, the distribution of productivity levels to the left can be seen with comparison of these figures. For the no-split case, the skewness of the distribution with the informal split rises by a quarter. The increasing number of low-productivity industries shifts average productivity down from 1.8 to 1.3 for the overall economy (see Appendix C). Increasing kurtosis appears as a growing spike. Again, the probability of a worker finding a job with the lower level of productivity than their previous job is higher when the informal split is taken into consideration.

Informal split can also impact the distribution of productivity growth rates. Figures 5A and 5B, in contrast with the distribution of levels, show that the *asymmetry of growth-rate distribution decreases*. Indeed, the corresponding skewness (Appendix C) approaches zero, going from -1.7 to -0.8. This indicates that the tails on both sides balance out. Interestingly, the informal split has no impact on the mean growth rates, which remain 3.1% per year. At the same time, higher standard deviation (15.3 instead of 11.1) is caused by increasingly rare extreme deviations (as follows from a decreasing kurtosis value). In other words, the number of industries with extreme productivity growth, both positive and negative, increases. All in all, there is no evidence that including the informal split boosts the role of industries with growing or falling productivity.

Although the estimates produced by alternative decomposition methodologies differ, they paint essentially the same picture. The core is that the reallocation in the Russian economy in 1995–2012 was not growth-neutral. Its contribution into aggregate labour productivity growth was positive. This finding matches the evidence of other studies suggesting a consistent improvement in job quality during 2000–2012 (Gimpelson and Kapelyushnikov, 2014). On the other hand, a more precise account of the informality composition and associated trends discounts the positive contribution of labour reallocation. Reallocation remained progressive, but the trend towards the expansion of informality worked in the opposite direction. Workers who moved from the formal sector into the informal sector tended to take jobs in industries where the productivity levels were lower than in the industries they had left. A worker leaving large industrial plant might become a cab driver or salesperson (formal or informal), or might earn a living transforming their home garage or basement into a workshop. The latter option would allow them to remain in the same industry while working

informally. In any case, one hour of work at the new informal workplace is likely to produce much less value added than in the previous job in a formal workplace.

6 Conclusions

The present study was designed to examine the link between structural change and aggregate labour productivity growth of the Russian economy to obtain a quantitative evaluation of the impact of the country's expanding informal segment on productivity. Using a diverse set of analytical tools to decompose the aggregate labour productivity growth into the inter-industry and intra-industry components, three main findings emerge.

First, labour reallocation in Russia was significant, growth-enhancing and attenuating throughout the 1995–2012 period. Narrowing the focus to 2005–2012, we see that expanding labour reallocation to the informal segment of the economy *slowed* aggregate labour productivity growth. Further decomposition of the reallocation contribution revealed that this deceleration seems to have been caused by the expanding employment share of informal activities with low labour productivity.

Second, this study strengthens the idea of the informal sector's dual role. On the one hand, the informal sector acts as a safety valve, absorbing the social consequences of external shocks and holding employment stable. On the other hand, expanding informality is a drag on labour productivity, which is harmful to growth. The study also raises important questions about methods used for the shift-share analysis. Indeed, although the main findings have been confirmed with all three methods used, sectoral labour reallocation effects were sensitive to the approach used.

Finally, in line with Rodrik (2008), the study highlights the role of institutions. Russia's formal adoption of best practices from developed economies in the early years of transition to jump start the economy into a rapid shift from a planned to market economy was thwarted to some extent by the lack of state enforcement. The structural bonus was diluted by expanding informality, diminishing long-run growth. This failure highlights the drawbacks of the shock therapy approach as compared the more gradual reform strategies pursued by China and Vietnam, and suggests that optimal speed of reform may not be the fastest.[29] Such transition economies provide fertile opportunities for further study of informality on aggregate productivity growth and labour reallocation.

[29] A summary of the debate can be found in Wyplosz (2014, 228-230).

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Appendix A Terminology

The discussion above described the economy in terms of *industries*. Groups of industries can be combined into *aggregated sectors* to form, for example, the market economy, or allocated to *sectors* such as manufacturing. The full list of industries and aggregated sectors is given in Appendix B.

To define the *informal split*, each industry is divided into two *segments*, formal and informal. The formal segments of all industries together constitute the formal sector of the economy. Similarly, the combination of all informal segments is the informal sector of the economy. It is also possible to discuss informal segments of an aggregated sector, assuming the set of informal segments belong to the aggregated sector. For example, the informal segment of manufacturing consists of the informal segments of industries within manufacturing. The term *sectoral contribution* assumes the contribution of sectors or aggregated sectors only in the no-split case.

The term informal sector here only addresses the set of the informal segments of industries that fall within the market economy. Informal activities in the non-market economy are outside the scope of this paper.

Appendix B List of industries and composition of aggregated sectors

#	Code	Industry	Sector	Aggregated sector
1	AtB	Agriculture, Hunting, Forestry and Fishing	Agriculture	Market economy
2	23	Coke, refined petroleum products and nuclear fuel	Extended gas and oil	Market economy
3	C	Mining and quarrying	Extended gas and oil	Market economy
4	51	Wholesale trade	Extended gas and oil	Market economy
5	15t16	Food, Beverages and Tobacco	Manufacturing	Market economy
6	17t18	Textiles and Textile Products	Manufacturing	Market economy
7	19	Leather, Leather and Footwear	Manufacturing	Market economy
8	20	Wood and Products of Wood and Cork	Manufacturing	Market economy
9	21t22	Pulp, Paper, Paper, Printing and Publishing	Manufacturing	Market economy
10	24	Chemicals	Manufacturing	Market economy
11	25	Rubber and Plastics	Manufacturing	Market economy
12	26	Other Non-Metallic Mineral	Manufacturing	Market economy
13	27t28	Basic Metals and Fabricated Metal	Manufacturing	Market economy
14	29	Other Machinery	Manufacturing	Market economy
15	30t33	Electrical and Optical Equipment	Manufacturing	Market economy
16	34t35	Transport Equipment	Manufacturing	Market economy
17	36t37	Manufacturing, n.e.c. and Recycling*	Manufacturing	Market economy
18	E	Electricity, Gas and Water supply	Manufacturing	Market economy
19	F	Construction	Retail, Construction, Telecom	Market economy
20	50	Sale, Maintenance and Repair of Motor Vehicles and Motorcycles	Retail, Construction, Telecom	Market economy
21	52	Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods	Retail, Construction, Telecom	Market economy
22	H	Hotels and Restaurants	Retail, Construction, Telecom	Market economy
23	64	Post and Telecommunications	Retail, Construction, Telecom	Market economy
24	O	Other Community, Social and Personal Services	Retail, Construction, Telecom	Market economy
25	J	Financial intermediation	Fin. & Business Services	Market economy
26	71t74	Renting of Machinery and Equipment and Other Business Activities	Fin. & Business Services	Market economy
27	60	Inland transport	Transport	Market economy
28	61	Water Transport	Transport	Market economy
29	62	Air Transport	Transport	Market economy
30	63	Other Transport Services	Transport	Market economy
31	70	Real Estate Activities	Non-market services	Non-market economy
32	L	Public Admin and Defence; Compulsory Social Security	Non-market services	Non-market economy
33	M	Education	Non-market services	Non-market economy
34	N	Health and Social Work	Non-market services	Non-market economy

* n.e.c. = not elsewhere classified

Appendix C Distributions of labour productivity levels and growth rates by industry

Table C1 Measures of labour productivity level distribution in industries, 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 C2 Measures of labour productivity growth rates distribution in industries, 2005–2012

	NO Split	Informal Split
Mean	0.0320	0.0319
Standard deviation	0.1113	0.1520
Skewness	-1.7148	-0.7810
Kurtosis	9.4647	4.9661

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

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ISSN 1456-4564 (print) // ISSN 1456-5889 (online)