Bank of Russia

PRODUCTIVITY CONVERGENCE TRENDS WITHIN RUSSIAN INDUSTRIES: FIRM-LEVEL EVIDENCE

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E. Bessonova, A. Tsvetkova

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Address: 12 Neglinnaya street, Moscow, 107016
Tel.: +7 495 771-91-00, +7 495 621-64-65 (fax)
Website: www.cbr.ru

ABSTRACT

The paper focuses on trends in the convergence of labour and multifactor productivity in Russia. Using firm-level data for the 2011-2016 period, we obtain the following result: low-productivity firms grow faster than high-productivity ones. Despite this, the initial gap between the most and the least productive firms in the Russian economy is so wide that it is hardly possible to overcome in the short term. Moreover, we find that this gap has increased over the 2011-2016 period, suggesting divergence in productivity levels of Russian firms. To verify the divergence within narrowly defined industries, we also use the stochastic frontier analysis. Our estimates confirm divergence in most industries.

Keywords: productivity gap, β-convergence, σ-convergence, stochastic frontier analysis.

JEL Classification: D24, E22, O47.

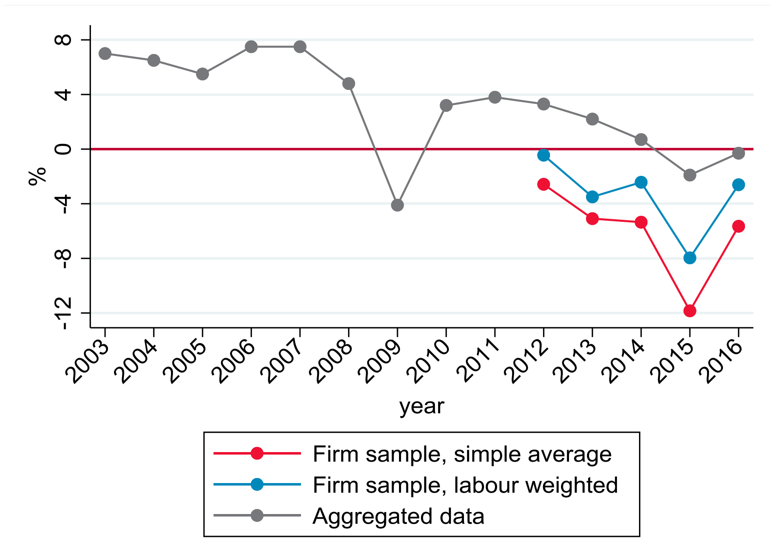
1. INTRODUCTION

A large number of studies examining productivity dynamics in various countries provide evidence of a significant productivity growth slowdown after the 2008 crisis. In recent years, advanced countries have suffered slowed growth in both labour and multifactor productivity (MFP). These trends are observed on both aggregate and micro-level data. In fact, Cette et al. (2017), using macro- and microeconomic data on France, found downward structural breaks in productivity levels even several years before the crisis.

Annual changes in Russia's productivity growth rates are similar to the worldwide trends. Official statistical data indicates that since 2009 labour productivity growth rates at an aggregate level have been significantly lower than in the earlier years of this century (see Figure 1). What is more, the years 2015 and 2016 saw negative aggregate productivity growth rates in Russia.

Our estimations of labour productivity at a firm level also show negative growth rates in the post-crisis period. Comparison between weighted and simple averages of labour productivity growth rates at a firm level indicates a gap in productivity between more and less efficient companies.

Figure 1. Labour productivity growth in Russia



Source: aggregate data - Rosstat,[1] firm-level data - authors' estimates based on the Ruslana database

Recent studies based on data from other countries also find a persistent gap between high- and low-efficiency firms within industries (Cunningham et al., 2017). This trend

[1]Labour productivity indices in the economy of the Russian Federation:
http://www.gks.ru/free_doc/new_site/vvp/vvp-god/ipt-okved2.xlsx
http://www.gks.ru/free_doc/new_site/vvp/vvp-god/pr-tru.xlsx

emerged before the 2008 crisis, and some researchers argue that this resulted in an aggregate productivity growth slowdown (Akcigit and Ates (2019)).

The stylized facts on firms' heterogeneity and convergence in productivity levels could be summed up as follows:

- a host of literature finds that productivity is highly heterogeneous even in narrowly defined industries;
- the persistency of high productivity levels at a firm level is observed;
- at the same time, a certain share of low-productivity firms show high growth rates, which is usually true of young firms with a strong growth potential.

As a result, growth at the frontier remains fast but a significant part of less efficient firms are not catching up, showing much lower rates of productivity growth than the most efficient companies. What aggregate slowdown of productivity growth stems from is change in the performance of non-frontier firms due to a decline in knowledge diffusion from leaders to laggards (Andrews et al. (2016); Akcigit and Ates, (2019)).

The availability of firm-level data makes it possible to examine the behavior of firms depending on their position in terms of the distance to frontier and to analyze the convergence process between leaders in an industry and laggard firms.

In several papers, convergence is found to be due to low-productivity firms growing faster than high-productivity ones (see Griffith et al. (2009); Bournakis and Mallick (2018); Gemmel et al. (2016); Brown et al., (2015); Conway et al. (2015); Chevalier et al. (2012)). Note that Andrews et al. (2016) and Cette et al. (2018) confirm this result. Other papers show that the dispersion of productivity levels within industries has increased in recent years, indicating that a significant share of low-efficiency firms do not catch up with leaders (Cette et al. (2018); Decker et al. (2017)).

In line with the existing evidence, we find that in a sample of Russian firms, productivity growth rates are negatively correlated with the initial level of productivity. We also show that the gap between leaders and laggards is much wider in the Russian economy than in OECD countries. Moreover, in line with Andrews et al. (2016) and Cette et al. (2018), we find that this gap is growing.

To check this result, we estimate the stochastic frontier model. Our results indicate that the technological efficiency decreases over the sample period. It means that the distance to frontier (in other words, the gap between leaders and laggards) increases. Therefore, we confirm that fast growth of the least productive firms does not lead to convergence in productivity levels in the entire sample.

The remainder of the paper is organized as follows. Section 2 summarizes the results obtained in the related literature. Section 3 describes the data on Russian firms. In section 4 we analyze productivity convergence using two approaches to measuring convergence: first, the correlation between the initial level of productivity and its growth (β-convergence); second, the dispersion analysis (σ-convergence). Section 5, using the stochastic frontier analysis, provides a robustness check for the key conclusion that the gap between leaders and laggards increases. Section 6 concludes.

2. RELATED LITERATURE

Convergence analysis was initially applied to cross-country studies. Research on a macro level provides ambiguous results (Abreu et al., 2015). On the one hand, the catching-up of developing countries is observed due mainly to technology transfers and capital deepening arising from a more extensive involvement in international trade and global value chains. Indeed, cross-country studies show a rise in living standards in fast growing developing countries (see Crafts and O'Rourke (2014) for a detailed overview of historical trends in convergence). On the other hand, recent empirical studies do not confirm that there has been convergence among advanced countries since the beginning of the 21th century. For example, Bergeaud et al. (2016) find that convergence on a macro level among developed countries was observed only for a short period, with signs of divergence emerging after the 2008 crisis.

Other research devoted to growth and the convergence process emphasizes institutional frictions which prevent the adaptation of new technologies in less developed economies (for example, Acemoglu et al. (2001)). In this strand of literature, technical change is regarded as an endogenous factor, and its effects on leading and developing countries could differ depending on these countries' adaptation capacity. Recent empirical studies stress special features of the process of technological transfer in the third wave of technological revolution which slow the diffusion of new technologies to economic agents behind the technological frontier (Brynjolfsson and McAfee (2011); Fernald (2014); Gordon (2015); Jones (2012)). Inklaar and Diewert (2016) using detailed industry-level data for 38 countries between 1995 and 2011 find that, on the one hand, a narrowing of dispersion of countries' productivity levels is observed during this period, but on the other hand, convergence to the average level of productivity is accompanied by an increasing gap between the average level of productivity and the productivity at the frontier.

Empirical studies relying on micro-level data show that heterogeneity exists not only among countries with different levels of economic development but also within one narrowly defined industry in a particular country (see Syverson, 2011, for the review of research in productivity dynamics). In an analysis that uses firm-level data, the authors find that differences in productivity levels within one industry persist. In his review, Syverson (2011) formulated a simple theoretical model which predicts sustainable heterogeneity in productivity levels in a competitive environment coming from firms' different reactions to exogenous shocks.

At the same time, heterogeneity among firms itself does not necessarily adversely affect aggregate productivity growth. Recent studies based on micro data show that an aggregate productivity slowdown arises from an increasing dispersion between leaders and laggards within the same industry. Andrews et al. (2016) find that OECD countries are experiencing a widening gap between leaders and laggards, while the production frontier is still moving forward (at least in services). This suggests that it is not a slowdown in technological progress that drives the aggregate productivity decline but an increasing heterogeneity of firms within industries. Baily and Montalbano (2016) propose the explanation of the slow growth by weakening in the dynamic adjustments that have traditionally fueled productivity improvement.

An alternative body of literature regards a substantial variation in productivity as a result of resource misallocation. These papers provide an explanation for a high productivity dispersion within narrowly defined industries. For example, as Hsieh and Klenow (2009) show, aggregate productivity in India and China could improve substantially if the reallocation of resources among companies in these countries changed productivity distribution in such a way as to make it similar to that in the U.S.

In the model of Hsieh and Klenow (2009), misallocation stems from two types of distortions which prevent firms from expanding. The first type is scale distortions. It means that if productive firms try to expand they face barriers such as size-dependent policy (Guner et al. (2008)). Examples of such policies are tax exemptions or direct subsidies for small companies. The second type of distortions leading to misallocation is capital distortions. As Midrigan and Xu (2014) and Gopinath et al. (2017) point out, borrowing constraints may prevent productive firms from investing and building up capital.

Bartelsman et al. (2013) argue that scale distortions prevent firms not only from expanding but also from entering the market. Midrigan and Xu (2014) add that borrowing constrains do not allow firms to adopt technology and change their production mode from labour intensive to technology intensive.

In addition to scale and capital distortions, Decker et al. (2018) suggest that resource misallocation arises from decreasing responsiveness of employment growth to productivity. In other words, they find that U.S. manufacturing firms hire less in response to high productivity (or fire less in response to low productivity).

Frictions described in this literature influence firms which do not grow although they are productive but also affect firms which do not exit despite their low productivity. For example, Akcigit et al. (2016) compare the life cycle of firms in the U.S. and India. In the U.S., if firms are productive they take over resources from less productive firms and grow, while unproductive firms exit the market. Alon et al. (2018) confirm that productivity growth among young U.S. firms is driven by selection and allocation from fast exiting nonproductive firms to expanding high-productivity ones. In India, productive firms face barriers preventing them from growth and stay small. They do not weed out unproductive firms, which are thus able to survive. As a consequence, there are not enough successful and productive companies in India, and the gap between leaders and laggards remains wide.

Andrews et al. (2016), as well as Akcigit and Ates, (2019), suggest that one of the forms of resource misallocation may be slow technology diffusion. Therefore, firms face the lack of access to tacit knowledge and opportunities to grow. In other words, as Midrigan and Xu (2014) point out with regard to borrowing constraints, the costs of moving from an economy based on production to that based on ideas increases for laggard firms.

Andrews et al. (2016) find that the widening productivity gap goes along with a negative correlation between productivity growth and its initial level. This results is confirmed by the bulk of literature (see for example, Griffith et al. (2009); Bournakis and Mallick (2018); Gemmel et al. (2016); Brown et al. (2015); Conway et al. (2015); Chevalier et al. (2012)). Andrews et al. (2016) suggest that this correlation has been weakening since 1997. They offer the following explanation: laggards catch-up with leaders but it takes longer now; in other words, convergence slows down. Chevalier et al. (2012) claim that the speed of convergence among French firms declines due mainly to the high productivity growth rates of firms at the technological frontier. They explain this by a greater impact of information technology and globalization on the most efficient companies. Bahar (2018) found the U-shape convergence curve with the highest TFP growth rates at the higher and lower bounds of initial productivity distribution. At the same time, the growth rates of firms in the middle of the distribution are significantly slower. He argues that this pattern is driven by firms in knowledge-intensive industries, which could be explained by stronger impediments to knowledge diffusion in these sectors.

Other studies also show that high productivity growth at the lower bounds of initial productivity distribution may be explained by the age structure of productivity distribution. As Haltiwanger et al. (2010) argue, startups and surviving young businesses are critical for job creation and contribute disproportionately to net growth in the U.S. Since new firms are usually low-productivity ones, their contribution is seen at the lower bound of productivity distribution. However, Ayyagari et al. (2011) show that small firms play a less important role in developing countries. Young firms’ (0-2 years) contributions to total employment is very small (the mean is 6.75%), while old firms (10+ years) contribute the most. According to their estimations, in developing countries, small and old firms account for the largest proportion of employment, also providing the largest part of job creation. In other words, economies in developing countries are based on firms that are old but are not growing and not increasing their market share. Moreover, Ayyagari et al. (2011) show that in countries where the contribution of small firms is larger, GDP per capita is lower, reflecting institutional barriers to growth. Poor countries’ performance is associated with the inability of firms to grow and expand from small to large.

Empirical findings on convergence could depend on the definition of leaders. Cette et al. (2018) finds that in France convergence emerges because a fixed group of firms which were leaders at the start of the sample period suffer a productivity decline, while firms which were initially laggards enjoy productivity growth. But this result is sensitive to the definition of the group of leaders. If it is not fixed and defined as a percentage of the most productive firms in each year, the result is opposite. The gap between leaders and laggards has been increasing since the beginning of the 1990th.

Thus, the convergence process among firms within an industry depends on productivity trends of firms in the higher and lower extremes of the distribution of the productivity levels. Most recent studies provide evidence of efficiency growth at the frontier. At the same time, overall dynamics will depend on the behavior of lagging firms. If the share of new firms with a high growth potential at the lower bound of the productivity distribution is small, then the presence of a large group of nonproductive firms which are not exiting the market could impede the convergence process.

Because different researchers find both an increasing gap in productivity within industries and fast productivity growth at the lower extreme of the initial productivity distribution, this paper analyzes two different types of convergence - catching up of low-productivity firms (higher growth rates at the lower bound) and an increase in dispersion in productivity levels. The hypothesis we test in this study could be formulated as follows:

H1. Productivity growth rates are negatively correlated with initial productivity levels.

H2. Productivity distribution within an industry is very persistent, migration between the quartiles of the distribution is not very frequent.

H3. β-convergence does not lead to a reduction of dispersion in productivity levels because (i) the initial productivity gap between leaders and laggard is too wide and (ii) high productivity growth rates are observed only for a tiny share of firms at the lower bound of productivity distribution. It does not therefore translate into a lower dispersion of productivity levels within an industry, i.e. σ-convergence is not observed.

Following the approach of Andrews et al. (2016) and Cette et al. (2018), we show that in Russia, as in OECD countries and France, low-productivity firms grow faster than high-productivity ones. However, taking into account new firms and in particular the permutation of firms, the dispersion indicators suggest that firms diverge from frontier. To verify this result, we apply the stochastic frontier analysis. We use two different specifications, both of which confirm that in most industries firms diverge from frontier.

3. DATA

Firm-level data of Russian companies comes from Bureau van Dijk's Ruslana database. We use 2011-2016 data on operating revenue, fixed assets, employment, the cost of goods sold, labour costs, and the date of incorporation. As discussed in the OECD (2001) Measuring Productivity Manual, revenue and value added can be used as a measure of output. We use value added in line with Aigner and Chu (1968), Greene (1980), Petrin and Levinsohn (2012), Andrews et al. (2016), Cette et al. (2018), because it is consistent with economy-wide productivity measures. We construct value added as revenue less the cost of goods sold plus labour costs. It reduces our sample fairly significantly, because there is less data on labour costs than that on other financials. In the case of the value-added concept of productivity, only primary inputs are used, while firms' supplies are not taken into account.

In calculating the official productivity index, Rosstat uses hours worked as an approximation of the labour input. As we do not have data on hours worked, we use employment as an approximation of labour following Aigner and Chu (1968), Greene (1980), Andrews et al. (2016), Cette et al. (2018). We use fixed assets as an approximation of capital. Labour productivity is defined as value added divided by employment.

Figure 2. Number of observations by year and sector

Sector		2011	2012	2013	2014	2015	2016
C	Mining	916	960	1226	1417	1508	1378
D	Manufacturing	9,327	9,530	12,707	14,668	15,579	16,376
E	Utilities	2,154	2,136	2,829	3,253	3,543	3,680
G	Wholesale and retail trade	8,930	10,755	17,417	22,544	24,207	25,633
H	Hotels and restaurants	973	978	1479	1706	1875	1873
I	Transportation and communications	3,172	3,384	4,635	5,405	5,820	6,109
K	Business services	7,531	7,980	11,412	14,457	16,262	17,705
O	Personal and other services	1,606	1,556	2,407	2,671	2,671	2,707
Total		34,609	37,279	54,112	66,121	71,465	75,461

Source: Ruslana database, authors' estimates

We conduct an analysis for non-farm non-financial market sectors, including mining and quarrying, manufacturing, utilities, wholesale and retail trade, hotels and restaurants, transportation and communications, business services, and personal and other services (see Appendix A). We exclude agriculture, construction, financial services and the public sector from our analysis. Factors used or output produced in these sectors differ from the standard set usually taken into consideration (value added, labour and capital). Therefore, the analysis of these sectors requires a different production function specification which takes into account additional production factors (as in agriculture) or a set of outputs (as in the public sector). However, in some specifications we use data for agriculture and construction in order to make our results comparable with those of other studies.

We exclude firms with fewer than 10 employees, because small firms are insufficiently represented in the Ruslana database. As a result, our unbalanced sample is made up of 34,609 to 71,465 companies per year over the 2011-2016 period (Figure 2).

As shown in Figure 3, our sample represents on average 25% of employment headcount according to Rosstat (column 1). At the same time, the structure of employment is reproduced adequately: the shares of retail and wholesale trade (sector G) and manufacturing (sector D) are the largest.

We divide our sample into 173 industries. We begin with as narrow an industry classification as possible. This allows us to assume the same production function for firms in each industry. However, we have to aggregate some industries until we have a sufficient number of observations in order to estimate the stochastic frontier model. As a result, most of the industries are aggregated at the three- or four-digit numerical code of Russian Classification of Economic Activities (OKVED ver.1), while some of them are aggregated at the two-, four-, five- or even six-digit codes (see Appendix B).

Value added and labour productivity are deflated by the industry-specific producer price index[2] for manufacturing or by the industry-specific value added deflator[3] for the other sectors. Capital is deflated by a sector-specific capital price index. It is constructed as value indices[4] divided by volume indices.[5]

Figure 3. Sample representativeness

		Share of employees represented in sample	Number of employees, thousand		Share of sector in total employment, sample	Share of sector in total employment, Rosstat
			Sample	Rosstat		
C	Mining	53%	569	1082	6%	3%
D	Manufacturing	34%	3,366	9,844	33%	24%
E	Utilities	37%	704	1923	7%	5%
G	Wholesale and retail trade	22%	2,808	12,890	27%	31%
H	Hotels and restaurants	14%	190	1,338	2%	3%
I	Transportation and communications	18%	977	5,501	10%	13%
K	Business services	23%	1,390	6,002	14%	15%
O	Personal and other services	9%	226	2560	2%	6%
Total		25%	10,229	41,140	100%	100%

Source: Rosstat,[6] Ruslana database, authors' estimates

4. PRODUCTIVITY CONVERGENCE

We begin our productivity convergence analysis with the study of various productivity patterns among groups of leaders and laggards. Recent studies suggest that trends within different productivity groups depend on the definition of these groups (Cette, Corde and Lecat, (2018)). For the groups fixed in the first year of observation, leaders usually show a decline or stagnation in productivity levels, while the least productive companies usually enjoy growth. If firm dynamics (i.e., permutation and entries by groups each year) are taken into account and groups are redefined each year, then firms from the leading group show faster growth and laggards much lower growth rates. As a result, in the case of groups redefined each year, the gap in productivity levels between leaders and laggards widens.

[2] Producer price indices by economic activity from 2012 to 2016 https://fedstat.ru/indicator/43561

[3] Gross value added deflators (basic prices) according to the 2008 SNA methodology (OKVED 2007) https://fedstat.ru/indicator/57408

[4] Fixed assets at the end of the year at the full book value, full range of organizations, until 2016 https://fedstat.ru/indicator/40442

[5] The physical volume index of fixed assets, full range of organizations, until 2016 https://fedstat.ru/indicator/36733

[6] Average annual employment headcount in Russia by economic activity according to the balance of labour resources.
http://www.gks.ru/free_doc/new_site/population/trud/05-05.xls

Moreover, this trend is documented for various countries (see Cette, Corde and Lecat (2018) for France; Berlingieri, Blanchenay and Criscuolo (2017) for OECD countries; Decker, Haltiwanger, Jarmin and Miranda (2016) for US; Gamberoni, Giordano and Lopez-Garcia (2016) document widening gap of marginal product of labour for EU countries).

Following the recent literature, we apply two approaches to define the labour productivity frontier: division with and without renewal. Division without renewal implies that groups of firms are defined based on labour productivity in the first year of the sample period. We divide our sample into 10 groups, where the 1st decile represents the least productive firms in 2011 and the 10th decile - the most productive ones in 2011. Each group is fixed. It means that we assign each company to the group once in 2011. Afterwards, firms do not migrate into another group regardless of changes in their productivity. In other words, we follow companies which were in our sample in 2011. This approach is affected by survival bias, because firms exit from the market and we do not include new companies in the analysis.

The second approach is division with renewal. Under this approach, all firms are included in the analysis. In each year, we divide our sample into 10 groups, where the 1st decile is the least and the 10th decile the most productive group. Firms may migrate from one group to another according to changes in their productivity. Then we calculate the average productivity in each group and compare it with the result for this group in 2011. Therefore, it is not important under this approach which firms these groups are comprised of, instead we focus on the evolution of different moments of productivity distribution.

Figure 4. Accumulated labour productivity growth, frontier without renewal

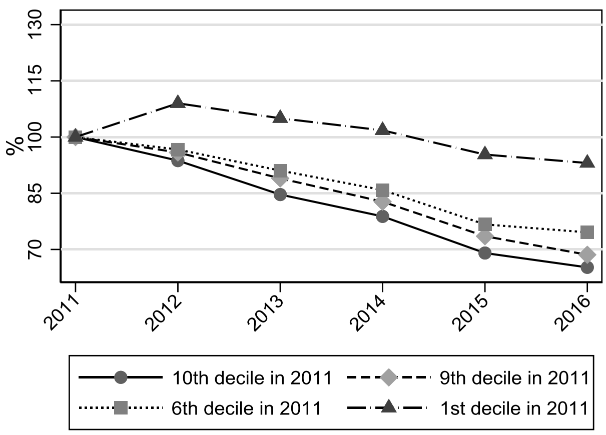
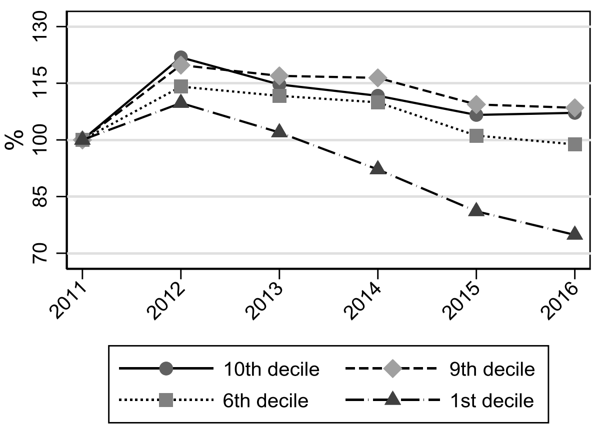


Figure 5. Accumulated labour productivity growth, frontier with renewal



Source: authors' estimates

Note: firms from the 10th decile are the most productive, firms from the 1st decile are the least productive. The left hand graph presents the evolution of productivity of firms, which were in the sample in 2011. Division by deciles is made in 2011, and firms stay in their deciles, there is no entry of new firms. The right hand graph presents the evolution of productivity levels. Division by deciles is made each year, resulting levels of productivities is compared with the levels pf productivity in 2011.

As shown in the literature, under the division without renewal, leaders' productivity declines while the productivity of laggards improves. We calculate average accumulated growth in the 1st, 6th, 9h, 10th deciles (Figure 4). The slowest decline is seen in the group of firms with the lowest labour productivity in 2011, whereas firms from the 10th, 9th and 6th deciles experience a more severe labour productivity decrease. This result holds for almost all sectors, which may be regarded as an argument for productivity convergence.

Division with renewal yields the opposite results: productivity of the most productive firms grows faster than that of the less productive ones (Figure 5). The average productivity in most productive deciles improves over the sample period. At the same time, the average productivity in the least productive deciles declines. This result holds for all the sectors. It means that taking into account the whole sample rather than concentrating on productivity trends only among survivals could be crucial for describing convergence process within industries. On the one hand, if firms survive despite their low productivity at the beginning of the period observed, they grow. Other firms from the least productive group exit, with new low-productivity firms taking their place. In other words, if some firms from the least productive group grow, it does not mean that the distribution of all firms converges to frontier.

In the next two sections, we proceed with more formal definitions of convergence that are commonly used in economic literature: σ-convergence and β-convergence.

The first concept (σ-convergence) implies the convergence of firms if the dispersion of their productivity levels narrows over time. The dispersion indicator is not always dispersion itself. The 90-to-10 ratio (the ratio of the 10th decile to the 1st decile of the productivity distribution) or interdecile dispersion (it is calculated as (10th-1st)/(10th+1st)) are also widely used.

β-convergence reflects the catching-up behavior of the least productive firms. It is said that the least productive firms converge to the most productive ones if average growth rates are higher for firms from the low-efficiency group. In other words, β-convergence means a negative correlation between the initial level of productivity and its growth.

Young et al. (2008) show that β-convergence is not always accompanied by σ-convergence. Strictly stating β-convergence is a necessary but not sufficient condition for σ-convergence. As Quah (1993) points out, β-convergence does not shed light on the evolution of productivity distribution. It is perfectly consistent with diverging or converging distributions. In other words, actual divergence may be accompanied by β-convergence. It means that the sign of the β-convergence coefficient may be misinterpreted as an indicator of convergence or divergence in the sense of dispersion narrowing over the period under observation.

These two concepts of convergence could lead to different conclusions about convergence because they account for exit and entry and migration between productivity groups differently.

- β-convergence is affected by survival bias because it is estimated based on companies which are found in the sample for two consecutive years. The calculation of σ-convergence involves all companies.

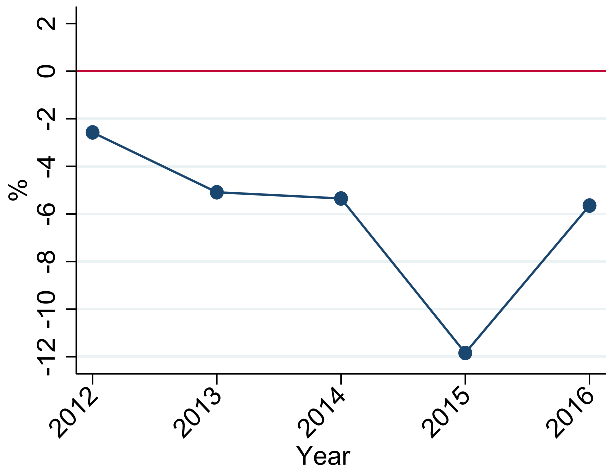
- β-convergence is also sensitive to permutation. For example, if there are only two firms with initially high and low productivity and they exchange their positions, then this approach indicates convergence because the low initial level of productivity is associated with growth, while its high initial level is associated with decline. At the same time, productivity dispersion is unchanged, the gap between high and low productivity level remains. Therefore, dispersion indicates no convergence or divergence.

4.1. β-convergence

Following the existing literature, we estimate the correlation between the initial distance to frontier and productivity growth (β-convergence). We test the hypothesis that laggards grow faster than leaders.

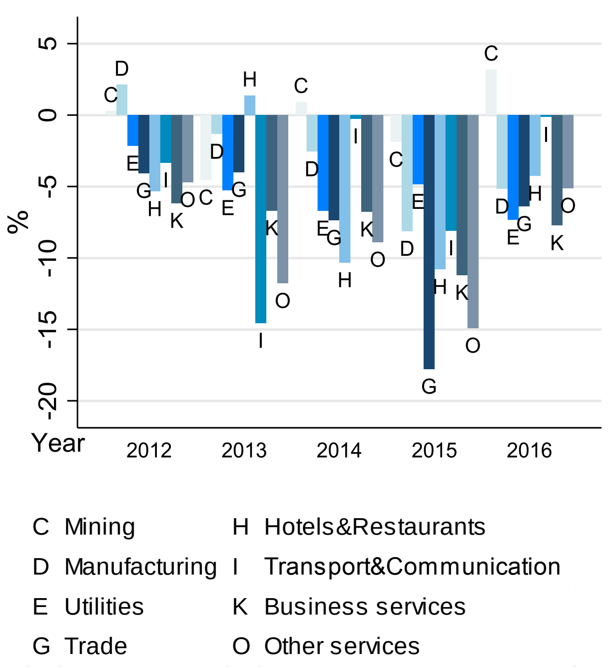
Our estimation shows that average labour productivity growth varies by year, sector, age and firm size, prompting us to include these control variables in the estimation (Figure 6 - Figure 9). To account for differences in mean average growth rates for these dimensions we use the conditional β-convergence approach, which implies that firms converge to the group-specific mean.

Figure 6. Labour productivity growth



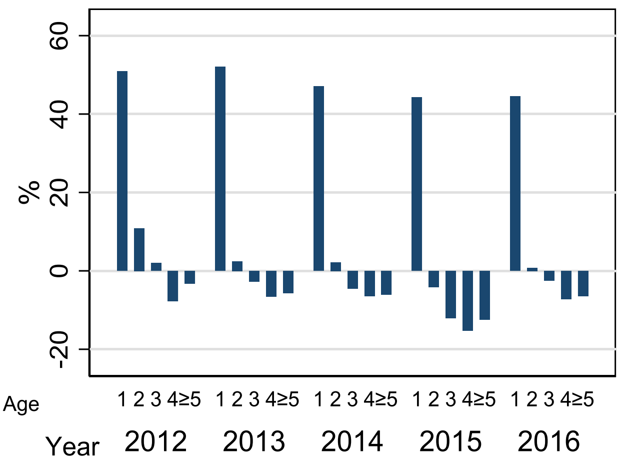
Source: authors' estimates

Figure 7. Labour productivity growth by sector



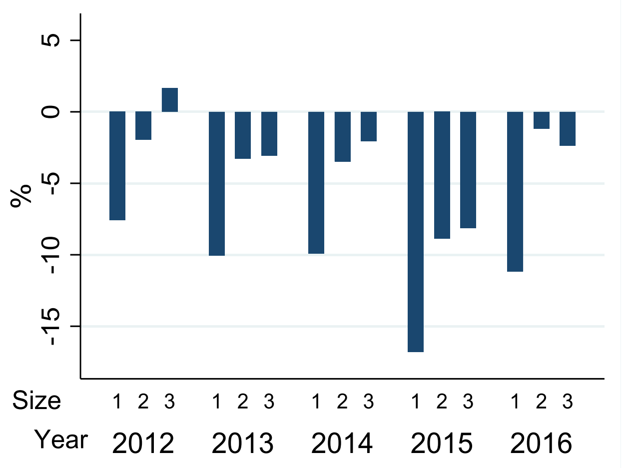
Source: authors' estimates

Figure 8. Labour productivity growth by age



Source: authors' estimates

Figure 9. Labour productivity growth by size



Source: authors' estimates

In the first step, we estimate the following equation with controls for size, age, sector and year (model 1).

$$\Delta lp_{it} = \beta_0 + \beta_1 gap_{it-1} + \beta_3 age_{it} + \beta_4 {age_{it}}^2 + \sum_{p=2}^{3} \beta_p * G_p + \sum_{j=2013}^{2016} \beta_j * Y_j + \sum_{k=2}^{8} \beta_k * S_k,$$

where

Δlp_{it} is the growth rate of labour productivity of firm i, Δlp_{it} is calculated as the difference between log labour productivity in year t and year $t-1$;

gap_{it} is the difference between the median productivity of 5% of the most productive firms and the productivity of firm i in year t (distance to frontier);

age_{it} is the age of firm i in period t; we also include squared age in order to control for a possible nonlinear relation between age and labour productivity growth;

G_p is a dummy variable for pth size;

Y_j is a dummy variable for jth year;

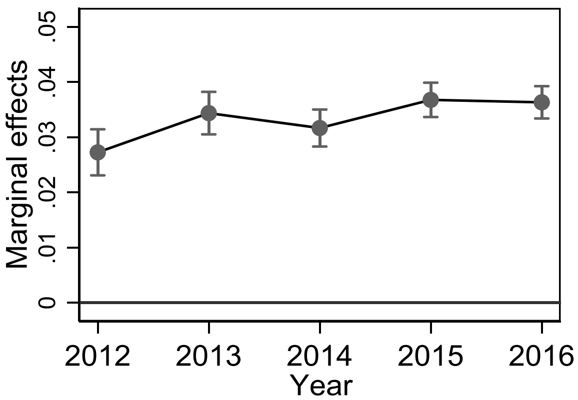
S_k is a dummy variable for kth sector.

A significant positive coefficient for the distance to frontier gap_{it} implies that the worse initial conditions, the higher the labour productivity growth rate, in line with Cette et al. (2018) and Andrews et al. (2016). It suggests β-convergence.

We run several specifications to check the robustness of the presence of β-convergence to different definitions of productivity (labour productivity and MFP) and different sets of control variables. We present the results of eight specifications of β-convergence in Table 1. The dependent variable in the first three specifications is labour productivity growth. The first specification is a pooled model, presented above, the independent variable is a lagged gap to the productivity frontier, we also include age, size and year controls. We add size-gap and year-gap interactions to the second specification. We do not include size-gap and year-gap interactions in the third specification; instead, we include age-gap interactions. The dependent variable in the fourth and fifth specifications is multifactor productivity growth instead of labour productivity. We calculate the dependent variable, choose controls and the number of sectors following Cette et al. (2018) (specification 4), and Andrews et al. (2016) (specification 5). In the fifth specification, we estimate labour and capital shares as elasticities of value added with respect to labour and capital. To estimate production functions, we use the Levinsohn-Petrin-Wooldridge approach (Pterin and Levihnson, 2012, Wooldridge, 2009). We include growth rate at frontier. The errors are clustered at an industry level.

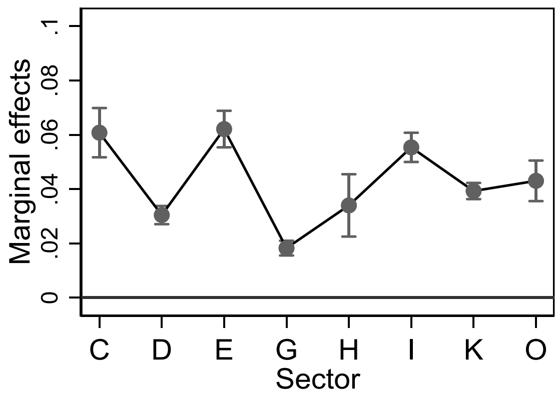
We estimate fixed effects models instead of pooled models in the last three specifications. The sixth specification is a modified second specification with fixed effects included and sector controls excluded. The seventh and eighth specifications are modified fourth and fifth specifications, respectively, with fixed firms effects included (for details, see Appendix C).

Figure 10. Speed of β-convergence by year



Source: authors' estimates
Note: average marginal effects with 95% confidence intervals

Figure 11. Speed of β-convergence by sector



C	Mining	H	Hotels&Restaurants
D	Manufacturing	I	Transport&Communication
E	Utilities	K	Business services
G	Trade	O	Other services

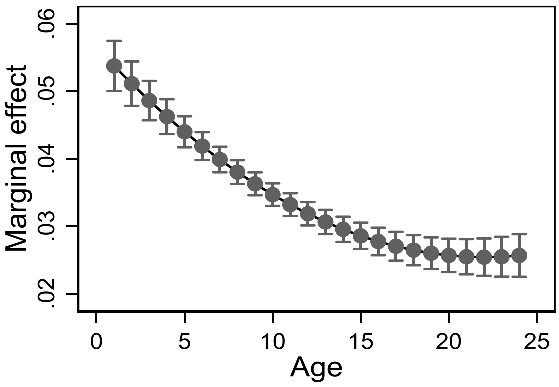
Source: authors' estimates
Note: average marginal effects with 95% confidence intervals

In Table 1, we report average marginal effects of the gap in the previous period, in other words, an average change in productivity growth with respect to a change in the gap in the previous period. Pooled OLS estimations of the convergence coefficient provide similar results for the speed of β-convergence for both labour and multifactorial productivity. The average marginal effects in the pooled models lie in the range of 0.03-0.1. Thus, the average rate of convergence in the Russian economy is close to the estimates of convergence rates among countries (about 2%, see, for example, Abreu et al. (2005)), which may reflect large differences in the levels of regional development within Russia. We do not observe a convergence slowdown over the 2012-2016 period (Figure 10), in contrast with Cette at al. (2018) estimations. They report a sharp decline in the speed of β-convergence in the post-crisis period.

The speed of β-convergence varies for different sectors (see Figures 11, which plots the estimates of β_1 plus coefficient by a cross-term of the gap and sector dummy). Manufacturing and trade show the lowest rates of β-convergence.

Results of the third specification show that the convergence speed of young firms is higher than that of older enterprises (Figure 12). It takes a new firm 13 years to halve the distance to frontier. But as a new firm ages it does not get closer to frontier. On the contrary, it takes even more time to halve the distance to frontier (Figure 13).

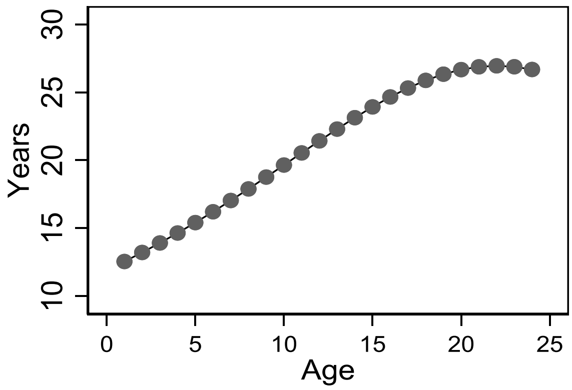
Figure 12. Speed of β-convergence by age



Source: authors' estimates

Note: average marginal effects with 95%confidence intervals

Figure 13. Half-life of convergence to frontier



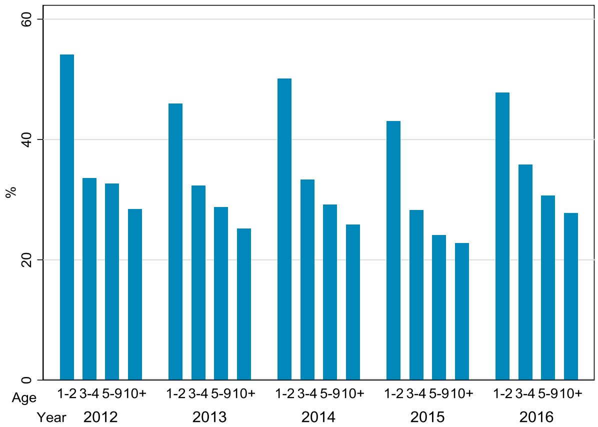
Source: authors' estimates

In specifications 1-5, we estimate convergence coefficients for labour and multifactorial productivity conditional on an array of explanatory variables: years, sectors, age and size. In Models 6-8, we assume convergence conditional on individual constants for each firm. It is the extreme version of conditionality: in introducing fixed effects into the model we take into account all possible observable and unobservable characteristics of firms. In other words, in this type of the model, each firm converges to its individual level of productivity instead of the productivity frontier in industry. Consequently, in line with the literature (Dowrick and Rogers (2002); Barro (2012)) convergence rates in specifications 6-8 are substantially higher than those in specifications 6-8.

Summarizing the results of various specifications, we conclude that in the case of the Russian economy, the β-convergence process is mainly driven by the catching up of young new firms. Indeed, the share of high-productivity growth firms among young firms is significantly higher than in the other age groups (Figure 14), and the distribution of the labour productivity growth rates for young firms has a fat tail at positive values (Figure 15). At the same time, as the age of the survivals increases the rate of convergence slows down, and, as a result, older firms stagnate without reaching the productivity levels of frontier companies. These results are in line with the findings of Haltiwanger et al. (2013), who show a large contribution of surviving young firms to net growth for the U.S. In fact, Decker et al.

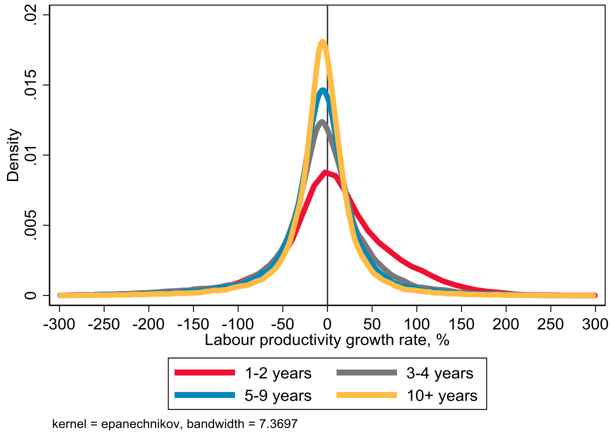
(2014), also using U.S. data, show that this group of enterprises is extremely uneven and the share of firms with very high growth rates is not large.

Figure 14. Share of firms with labour productivity growth of more than 10% by age group



Source: authors' estimates

Figure 15. Density of labour productivity growth by age group



Source: authors' estimates

Table 1. Estimation results of β-convergence

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Productivity	Labour productivity	Labour productivity	Labour productivity	MFP	MFP	Labour productivity	MFP	MFP
MFP estimation	-	-	-	Non-parametric: share of labour cost in value added	Levinsohn-Petrin-Wooldridge	-	Non-parametric: share of labour cost in value added	Levinsohn-Petrin-Wooldridge
Frontier identification	5% best in industry	5% best in industry	5% best in industry	5% best in sector	5% best in industry	5% best in industry	5% best in sector	5% best in industry
Sectors	C D E G H I K O	C D E G H I K O	C D E G H I K O	A C D E F G I O	C D E F G H I K	C D E G H I K O	A C D E F G I O	C D E F G H I K
Regression	Pooled	Pooled	Pooled	Pooled	Pooled	Fixed effect	Fixed effect	Fixed effect
Error clusterisation	No	No	No	No	Yes	No	No	Yes
Coefficient of convergence*	**0.03**	**0.03**	**0.03**	**0.04**	**0.10**	**0.51**	**0.62**	**0.69**
Frontier growth	No	No	No	No	Yes	No	No	Yes
Age controls	Yes	Yes	Yes	No	Yes	Yes	No	Yes
Size dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector dummies	Yes	Yes	Yes	Yes	Yes	No	No	No
Year*gap interaction	No	Yes	No	Yes	Yes	Yes	Yes	Yes
Sector*gap interaction	No	Yes	No	No	No	No	No	No
Age*gap interaction	No	No	Yes	No	No	No	No	No

Note: The table presents the estimates of the β-convergence coefficient for various productivity measures. Reported coefficients in all the columns are the average marginal effects of the gap to frontier on productivity growth. We estimate labour productivity convergence conditional on age, year and sector using the first three specifications. The second specification allows the β-convergence coefficient to vary as it includes sector-gap and size-gap interactions. The third specification allows the β-convergence coefficient to vary with age. We estimate MFP convergence using the fourth and fifth specifications following Cette et al. (2018) and Andrews et al. (2016). The last three specifications are the extreme cases of conditional β-convergence as we include not only observable controls, but also unobserved cross-firm heterogeneity (fixed effects). The sixth, seventh and eighth specifications are modified second, fourth and fifth specifications correspondingly with fixed effects included.
**All estimated convergence coefficients are significant at 1% level.*

4.2. σ-convergence

The recent literature shows that productivity is highly heterogeneous even in narrowly defined industries. Moreover, the gap is increasing despite a negative correlation between the productivity level and its growth. In means that β-convergence is accompanied with σ-divergence.

For example, Berlingieri et al. (2017) report σ-divergence of productivity based on firm-level data from OECD countries. The main indicator of dispersion they use is the difference between the 90th and 10th percentiles of log-productivity (a ratio of 90 to 10). This indicator takes into account change in the sample over time and all shocks which are neglected by the β-convergence indicator. On the other hand, the extreme observations with the highest and the lowest productivity are excluded from the analysis. It makes the 90-to-10 ratio more robust to outliers than a simple standard deviation. Berlingieri et al. (2017) calculate this ratio for manufacturing and services for 16 countries[7] in 2011.

Figure 16. Ratio of labour productivity of the 10th to 1st decile, division without renewal, logarithmic scale

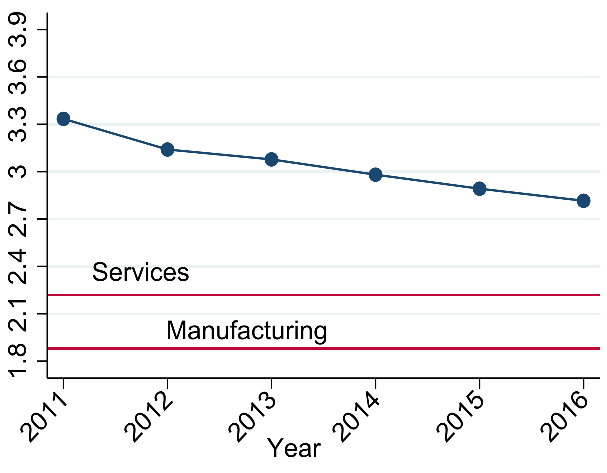
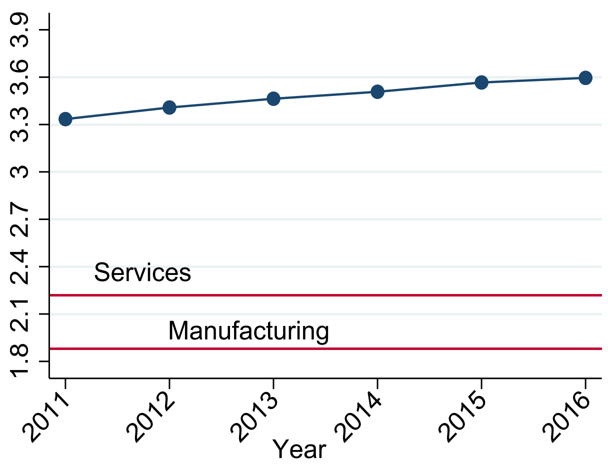


Figure 17. Ratio of labour productivity of the 10th to 1st decile, division with renewal, logarithmic scale



Source: authors' estimates
Note: red line corresponds to the 90-to-10 ratio reported in Berlingieri et al. (2017) as unweighted average for several countries. The sample includes: Australia, Austria, Belgium, Chile, Denmark, Finland, France, Hungary, Indonesia, Italy, Japan, the Netherlands, New Zealand, Norway, Portugal, Sweden.

Figure 16 shows that the log of the ratio was 3.48 in 2011. The red lines represent unweighted averages in manufacturing and services sectors for countries calculated by Berlingieri et al. (2017). We find that in Russia the ratio was higher than in all the countries in the sample used by Berlingieri et al. (2017), except for the services sector in Chile. The estimates for the U.S. are also lower: 1.9 in 1997-2010 reported by Cunningham et al. (2017) and 1.4 in 1977 reported by Syverson (2004). The relatively high level of productivity dispersion may be associated with the high regional segmentation in Russia (see Appendix D).

[7] The sample includes: Australia, Austria, Belgium, Chile, Denmark, Finland, France, Hungary, Indonesia, Italy, Japan, the Netherlands, New Zealand, Norway, Portugal, Sweden.

Applying the division-without-renewal approach we find that the ratio declined over the sample period. It means that among firms found in the sample in 2011 the gap decreased. But it remained wider than the values reported by Berlingieri et al. (2017). Wholesale and retail trade (G) and business services (K) feature the greatest gap between the most and the least productive firms.

If we focus on the 1st and 10th deciles in each year, including all firms into our analysis, we find that the gap remains substantially higher than Berlingieri et al. (2017) present. Moreover, the ratio increased over the sample period.

Figure 18 summarizes the difference between the 90-to-10 ratio of labour productivity in 2016 and in 2011 across 173 industries in the sample. Unlike Griffith et al. (2009) or Conway et al. (2015), we find that the dispersion increased over the sample period in most industries. Mining and quarrying (sector C) saw the highest ratio growth. This suggests that mining and quarrying experienced the most rapid divergence of labour productivity.

Figure 18. Change in the 90-to-10 ratio of labour productivity in 173 industries in 2011-2016

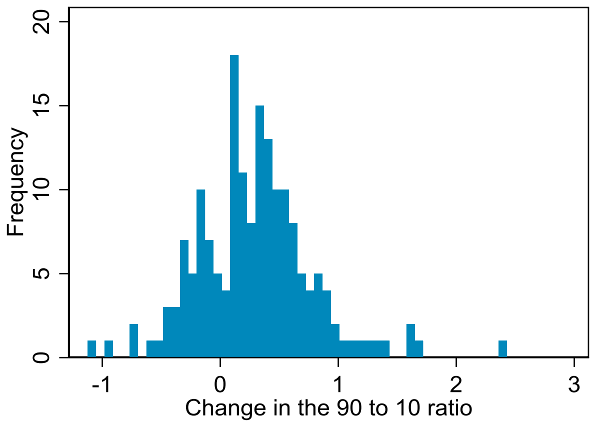
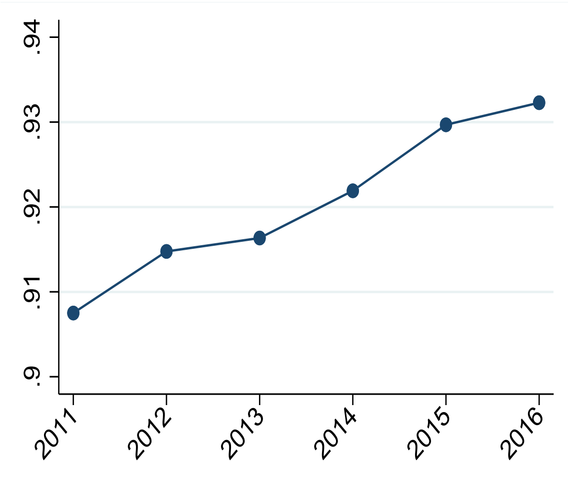


Figure 19. Interdecile dispersion of labour productivity (10th-1st) / (10th+1st)



Source: authors' estimates

Another indicator of σ-convergence is interdecile dispersion. It is calculated as the difference between the 10th and 1st deciles divided by their sum. As can be seen from Figure 19, this indicator shows a moderately positive change in the post-crisis period. Cette et al. (2018) obtained a similar result for French companies. Both indicators therefore provide evidence of σ-divergence.

We also check the persistence of the position of a firm in the distribution of labour productivity. To construct the transition matrices, we estimate a dynamic multinomial model. The dependent variable is the resulting productivity quartile, while the explanatory variables are the productivity quartile in the previous year and controls for age and size. As Wooldridge (2005) points out, in this type of model, the treatment of a lagged dependent variable as exogenous is an issue known as an initial condition problem. The GMM framework is normally used to solve this problem in the case of linear models. However, in nonlinear models such as our dynamic multinomial model, the initial condition problem is more complicated. In order to solve this problem, Wooldridge (2005) proposes to control for unobserved heterogeneity by including the initial value of a dependent variable as well as initial and average values of exogenous variables. We follow Skrondal and Rabe-Hesketh (2014) and use the program gllamm in the Stata statistical package in order to implement the Wooldridge (2005) approach. As result, we estimate the following model:

$$PR(Qt_{it} = k) = \frac{\exp(\boldsymbol{\beta_k X})}{1 + \sum_{m=1}^{3} \exp(\boldsymbol{\beta_m X})}$$

Where Qt_{it} is a productivity quartile of firm i in year t, k takes values from 1 to 3, the fourth (the most productive) quartile is treated as a baseline outcome. $\boldsymbol{X}$ is a vector of explanatory variables and controls. $\boldsymbol{X}$ includes the productivity quartile in the previous year Qt_{it-1}; age of firm i in year t, age_{it}; two dummy variables for size categories 2 (the number of employees larger than 50 and smaller than 250) and 3 (more than 250 employees) $size_{it}$. $\boldsymbol{X}$ also includes initial values of these variables: the initial quartile, age and two dummies for size. Moreover, $\boldsymbol{X}$ includes the average values of exogenous variables: age and two dummies for size.

We follow Wooldridge (2005) and Skrondal and Rabe-Hesketh (2014) by including only observations which are part of a consecutive sequence of at least two non-missing records. We estimate this model separately for each sector. We present the results in Appendix E. Positive coefficients mean that a firm is more likely to be in a particular quartile than in the baseline quartile (the fourth quartile), and, vice versa, negative coefficients mean that a firm is less likely to be in a particular quartile than in the baseline quartile (the fourth quartile).

The dynamic multinomial model enables us to predict modeled probabilities of getting in a particular quartile of productivity distribution given the previous quartile and controls (Figure 20).

Transition matrices between quartiles illustrate that the group of the most productive firms is relatively stable. For example, 81% of the most productive firms (the 4th quartile) in 2011 remain in the same quartile in 2012, 12% of them go down to the 3rd quartile, 1% - to the 3rd and 1% to the worst quartile. In the following years, the share of the most productive firms remaining in the 4th quartile is even higher at 84-85%. Moreover, the share of firms from the 3rd quartile improving to the 4th quartile is no more than 14%. The probability that firms in the lowest quartile will manage to improve their position is also very low at 16-18% in different years. Thus, both the group of the most efficient firms and that of the least efficient ones remain stable over the period under analysis.

Using labour productivity data, we show that laggards grow on average faster than leaders. Moreover, we find a significant β-convergence coefficient. At the same time, the Russian economy is characterized by a very large disparity in productivity levels in comparison with other countries. Therefore, the starting point of the least productive firms is very low. Over six years of the sample period, firms which were the least productive in 2011 approached leaders, but they remain far less productive. In addition, we found that the rate of β-convergence decreased with firms' age, making the survivals unable to get significantly closer to the frontier firms. This gap between the most and the least productive firms appears to be too wide to overcome in the near future. Moreover, despite the presence of β-convergence (i.e. the catching up of the least productive firms) we find that with all firms, including those new in the sample, taken into account, the gap between the most and the least productive firms has increased over the post-crisis period. The persistence of productivity levels means that fast productivity growth at the lower bound is not enough for convergence to occur.

Figure 20. Transition matrices between quartiles of labour productivity distribution simulated from a dynamic multinomial model

		2012				
		4	3	2	1	
2011	4	81%	17%	2%	1%	100%
	3	12%	69%	17%	2%	100%
	2	1%	14%	71%	13%	100%
	1	1%	2%	14%	84%	100%

		2013				
		4	3	2	1	
2012	4	85%	13%	1%	1%	100%
	3	14%	68%	16%	2%	100%
	2	2%	16%	69%	14%	100%
	1	1%	2%	16%	82%	100%

		2014				
		4	3	2	1	
2013	4	84%	13%	2%	1%	100%
	3	13%	68%	17%	2%	100%
	2	2%	15%	68%	15%	100%
	1	1%	2%	14%	83%	100%

		2015				
		4	3	2	1	
2014	4	84%	13%	2%	1%	100%
	3	12%	67%	18%	3%	100%
	2	2%	15%	68%	16%	100%
	1	1%	2%	14%	84%	100%

		2016				
		4	3	2	1	
2015	4	84%	13%	2%	1%	100%
	3	12%	67%	18%	3%	100%
	2	2%	14%	66%	18%	100%
	1	1%	2%	13%	84%	100%

Source: authors' estimates

Note: firms in the fourth quartile are the most productive in terms of labour productivuty, firms in the first quartile are the least productive in terms of labour productivuty. Transition matrices illustrate the share of firms which transit from quartile to quartile in each year.

5. MULTIFACTOR PRODUCTIVITY CONVERGENCE UNDER THE STOCHASTIC FRONTIER MODEL

In this section, we apply the stochastic frontier analysis (SFA) to verify the result regarding the divergence dynamics obtained in the previous section. SFA allows estimating multifactor productivity growth as well as relative efficiency of a firm and its evolution simultaneously, because convergence parameters are explicitly included in the specifications. In this type of models, the leaders (i.e. firms closest to the stochastic production possibility frontier) are defined using information on firms' performance during the entire sample period. In this sense, the pool of leaders is expected to be more stable and less sensitive to changes in the position of a firm over years.

We adopt the panel production frontier model with a translog specification (see, for example, Kim (1992); Coelli et al. (1999); Coelli et al. (2003); Adetutu et al. (2015)):

$$y_{it} = \beta_0 + \beta_1 l_{it} + \beta_2 k_{it} + \beta_3 t + \beta_4 l_{it}^2 + \beta_5 k_{it}^2 + \beta_6 t^2 + \beta_7 l_{it} k_{it} + \beta_8 l_{it} t + \beta_{89} k_{it} t + v_{it} - u_{it},$$

where

y_{it} is the logarithm of value added of firm i in period t,

l_{it} is the logarithm of labour force,

$k_{it}$is the logarithm of capital used,

t is period of time,

v_{it} is the error term, $v_{it} \sim N(0, \sigma_v^2)$,

$u_{it} \geq 0$ represents technical inefficiency.

The deterministic part of production function represents the production frontier, i.e. the highest level of production at given levels of labour and capital.

We adopt two types of specifications for the inefficiency part:

1. the time varying decay specification following Battese and Coelli (1992):

$$u_{it} = G(t) u_i, \; G(t) = e^{\gamma(t-T)},$$

where

u_i is the time invariant component of inefficiency,

$u_i \sim N^+(0, \sigma_u^2)$, $G(t)$ is the time function,

γ is the decay parameter,

T is the terminal period.

γ is the parameter indicating convergence or divergence.

If $\gamma < 0$ firms converge to frontier, and if $\gamma > 0$ firms diverge from frontier. The model ignores temporary productivity deviations. It smooths fluctuations of productivity, consequently, only firms with constantly high productivity levels are regarded as leaders. Since the groups of leaders are stable over the sample period but these groups include enterprises which are the most productive over the entire sample period, the time decay specification compromises between two approaches to defining frontier used in the previous section (division with or without renewal).

2. the modified Kumbhakar (1990) model:

$$u_{it} = G(t)u_i,\ G(t) = \left[1 + \exp(\sum_{j=2012}^{2016} \beta_j * Y_j)\right]^{-1},$$

Where

u_i is the time invariant component of inefficiency, $u_i \sim N^+(0, \sigma_u^2)$,

$G(t)$ is the time function, Y_j is a dummy variable for jth year.

The crucial difference between the two specifications is flexibility. In the first specification, we assume a smooth technical efficiency exponential increase or decrease. Therefore, we impose restrictions on the evolution of technical efficiency. We parametrize it with just one coefficient γ (the decay parameter). In the second specification, we relax this assumption. We assume that technical efficiency may fluctuate from year to year. We introduce dummy variables for each year reflecting a different gap to the frontier in each year.

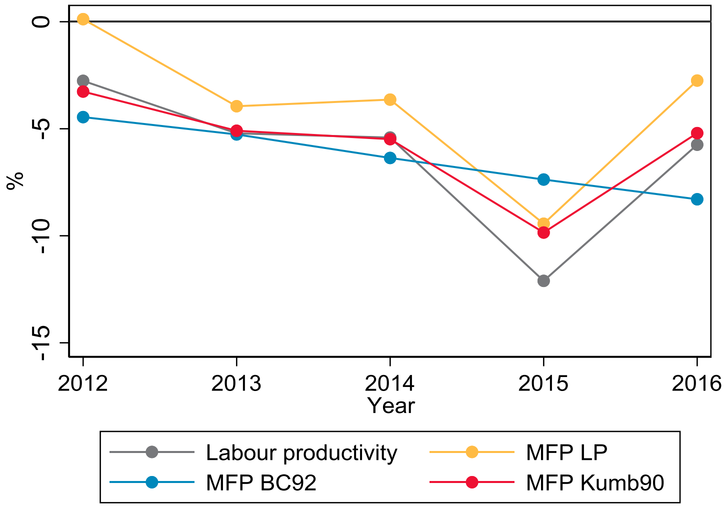
We estimate the time varying decay specification for all 173 industries in our sample. For the second specification with the time dummies in the inefficiency term (Kumbhakar 90), the estimation procedure was not converged for twelve industries.

Both specifications allowed estimating the technical efficiency index, i.e., the distance to frontier: $Index = \exp(u_{it})$. Its value lies between 0 and 1, where 1 is the most efficient firm. It is another measure of firms' efficiency along with relative labour productivity estimated in the previous section.

In the case of two stochastic frontier models, we estimated MFP growth rates for each firm as a sum of three components - technological progress, change in the efficiency level of a firm and the return to scale term (for details, see Appendix F). In Figure 3, we present the average MFP growth rates for both specifications and compare them with labour productivity growth and MFP growth calculated following the Levinsohn-Petrin-Wooldridge approach (see section 3). Estimations of MFP growth as part of both stochastic frontier models are relatively close to labour productivity growth and non-stochastic MFP growth. The first model produces a smooth MFP growth decline due to a rigid specification of the technical efficiency component. The second model yields a more volatile MFP growth because the second specification allows technical efficiency to fluctuate each year. As a result, the first specification extrapolates the negative trend to the last year of the sample, while the second specification indicates some recovery in 2016, which is in line with the labour productivity and non-stochastic MFP evolution.

The distribution of technical efficiency as part of the stochastic frontier model is more stable over time than the distribution of relative labour productivity estimated earlier. To illustrate this point, we calculate transition matrices between the quartiles of technical efficiency distribution for the time decay specification. The results for the Kumbhakar 90 specification are almost the same.

Figure 21. Average productivity growth rates estimated using different methodologies



Source: authors' estimates

Note: labour productivity growth is calculated as log difference of labour productivity. Multifactor productivity growth LP is estimated using the Levinsohn-Petrin-Wooldridge approach: as output growth unexplained by input growth. Shares of factor inputs are estimated via production function, with instrumented labour input. MFP BC92 growth is estimated as sum of three components: technical progress, technical efficiency change and scale effect. The inefficiency specification is time decay model following Battese and Coelli (1992). MFP Kumb90 growth is estimated as sum of the same three components, but in discrete time set up. The inefficiency specification is modified Kumbhakar90 model.

Figure 22 shows that these groups are even more stable than the quartiles of labour productivity distribution. It is almost impossible for firms to improve from the 3rd to the 4th quartile of estimated technical efficiency.

The persistence of technical efficiency, i.e., low probability of improving the relative position, indicates that the catching up impulse of β-convergence is not sufficient for companies to shift to the more productive groups. Next, we focus on technical efficiency estimations as an indicator of an increasing or decreasing gap between the production frontier and laggards.

In the time varying decay model (the first specification), we parametrize convergence with γ being a decay parameter. Positive γ indicates divergence and negative γ indicates convergence. In most industries in our sample we find positive γ (see Appendix H). It means that technical efficiency worsened over the sample period and companies diverge from frontier. As Figure 23 shows, among 173 industries under examination we find 139 industries with a statistically significant decay parameter (we show results with the opposite sign for comparability purposes). In all of these industries, we estimate a positive decay parameter. It indicates that firms diverge from frontier. In the rest of the industries we find an insignificant parameter γ, suggesting no evidence for convergence.

In the modified Kumbhakar 90 (the second specification), we parametrize convergence with a set of year dummies (β_j) instead of a single decay coefficient. Positive β_j indicates that the average distance to frontier in year j was shorter than in the baseline year (2011), while negative β_j indicates widening gap in year j relative to 2011. The results of the second specification (modified Kumbhakar 90) indicate that technical efficiency worsened in most of the industries over the sample period (Figure 24) (see Appendix I). In 94 industries out of 161, we find a negative coefficient for the 2016 dummy variable in the inefficiency term, it means the distance to frontier increased. Technical efficiency improves only in 5 industries in 2016 relative to 2011. In the rest 62 industries, change in technical efficiency is insignificant.

Figure 22. Transition matrices between technical efficiency quartiles

		2012				
		4	3	2	1	
2011	4	86%	14%	0%	0%	100%
	3	0%	84%	16%	0%	100%
	2	0%	0%	86%	13%	100%
	1	0%	0%	1%	99%	100%

		2013				
		4	3	2	1	
2012	4	94%	6%	0%	0%	100%
	3	3%	90%	7%	0%	100%
	2	0%	2%	91%	7%	100%
	1	0%	0%	2%	98%	100%

		2014				
		4	3	2	1	
2013	4	95%	5%	0%	0%	100%
	3	2%	91%	7%	0%	100%
	2	0%	2%	92%	6%	100%
	1	0%	0%	2%	98%	100%

		2015				
		4	3	2	1	
2014	4	96%	4%	0%	0%	100%
	3	1%	93%	6%	0%	100%
	2	0%	2%	94%	5%	100%
	1	0%	0%	2%	98%	100%

		2016				
		4	3	2	1	
2015	4	95%	5%	0%	0%	100%
	3	1%	92%	7%	0%	100%
	2	0%	1%	93%	6%	100%
	1	0%	0%	1%	99%	100%

Source: authors' estimates
Note: firms in the fourth quartile are the most efficient in terms of technical efficiency index, firms in the first quartile are the least effective in terms of technical efficiency index. Transition matrices illustrate the share of firms which transit from quartile to quartile in each year.

Thus, the Kumbhakar 90 specification, which is more flexible than the time varying decay model, supports our conclusion that most of the industries in our sample show divergence of technical efficiency.

Despite the fast productivity growth of laggards found previously (of β-convergence), the gap to frontier increases in most industries. It is confirmed by σ-convegrence indicators and stochastic frontier models. In the latter case, we estimate two different specifications: with divergence parametrized by a single coefficient (a smooth decline or improvement in the gap to frontier) and with divergence parametrized for each year in the sample separately. The results of both specifications show that in most industries technical efficiency decreased over the sample period, i.e., firms diverged from frontier. It means that the catching up impulse of young low-productivity firms is not sufficient for convergence in terms of decreasing the distance to frontier.

Figure 23. Estimated convergence parameters of the time varying decay model by industry (with the opposite sign)

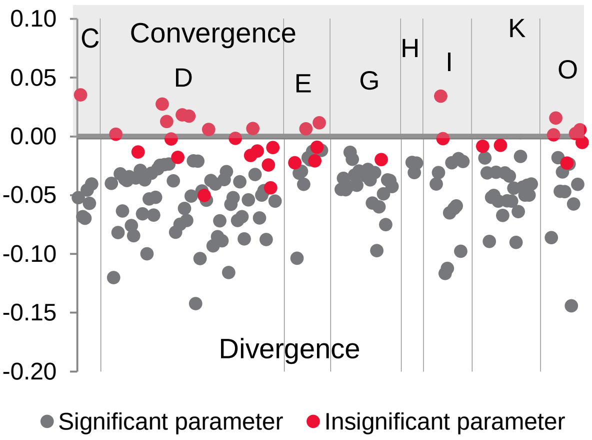
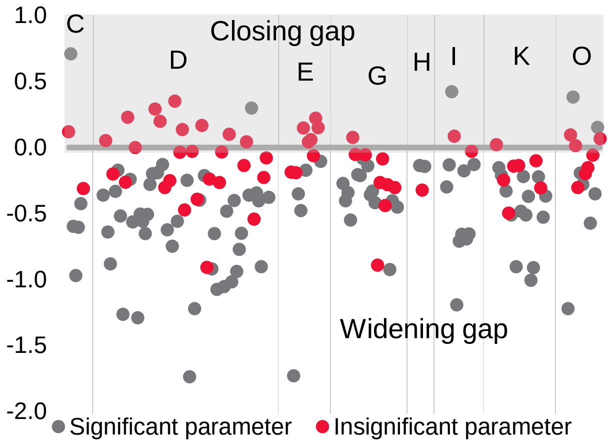


Figure 24. Estimated convergence parameters of modified Kumbhakar 90 model by industry



C	Mining	G	Wholesale and retail trade	K	Business services
D	Manufacturing	H	Hotels and restaurants	O	Personal and other services
E	Utilities	I	Transportation and communications		

Source: authors' estimates

Note: The left-hand graph presents estimated decay parameter γ for each industry in the first specification (Battese and Coelli, 1992), where γ is introduced in the inefficicency specification in the following way: $u_{it} = G(t)u_i,\ G(t) = e^{\gamma(t-T)}$. Positive γ means divergence, negative - convergence. We present it with opposite sign for comparability. The right-hand graph presents the estimated dummy coefficients for 2016. We modify the Kumbhakar 90 specification, instead of time and time squared we include year dummies in the inefficiency specification in the following way: $u_{it} = G(t)u_i,\ G(t) = \left[1 + \exp(\sum_{j=2012}^{2016} \beta_j * Y_j)\right]^{-1}$. Positive β_{2016} means that the average efficiency in 2016 was greater than in 2011, in other words, the gap between frontier and laggards decreased.

We compare the performance of industries in which firms do not diverge from frontier with industries where divergence is found (according to our first specification). To do so, we compare industries featuring the absence and presence of divergence dynamics within the same broader class of industries (mainly at the two-digit level of OKVED).

We compare the main components of MFP growth (technical progress and technical efficiency change) in groups of industries where firms diverge from frontier and where they do not. We find that in most industries the absence of divergence is associated with a smaller change in technical progress (for details, see Appendix G). It means that no divergence occurs in these industries because of the absence of growth at frontier rather than due to a stronger catching up process of low-productivity firms. At the same time, in the industries where most firms diverge from frontier, the productivity growth of leaders is stronger than in industries with no divergence. Thus, the absence of divergence does not result in a faster average productivity growth. In diverging industries, aggregate productivity growth may be stronger due to better performance of leaders.

6. CONCLUSIONS

In almost all studies examining correlation between the productivity level and its growth, β-convergence is found. It means that low-productivity firms on average grow faster than high-productivity ones. On the other hand, the literature shows that even in narrowly defined industries, the gap between leaders and laggards is wide and persistent. It means that fast growth of laggards relative to other groups of firms does not narrow the gap. Instead, σ-convergence, i.e., increasing dispersion of productivity, is found in a number of studies.

We show that this result also holds for Russian firms. On the one hand, we have found that low-productivity firms on average show higher productivity growth rates (the so-called β-convergence). On the other hand, despite the confirmed β-convergence, the distance between leaders and laggards in the Russian economy is large, this gap is wider than that reported for other countries. In addition, over the period of observation, the gap continues to grow, suggesting divergence in productivity levels (i.e., σ-divergence).

The lack of convergence is due to two facts. First, the share of very efficient firms appears to be tiny, and second, the distribution of firms is highly persistent, i.e., leaders enjoy high productivity over the period of observation and firms at the lower bound of distribution tend to remain in this position. Thus, the observed β-convergence, driven mainly by new entrants, is not significant enough to translate into aggregate productivity growth, because the share of inefficient stagnating companies is quite high in the Russian economy. Other approaches to estimating convergence show no convergence (the σ-convergence model) or even statistically significant divergence coefficients in the stochastic frontier analysis.

In comparison with the σ-convergence model, the stochastic frontier approach is more robust to the choice of leaders and the definition of laggards. According to SFA models, leaders are defined based on firms' performance over the entire sample period. In addition, the convergence parameter is explicitly included in the specification of the production function under this approach. The results of our stochastic frontier analysis confirm that in most of the industries in our sample the gap between leaders and laggards increases. This finding is in line with the results of the analysis of β-convergence, where we show that high growth rates run peter out as firms age and older firms are unable to continue catching up.

Thus, the results of different convergence analysis methods do not contradict one another. Rather, they reveal the sources of divergence in firms' productivity levels which are not the lack of growth at frontier or low growth of new efficient firms but the lack of reallocation of resources from old inefficient firms to leaders operating at the production frontier or to fast-growing entrants.

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Appendix A

Sector list

Sector Code	Sector
C	Mining and quarrying
D	Manufacturing
E	Electricity, gas and water supply
G	Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods
H	Hotels and restaurants
I	Transport, storage and communication
K	Real estate, renting and business activities
O	Other community, social and personal service activities

Appendix B

Industry list

Sector code	Industry code	Industry
C	10.1 †	Mining and agglomeration of hard coal
C	10.2+10.3 § ‡	Mining and agglomeration of lignite and peat
C	11.1	Extraction of crude petroleum and natural gas
C	11.2	Service activities incidental to oil and gas extraction, excluding surveying
C	13	Mining of metal ores
C	14.1	Quarrying of stone
C	14.2 †	Quarrying of sand and clay
D	15.1	Production, processing and preserving of meat and meat products
D	15.2 ~	Processing and preserving of fish and fish products
D	15.3 § †	Processing and preserving of fruit and vegetables
D	15.4	Manufacture of vegetable and animal oils and fats
D	15.5 ~	Manufacture of dairy products
D	15.6	Manufacture of grain mill products, starches and starch products
D	15.7 †	Manufacture of prepared animal feeds
D	15.8	Manufacture of other food products
D	15.9	Manufacture of beverages
D	17.1+17.2	Preparation and spinning of textile fibres and Textile weaving
D	17.4	Manufacture of made-up textile articles, except apparel
D	17.5 †	Manufacture of other textiles
D	17.6+17.7 § †	Manufacture of knitted and crocheted fabrics and articles
D	18	Manufacture of wearing apparel: dressing and dyeing of fur
D	19	Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear
D	20.1 †	Sawmilling and planing of wood; impregnation of wood
D	20.2	Manufacture of veneer sheets; manufacture of plywood, laminboard, particle board, fibre board and other panels and boards
D	20.3	Manufacture of builders' carpentry and joinery
D	20.4+20.5	Manufacture of wooden containers and other products of wood; manufacture of articles of cork, straw and plaiting materials
D	21.1	Manufacture of pulp, paper and paperboard
D	21.2	Manufacture of articles of paper and paperboard
D	22.1	Publishing
D	22.2	Printing and service activities related to printing
D	23.2 § †	Manufacture of refined petroleum products
D	24	Manufacture of chemicals and chemical products
D	25.1 § †	Manufacture of rubber products
D	25.2	Manufacture of plastic products
D	26.1 § ~	Manufacture of glass and glass products
D	26.2+26.32 †	Manufacture of non-refractory ceramic goods other than for construction purposes; manufacture of refractory ceramic products and ceramic tiles and flags
D	26.4	Manufacture of bricks, tiles and construction products, in baked clay
D	26.5 § †	Manufacture of cement, lime and plaster
D	26.6	Manufacture of articles of concrete, plaster and cement
D	26.7 § †	Cutting, shaping and finishing of stone
D	26.8	Manufacture of other non-metallic mineral products
D	27.1 †	Manufacture of basic iron and steel and of ferro-alloys
D	27.2 § †	Manufacture of tubes

§ no divergence in Battese and Coelli (1992) model
~ no data in Kumbhakar (1990) model
† no divergence or convergence in Kumbhakar (1990) model
‡ convergence in Kumbhakar (1990) model

Sector code	Industry code		Industry
D	27.3	†	Other first processing of iron and steel and production of ferro-alloys
D	27.4		Manufacture of basic precious and non-ferrous metals
D	27.5		Casting of metals
D	28.1	†	Manufacture of structural metal products
D	28.2		Manufacture of tanks, reservoirs and containers of metal; manufacture of central heating radiators and boilers
D	28.3	†	Manufacture of steam generators, except central heating hot water boilers
D	28.4	§ ~	Forging, pressing, stamping and roll forming of metal; powder metallurgy
D	28.5		Treatment and coating of metals; general mechanical engineering
D	28.6	§ †	Manufacture of cutlery, tools and general hardware
D	28.7		Manufacture of other fabricated metal products
D	29.11	†	Manufacture of engines and turbines, except aircraft, vehicle and cycle engines
D	29.12	†	Manufacture of pumps and compressors
D	29.13		Manufacture of taps and valves
D	29.21		Manufacture of furnaces and furnace burners
D	29.22		Manufacture of lifting and handling equipment
D	29.23	†	Manufacture of non-domestic cooling and ventilation equipment
D	29.24	†	Manufacture of other general purpose machinery n.e.c.
D	29.3	~	Manufacture of agricultural and forestry machinery
D	29.4		Manufacture of machine-tools
D	29.5		Manufacture of other special purpose machinery
D	29.7	§ †	Manufacture of domestic appliances n.e.c.
D	30.0		Manufacture of office machinery and computers
D	31.1		Manufacture of electric motors, generators and transformers
D	31.2		Manufacture of electricity distribution and control apparatus
D	31.3		Manufacture of insulated wire and cable
D	31.4	~	Manufacture of accumulators, primary cells and primary batteries
D	31.5		Manufacture of lighting equipment and electric lamps
D	31.6	§ †	Manufacture of electrical equipment n .e .c.
D	32	§ †	Manufacture of radio, television and communication equipment and apparatus
D	33		Manufacture of medical, precision and optical instruments, watches and clocks
D	34.1	§ ‡	Manufacture of motor vehicles
D	34.2	†	Manufacture of bodies (coachwork) for motor vehicles; manufacture of trailers and semi-trailers
D	34.3		Manufacture of parts and accessories for motor vehicles and their engines
D	35.2		Manufacture of railway and tramway locomotives and rolling stock
D	36.1		Manufacture of furniture
D	36.2	§ †	Manufacture of jewellery and related articles
D	36.5	§ ~	Manufacture of games and toys
D	36.6	§ †	Miscellaneous manufacturing n.e.c.
D	37.1		Recycling of metal waste and scrap
E	40.11.1	§ †	Production of electricity by thermal stations
E	40.11.5		Power pant supposrtung activities
E	40.12	†	Transmission of electricity
E	40.13.1		Operation of distribution systems
E	40.13.2		Sale of electricity to the user
E	40.13.3	§ †	Distribution electricity supporting activities
E	40.2		Manufacture of gas; distribution of gaseous fuels through mains
E	40.30.0	†	Steam and hot water supply
E	40.30.1	†	Production of steam and hot water for heating, power and other purposes

§ no divergence in Battese and Coelli (1992) model
~ no data in Kumbhakar (1990) model
† no divergence or convergence in Kumbhakar (1990) model
‡ convergence in Kumbhakar (1990) model

Sector code	Industry code	Industry
E	40.30.2 § †	Collection of steam and hot water for heating, power and other purposes
E	40.30.3 § †	Distribution of steam and hot water for heating, power and other purposes
E	40.30.4+40.30.5 § †	Production and distribution of steam amd hot water supporting activities and Sale of of steam and hot water
E	41.0	Collection, purification and distribution of water
G	50.1	Sale of motor vehicles
G	50.2	Maintenance and repair of motor vehicles
G	50.3	Sale of motor vehicle parts and accessories
G	50.5	Retail sale of automotive fuel
G	51.1 †	Wholesale on a fee or contract basis
G	51.2 †	Wholesale of agricultural raw materials and live animals
G	51.3	Wholesale of food, beverages and tobacco
G	51.4	Wholesale of household goods
G	51.5	Wholesale of non-agricultural intermediate products, waste and scrap
G	51.8 †	Wholesale of machinery, equipment and supplies
G	51.9	Other wholesale
G	52.1	Retail sale in non-specialized stores
G	52.2	Retail sale of food, beverages and tobacco in specialized stores
G	52.3	Retail sale of pharmaceutical and medical goods, cosmetic and toilet articles
G	52.41 †	Retail sale of textiles
G	52.42 †	Retail sale of clothing
G	52.43 ~	Retail sale of footwear and leather goods
G	52.44 †	Retail sale of furniture, lighting equipment and household articles n.e.c.
G	52.45 § †	Retail sale of electrical household appliances and radio and television goods
G	52.46 †	Retail sale of hardware, paints and glass
G	52.47	Retail sale of books, newspapers and stationery
G	52.48	Other retail sale in specialized stores
G	52.6 †	Retail sale not in stores
G	52.7	Repair of personal and household goods
H	55.1	Hotels
H	55.2 †	Camping sites and other provision of short-stay accommodation
H	55.3+55.4+55.5	Restaurants and Bars and Canteens and catering
I	60.1	Transport via railways
I	60.2	Other land transport
I	60.3 § ‡	Transport via pipelines
I	61.1 § †	Sea and coastal water transport
I	61.2	Inland water transport
I	62	Air transport
I	63.11	Cargo handling
I	63.12	Storage and warehousing
I	63.2	Other supporting transport activities
I	63.3	Activities of travel agencies and tour operators; tourist assistance activities n.e.c.
I	63.4 †	Activities of other transport agencies
I	64.1 ~	Post and courier activities
I	64.2	Telecommunications
K	70.1 § †	Real estate activities with own property
K	70.2	Letting of own property
K	70.3	Real estate activities on a fee or contract basis
K	71.1 ~	Renting of automobiles

§ no divergence in Battese and Coelli (1992) model
~ no data in Kumbhakar (1990) model
† no divergence or convergence in Kumbhakar (1990) model
‡ convergence in Kumbhakar (1990) model

Sector code	Industry code	Industry
K	71.2 †	Renting of other transport equipment
K	71.3	Renting of other machinery and equipment
K	72.1 †	Hardware consultancy
K	72.2	Software consultancy and supply
K	72.3 § †	Data processing
K	72.4	Database activities
K	72.5+72.6 †	Maintenance and repair of office, accounting and computing machinery and Other computer related activities
K	73	Research and development
K	74.1	Legal, accounting, book-keeping and auditing activities; tax consultancy; market research and public opinion polling: business and management consultancy; holdings
K	74.20.0	Architectural and engineering activities and related technical consultancy
K	74.20.1	Architectural and engineering activities
K	74.20.2	Geological and prospecting activities
K	74.20.3	Geodetic surveying and cartographic activities
K	74.3 †	Technical testing and analysis
K	74.4	Advertising
K	74.5 †	Labour recruitment and provision of personnel
K	74.6	Investigation and security activities
K	74.7 ~	Industrial cleaning
K	74.8	Miscellaneous business activities n.e.c.
O	90.00	Sewage and refuse disposal, sanitation and similar activities
O	90.01 § †	Collection and treatment of sewage
O	90.02 § ‡	Collection and treatment of other waste
O	90.03 †	Sanitation, remediation and similar activities
O	92.1 †	Motion picture and video activities
O	92.2	Radio and television activities
O	92.3+92.5	Other entertainment activities and Library, archives, museums and other cultural activities
O	92.4 †	News agency activities
O	92.6 †	Sporting activities
O	92.7 ~	Other recreational activities
O	93.01	Washing and dry-cleaning of textile and fur products
O	93.02 § †	Hairdressing and other beauty treatment
O	93.03	Funeral and related activities
O	93.04 § ‡	Physical well-being activities
O	93.05 § †	Other service activities n.e.c

§ no divergence in Battese and Coelli (1992) model
~ no data in Kumbhakar (1990) model
† no divergence or convergence in Kumbhakar (1990) model
‡ convergence in Kumbhakar (1990) model

Appendix C

Estimation results of β-convergence models

Model 1. Labour productivity

$$\Delta lp_{it} = \beta_0 + \beta_1 gap_{it-1} + \beta_3 age_{it} + \beta_4 {age_{it}}^2 + \sum_{p=2}^{3} \beta_p * G_p + \sum_{j=2013}^{2016} \beta_j * Y_j + \sum_{k=2}^{8} \beta_k * S_k$$

Δlp	Coef.	Std. Err.	95% Conf. Interval	
gap_{t-1}	0.03***	0.001	0.03	0.04
$year$				
2013	-0.03***	0.004	-0.03	-0.02
2014	-0.02***	0.004	-0.03	-0.01
2015	-0.08***	0.003	-0.08	-0.07
2016	-0.1***	0.003	-0.02	-0.01
$sector$				
D	-0.01	0.007	-0.02	0.00
E	-0.02***	0.008	-0.04	-0.01
G	-0.07***	0.007	-0.08	-0.05
H	-0.03***	0.009	-0.05	-0.01
I	-0.02***	0.007	-0.034	-0.005
K	-0.04***	0.007	-0.06	-0.03
O	-0.04***	0.008	-0.06	-0.02
$size$				
2	0.09***	0.002	0.08	0.09
3	0.09***	0.003	0.08	0.09
age	-0.003***	0.000	-0.003	-0.003
age^2	0.00002***	0.000	0.00001	0.00002
$const$	-0.10***	0.008	-0.12	-0.09

Number of obs 201,920
Adj. R-squared 0.023
*** p<0.01, ** p<0.05, * p<0.1

Δlp_{it} - growth rate of labour productivity of firm i, Δlp_{it} is calculated as difference of log labour productivity in year t and year $t-1$;

age_{it} - age of firm i in period t; we also include squared age in order to control for possible nonlinear relation between age and labour productivity growth;

G_p - dummy variable for pth size (1) firms with number of employees less than 50, 2) firms with number of employees greater than 50 and less than 250, 3) firms with number of employees greater than 250) ;

Y_j - dummy variable for jth year;

S_k - dummy variable for kth sector,

gap_{it} - distance to frontier of firm i in year t, where frontier is top5% productive firms in each industry (173 industries).

Model 1 provides us with several findings:

1. Labour productivity growth was the highest in 2012, and the most significant decline was in 2015; labour productivity growth was the highest in mining and quarrying (sector C).
2. We find positive correlation between size and labour productivity growth. This is supported by studies based on US firm-level data (Decker et al. 2017) as well as on 18 European industry-level data (Pagano and Schivardi, 2003). At the same time negative correlation between size and labour productivity growth is found in studies based on Italian firm-level data (Akcigit et al., 2017; Ganau and Rodríguez Pose, 2018).
3. We find negative correlation between labour productivity growth and age. This finding is supported by variety of studies (Huergo and Jaumandreu,2004; Haltiwanger et al. 2012; Decker et al. 2017; Ganau and Rodríguez Pose, 2018). The negative effect decreases with age increasing.

Model 2. Labour productivity with year and sector interactions

$$\Delta lp_{it} = \beta_0 + \beta_1 gap_{it-1} + \beta_2 age_{it} + \beta_3 age_{it}{}^2 + \sum_{p=2}^{3} \beta_p * G_p + \sum_{j=2013}^{2016} \beta_j * Y_j + \sum_{k=2}^{8} \beta_k * S_k + \sum_{l=2013}^{2016} \beta_l * Y_l * gap_{it-1} + \sum_{m=2}^{8} \beta_m * S_m * gap_{it-1}$$

Δlp	Coef.	Std. Err.	95% Conf. Interval	
gap_{t-1}	0.054***	0.005	0.04	0.06
$year$				
2013	-0.043***	0.008	-0.06	-0.03
2014	-0.03***	0.007	-0.04	-0.02
2015	-0.1***	0.007	-0.11	-0.09
2016	-0.035***	0.007	-0.05	-0.02
$sector$				
D	0.07***	0.015	0.04	0.10
E	-0.011	0.016	-0.04	0.02
G	0.044***	0.015	0.02	0.07
H	0.045**	0.020	0.01	0.08
I	0.004	0.016	-0.03	0.04
K	0.015	0.015	-0.01	0.04
O	0.013	0.017	-0.02	0.05
$size$				
2	0.089***	0.002	0.08	0.09
3	0.089***	0.003	0.08	0.10
age	-0.003***	0.0002	-0.0032	-0.0026
age^2	0.00002***	0.000001	0.00001	0.00002
$year * gap_{t-1}$				
2013	0.007**	0.003	0.001	0.013
2014	0.004	0.003	-0.001	0.010
2015	0.009***	0.003	0.004	0.015
2016	0.009***	0.003	0.004	0.014
$sector * gap_{t-1}$				
D	-0.03***	0.005	-0.04	-0.02
E	0.001	0.006	-0.01	0.01
G	-0.042***	0.005	-0.05	-0.03
H	-0.027***	0.007	-0.04	-0.01
I	-0.005	0.005	-0.02	0.01
K	-0.021***	0.005	-0.03	-0.01
O	-0.018***	0.006	-0.03	-0.01
$const$	-0.157***	0.015	-0.19	-0.13

Number of obs 201,920
Adj. R-squared 0.0245
*** p<0.01, ** p<0.05, * p<0.1

Model 3. Labour productivity with age interactions

$$\Delta lp_{it} = \beta_0 + \beta_1 gap_{it-1} + \beta_2 age_{it} + \beta_3 age_{it}{}^2 + \sum_{p=2}^{3} \beta_p * G_p + \sum_{j=2013}^{2016} \beta_j * Y_j + \sum_{k=2}^{8} \beta_k * S_k + \beta_4 age_{it} * gap_{it-1} + \beta_5 age_{it} * gap_{it-1},$$

Δlp	Coef.	Std. Err.	95% Conf. Interval	
gap_{t-1}	0.057***	0.002	0.05	0.06
$year$				
2013	-0.025***	0.004	-0.03	-0.02
2014	-0.019***	0.004	-0.03	-0.01
2015	-0.077***	0.003	-0.08	-0.07
2016	-0.012***	0.003	-0.02	-0.01
$sector$				
D	-0.010	0.007	-0.024	0.003
E	-0.026***	0.008	-0.04	-0.01
G	-0.069***	0.007	-0.08	-0.06
H	-0.025***	0.009	-0.04	-0.01
I	-0.018**	0.007	-0.03	0.00
K	-0.044***	0.007	-0.06	-0.03
O	-0.037***	0.008	-0.05	-0.02
$size$				
2	0.093***	0.002	0.088	0.098
3	0.088***	0.003	0.082	0.094
age	-0.002**	0.0007	-0.0031	-0.0002
age^2	0.000009	0.00002	-0.00003	0.00005
$age * gap_{t-1}$	-0.003***	0.0003	-0.003	-0.002
$age^2 * gap_{t-1}$	0.00006***	0.00001	0.00005	0.00008
$const$	-0.118***	0.009	-0.14	-0.10

Number of obs 199,822
Adj. R-squared 0.0245
*** p<0.01, ** p<0.05, * p<0.1

Model 4. Multifactor productivity (share of labour cost)

$$\Delta mfp_{it} = \beta_0 + \beta_1 m\_gap_{it-1} + \sum_{j=2013}^{2016} \beta_j * Y_j + \sum_{k=2}^{9} \beta_k * S_k + \sum_{p=2}^{3} \beta_p * G_p + \sum_{l=2013}^{2016} \beta_l * Y_l * m\_gap_{it-1}$$

Companies in sector K (Business services) were excluded from analysis, companies in sectors A and F are included into analysis (Agriculture and Construction).

Δmfp	Coef.	Std. Err.	95% Conf. Interval	
m_gap_{t-1}	0.04***	0.002	0.03	0.04
$year$				
2013	-0.05***	0.009	-0.07	-0.03
2014	-0.01*	0.008	-0.03	0.00
2015	-0.1***	0.008	-0.12	-0.08
2016	-0.07***	0.008	-0.09	-0.06
$sector$				
C	-0.06***	0.008	-0.07	-0.04
D	-0.03***	0.004	-0.04	-0.02
E	-0.1***	0.006	-0.11	-0.08
F	-0.01**	0.005	-0.020	-0.002
G	-0.09***	0.004	-0.10	-0.08
I	-0.03***	0.005	-0.04	-0.02
O	-0.06***	0.006	-0.07	-0.05
$size$				
2	0.13***	0.003	0.12	0.13
3	0.15***	0.003	0.14	0.16
$year * m\_gap_{t-1}$				
2013	0.003	0.003	-0.003	0.009
2014	-0.002	0.003	-0.007	0.004
2015	0.01***	0.003	0.00	0.02
2016	0.01***	0.003	0.01	0.02
$const$	-0.13***	0.00731	-0.14	-0.11

Number of obs 199,122
Adj. R-squared 0.0261
*** p<0.01, ** p<0.05, * p<0.1

Δmfp_{it} - growth rate of multifactor productivity of firm i, multifactor productivity is calculated as in Cette et al. (2018):

$$mfp_{it} = ln\left(\frac{Y_{it}}{K_{it}^{1-\alpha} L_{it}^{\alpha}}\right),$$

Where Y_{it} is value added of of firm i in period t;
K_{it} - capital,
L_{it} - labour force,
α - average share of labour cost in value added in industry (in each of 173 industries),
m_gap_{t-1}- distance to the frontier in previous year, where frontier is the defined as average MFP of the 5% most productive companies in each sector.

Model 5. Multifactor productivity (Wooldridge method)

$$\Delta mfp_{it} = \beta_0 + \beta_1 \Delta mfp\_fr_t + \beta_2 m\_gap_{it-1} + \sum_{l=2013}^{2016} \beta_l * Y_l * m\_gap_{it-1} + \sum_{p=2}^{5} \beta_p * G_p + \sum_{j=2013}^{2016} \beta_j * Y_j$$

Companies in sector O (Personal and other services) were excluded from analysis; companies in sector F are included into analysis (Construction).

Δmfp	Coef.	Std. Err. (clustered by industry)	95% Conf. Interval	
Δmfp_fr	0.18***	0.02	0.14	0.22
m_gap_{t-1}	0.09***	0.01	0.07	0.10
$year * m\_gap_{t-1}$				
2013	0.01	0.01	-0.01	0.02
2014	0.01*	0.01	0.00	0.02
2015	0.02***	0.01	0.00	0.03
2016	0.02***	0.01	0.01	0.03
age				
2	-0.21***	0.02	-0.24	-0.18
3	-0.25***	0.01	-0.28	-0.23
4	-0.3***	0.01	-0.32	-0.27
5	-0.28***	0.01	-0.31	-0.26
$size$				
2	0.11***	0.01	0.10	0.13
3	0.13***	0.01	0.12	0.14
4	0.15***	0.01	0.13	0.16
5	0.16***	0.01	0.13	0.19
$178\ industry\ dummies$				
$year$				
2013	-0.01	0.02	-0.04	0.02
2014	-0.03**	0.01	-0.06	0.00
2015	-0.09***	0.02	-0.13	-0.05
2016	-0.04**	0.02	-0.08	-0.01
$const$	0.01	0.03	-0.05	0.07

Number of obs 189,501
Adj. R-squared 0.07
*** p<0.01, ** p<0.05, * p<0.1

Δmfp_{it} - growth rate of multifactor productivity of firm i, multifactor productivity is calculated as in Andrews et al. (2016) employing the one-step GMM estimation method proposed by Wooldridge (2009).
m_gap_{t-1}- distance to the frontier in previous year, where frontier is the defined as average MFP of the 5% most productive companies in each industry (178 industries).
Δmfp_fr_t - growth rate of the frontier.
age is a set of dummy variables for corresponding to the following categories in age: 0-2, 3-4, 5-9, 10-29, 30 and older.
$size$ is a set of dummy variables corresponding to the following categories in employment: below 50, 50-99, 100-250, 25-999, 1000 and above.

Model 6. Labour productivity with year interactions and fixed effects

$$\Delta lp_{it} = \alpha_i + \beta_0 + \beta_1 gap_{it-1} + \sum_{j=2013}^{2016} \beta_j * Y_j + \sum_{p=2}^{3} \beta_p * G_p + \beta_2 age_{it} + \beta_3 {age_{it}}^2 + \sum_{l=2013}^{2016} \beta_l * Y_l * gap_{it-1}$$

Δlp		Coef.	Std. Err.	95% Conf. Interval	
gap_{t-1}		0.48***	0.003	0.48	0.49
$year$					
	2013	-0.2***	0.01	-0.21	-0.18
	2014	-0.18***	0.01	-0.20	-0.16
	2015	-0.27***	0.01	-0.30	-0.25
	2016	-0.26***	0.02	-0.30	-0.23
$size$					
	2	0.08***	0.01	0.06	0.09
	3	0.11***	0.01	0.09	0.14
age		0.01	0.004	-0.003	0.01
age^2		-4E-06	3.34E-05	-6.93E-05	6.18E-05
$year * gap_{t-1}$					
	2013	0.03***	0.003	0.02	0.03
	2014	0.03***	0.003	0.03	0.04
	2015	0.04***	0.003	0.04	0.05
	2016	0.04***	0.003	0.04	0.05
$const$		-1.2***	0.04	-1.29	-1.12

Number of obs 201,920

*** p<0.01, ** p<0.05, * p<0.1

Δlp_{it} - growth rate of labour productivity of firm i, Δlp_{it} is calculated as difference of log labour productivity in year t and year $t-1$;

age_{it} - age of firm i in period t; we also include squared age in order to control for possible nonlinear relation between age and labour productivity growth;

G_p - dummy variable for pth size (1) firms with number of employees less than 50, 2) firms with number of employees greater than 50 and less than 250, 3) firms with number of employees greater than 250) ;

Y_j - dummy variable for jth year;

gap_{it} - distance to frontier of firm i in year t, where frontier is top5% productive firms in each industry (173 industries).

Model 7. Multifactor productivity, fixed effects (share of labour costs)

$$\Delta mfp_{it} = \alpha_i + \beta_0 + \beta_1 m\_gap_{it-1} + \sum_{j=2013}^{2016} \beta_j * Y_j + \sum_{k=2}^{9} \beta_k * S_k + \sum_{p=2}^{3} \beta_p * G_p + \sum_{l=2013}^{2016} \beta_l * Y_l * m\_gap_{it-1}$$

Δmfp		Coef.	Std. Err.	95% Conf. Interval	
m_gap_{t-1}		0.61***	0.003	0.61	0.62
$year$					
	2013	-0.18***	0.01	-0.19	-0.16
	2014	-0.15***	0.01	-0.16	-0.13
	2015	-0.22***	0.01	-0.23	-0.20
	2016	-0.19***	0.01	-0.20	-0.18
$size$					
	2	0.21***	0.01	0.20	0.22
	3	0.35***	0.01	0.32	0.37
$year * m\_gap_{t-1}$					
	2013	0.01***	0.002	0.01	0.02
	2014	0.01***	0.002	0.00	0.01
	2015	0.01***	0.002	0.00	0.01
	2016	-0.0005***	0.002	-0.01	0.00
$const$		-1.69***	0.01	-1.71	-1.67

Number of obs 201,914

*** p<0.01, ** p<0.05, * p<0.1

Δmfp_{it} - growth rate of multifactor productivity of firm i, multifactor productivity is calculated as in Cette et al. (2018):

$$mfp_{it} = ln\left(\frac{Y_{it}}{K_{it}^{1-\alpha} L_{it}^{\alpha}}\right),$$

Where Y_{it} is value added of of firm i in period t;
K_{it} - capital,
L_{it} - labour force,
α - average share of labour cost in value added in industry (in each of 173 industries),
m_gap_{t-1}- distance to the frontier in previous year, where frontier is the defined as average MFP of the 5% most productive companies in each sector.

Model 8. Multifactor productivity, fixed effects (Wooldrige)

$$mfp_{it} = \alpha_i + \beta_0 + \beta_1 m\_gap_{it-1} + \sum_{j=2013}^{2016} \beta_j * Y_j + \sum_{k=2}^{9} \beta_k * S_k + \sum_{p=2}^{3} \beta_p * G_p + \sum_{l=2013}^{2016} \beta_l * Y_l * m\_gap_{it-1}$$

Δmfp		Coef.	Std. Err. (clustered by industry)	[95% Conf. Interval]	
Δmfp_fr		0.48***	0.02037	0.44058	0.52099
m_gap_{t-1}		0.65***	0.01261	0.62587	0.67565
$year * m\_gap_{t-1}$					
	2013	0.03***	0.00569	0.02115	0.04359
	2014	0.04***	0.0055	0.03194	0.05365
	2015	0.05***	0.00634	0.03765	0.06267
	2016	0.06***	0.00779	0.04008	0.07082
age					
	2	-0.03**	0.01345	-0.0578	-0.0047
	3	-0.01	0.01342	-0.0372	0.01575
	4	-0.002	0.01542	-0.0328	0.02802
	5	0.06	0.07901	-0.0911	0.22076
$size$					
	2	0.25***	0.01465	0.22052	0.27834
	3	0.47***	0.02429	0.41892	0.51477
	4	0.64***	0.03865	0.56274	0.71528
	5	0.63***	0.06648	0.50311	0.76548
$year$					
	2013	-0.1***	0.012	-0.1279	-0.0806
	2014	-0.13***	0.01566	-0.1568	-0.095
	2015	-0.2***	0.01705	-0.2358	-0.1685
	2016	-0.23***	0.01988	-0.2677	-0.1892
$const$		-1.85***	0.04354	-1.933	-1.7611

Number of obs 189,501

*** p<0.01, ** p<0.05, * p<0.1

Δmfp_{it} - growth rate of multifactor productivity of firm i, multifactor productivity is calculated as in Andrews et al. (2016) employing the one-step GMM estimation method proposed by Wooldridge (2009).

m_gap_{t-1}- distance to the frontier in previous year, where frontier is the defined as average MFP of the 5% most productive companies in each industry (178 industries).

Δmfp_fr_t - growth rate of the frontier.

age is a set of dummy variables for corresponding to the following categories in age: 0-2, 3-4, 5-9, 10-29, 30 and older.

$size$ is a set of dummy variables corresponding to the following categories in employment: below 50, 50-99, 100-250, 25-999, 1000 and above.

Appendix D

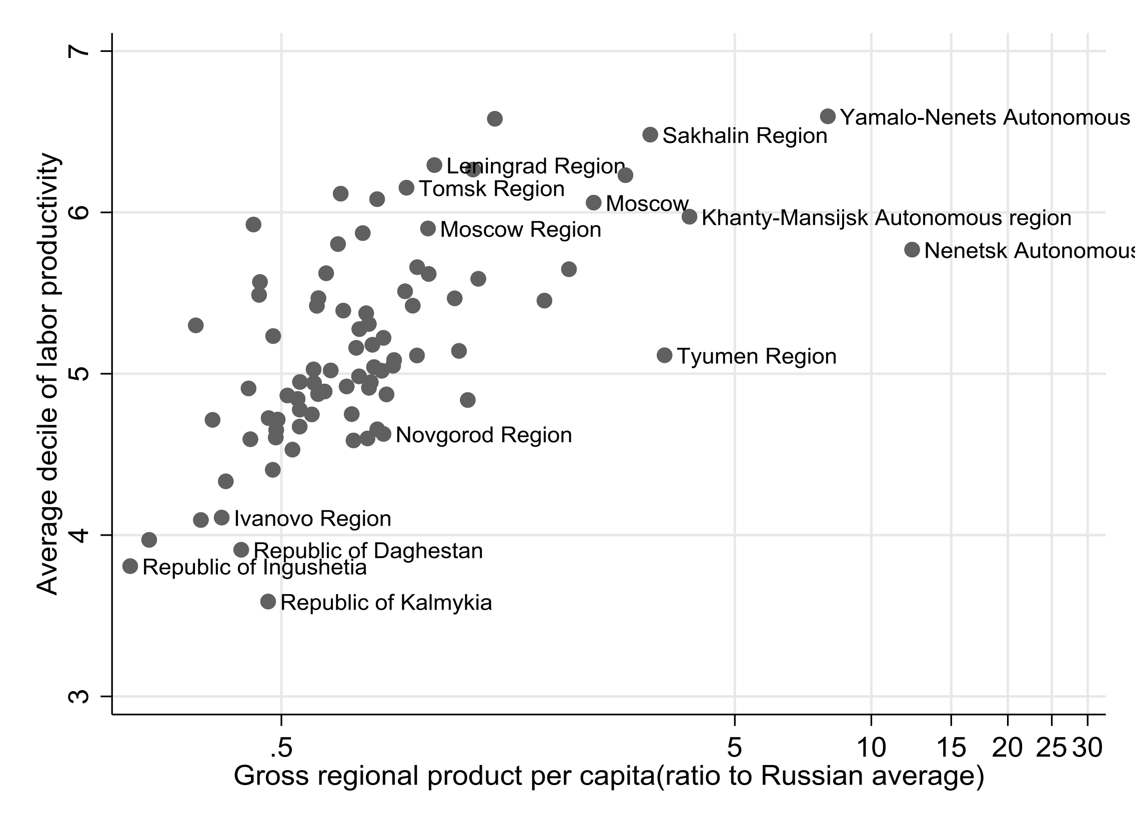
High level of productivity dispersion relative to what is shown in Berlingieri et al. (2017) may be associated with high regional inequality in Russia.

As shown in Gennaioli et al. (2014), dispersion of regional product per capita in Russia is high relative to the group of countries, which is analyzed in Berlingieri et al. (2017). Only data on regional dispersion in Denmark (due to Greenland), Chile and Indonesia are comparable with Russian data. In the other countries the regional dispersion is much less. Most significant differences concern the gap between the most rich and the most poorest region in Russian and in other countries. According to Gennaioli et al. (2014), in 2009 this ratio was 25.4 in Russia, while in 2010 in Indonesia it was 17.2, in Chile 8.6, and in European countries from Berlingieri's sample the ratio didn't exceed 4.7.

Figure 25 illustrates correlation between region performance and individual performance of firms there in 2016. The y-axis depicts deciles averaged by firms located in each region regardless the industry. The x-axis depicts the ratio of gross regional product per capita (logarithmic scale). The positive correlation is evident. It means that productivity leaders locate in leading regions and vice versa.

Due to high level of regional dispersion the gap between leaders located in successful regions and laggards located in sluggish regions may be significant.

Figure 25. Productivity leaders locate in leading regions



Appendix E

Estimation of dynamic multinomial model of transition between productivity quartiles

Sec	No of Obs.	Qt_{it}	$Qt_{it-1} = 3$	$Qt_{it-1} = 2$	$Qt_{it-1} = 1$	age_{it}	$size_{it} = 2$	$size_{it} = 3$	$Qt_{i0} = 3$	$Qt_{i0} = 2$	$Qt_{i0} = 1$	age_{i0}	$size_{i0} = 2$	$size_{i0} = 3$	$\overline{age_i}$	$\overline{size_i} = 2$	$\overline{size_i} = 3$	$Const$	$Rand.\ Eff.\ Var$
C	4969	3	1.81*** (0.21)	2.36*** (0.3)	2.53*** (0.47)	0 (0.05)	-0.6 (0.43)	-1.33 (0.82)	2.85*** (0.37)	2.74*** (0.44)	2.5*** (0.5)	-0.23* (0.13)	1.53*** (0.38)	1.42** (0.7)	0.25* (0.14)	-1.19** (0.59)	-0.19 (1.1)	-3.16*** (0.36)	1.61*** (0.19)
		2	2.33*** (0.31)	5.14*** (0.37)	5.65*** (0.5)	0.04 (0.06)	-1.26** (0.51)	-1.78* (0.92)	2.9*** (0.4)	3.46*** (0.47)	2.97*** (0.52)	-0.15 (0.14)	1.85*** (0.42)	1.69** (0.75)	0.14 (0.15)	-1.17* (0.67)	-0.31 (1.21)	-4.86*** (0.43)	
		1	1.99*** (0.5)	5.33*** (0.52)	7.86*** (0.62)	0.07 (0.07)	-1.04* (0.57)	-2.06** (1.04)	2.4*** (0.49)	3.09*** (0.53)	3.35*** (0.58)	0.03 (0.15)	2.06*** (0.44)	1.98** (0.8)	-0.07 (0.17)	-1.74** (0.73)	-0.5 (1.32)	-5.42*** (0.55)	
D	50526	3	2.03*** (0.07)	2.85*** (0.11)	1.72*** (0.17)	0 (0.02)	-0.22* (0.13)	0.29 (0.26)	2.49*** (0.12)	2.8*** (0.16)	2.61*** (0.2)	0.04 (0.04)	0.83*** (0.12)	0.93*** (0.24)	-0.03 (0.04)	-0.91*** (0.18)	-1.23*** (0.36)	-2.25*** (0.1)	1.65*** (0.07)
		2	2.66*** (0.1)	5.84*** (0.13)	5.18*** (0.18)	0.01 (0.02)	-0.39** (0.16)	0.45 (0.3)	2.96*** (0.13)	3.79*** (0.17)	3.51*** (0.21)	0.05 (0.04)	1.06*** (0.13)	1.38*** (0.26)	-0.05 (0.04)	-1.27*** (0.21)	-2.21*** (0.4)	-4.47*** (0.13)	
		1	1.61*** (0.15)	5.18*** (0.17)	7.03*** (0.2)	0.1*** (0.02)	-0.43** (0.18)	0.35 (0.33)	2.54*** (0.17)	3.65*** (0.2)	4.13*** (0.23)	0.25*** (0.04)	1.14*** (0.14)	1.7*** (0.28)	-0.33*** (0.05)	-1.69*** (0.24)	-2.71*** (0.44)	-4.48*** (0.15)	
E	11710	3	1.64*** (0.14)	2.11*** (0.21)	1.28*** (0.32)	-0.06* (0.04)	0.63** (0.29)	0.74 (0.57)	2.87*** (0.25)	3.11*** (0.33)	2.7*** (0.4)	0.02 (0.09)	0.62** (0.27)	0.44 (0.52)	0.09 (0.1)	-1.61*** (0.41)	-1.91** (0.78)	-2.19*** (0.21)	1.83*** (0.14)
		2	2.17*** (0.19)	4.8*** (0.24)	4.6*** (0.33)	-0.11*** (0.04)	0.17 (0.33)	0.92 (0.65)	3.09*** (0.27)	3.89*** (0.34)	3.46*** (0.41)	0.09 (0.1)	0.57** (0.29)	0.48 (0.56)	0.07 (0.1)	-1.14** (0.45)	-2.51*** (0.87)	-4.02*** (0.24)	
		1	1.5*** (0.28)	4.26*** (0.31)	6.35*** (0.37)	-0.16*** (0.05)	0.16 (0.37)	0.46 (0.74)	2.85*** (0.32)	3.84*** (0.38)	4.34*** (0.43)	0.25** (0.1)	0.75** (0.31)	0.87 (0.6)	-0.05 (0.11)	-1.51*** (0.5)	-2.65*** (0.96)	-4.33*** (0.29)	
G	62050	3	2.24*** (0.07)	2.87*** (0.12)	1.99*** (0.22)	0 (0.02)	-0.35*** (0.12)	0.11 (0.33)	2.87*** (0.13)	3.41*** (0.18)	3.34*** (0.25)	0.23*** (0.04)	0.93*** (0.1)	1.1*** (0.28)	-0.17*** (0.04)	-0.54*** (0.16)	-1.3*** (0.43)	-2.92*** (0.09)	1.68*** (0.07)
		2	2.54*** (0.1)	5.96*** (0.14)	5.28*** (0.22)	0.03 (0.02)	-0.81*** (0.15)	-0.29 (0.38)	3.09*** (0.15)	4.16*** (0.19)	4.31*** (0.26)	0.32*** (0.04)	1.05*** (0.11)	1.8*** (0.3)	-0.27*** (0.05)	-0.48** (0.19)	-1.73*** (0.48)	-4.94*** (0.11)	
		1	2.03*** (0.16)	5.67*** (0.18)	7.92*** (0.25)	0.15*** (0.03)	-1.03*** (0.17)	-0.97** (0.42)	2.28*** (0.18)	3.63*** (0.22)	4.44*** (0.27)	0.49*** (0.05)	1.08*** (0.13)	2.64*** (0.32)	-0.55*** (0.05)	-0.72*** (0.21)	-2.09*** (0.54)	-5.25*** (0.14)	
H	5375	3	2.02*** (0.22)	3.02*** (0.39)	1.77*** (0.57)	0.04 (0.05)	-0.39 (0.37)	-1.28 (0.99)	2.48*** (0.37)	2.95*** (0.52)	2.35*** (0.65)	0.19 (0.12)	0.84*** (0.32)	2.02** (0.92)	-0.14 (0.13)	-0.89* (0.49)	-1.07 (1.31)	-2.85*** (0.3)	1.81*** (0.19)
		2	2.49*** (0.32)	6.21*** (0.44)	5.36*** (0.58)	0.03 (0.06)	-0.16 (0.41)	-2.09* (1.25)	2.79*** (0.41)	3.51*** (0.55)	2.93*** (0.67)	0.21 (0.13)	0.52 (0.34)	2.25** (0.98)	-0.13 (0.14)	-1.05** (0.54)	-0.69 (1.53)	-4.99*** (0.38)	
		1	0.91* (0.49)	4.68*** (0.56)	6.62*** (0.66)	0 (0.07)	-0.29 (0.47)	-2.31 (1.62)	3.07*** (0.57)	4.1*** (0.68)	4.43*** (0.77)	0.3** (0.15)	0.43 (0.37)	3.62*** (1.09)	-0.18 (0.16)	-1.27** (0.61)	-2.09 (1.9)	-5.51*** (0.47)	

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Sec	No of Obs.	Qt_{it}	$Qt_{it-1} = 3$	$Qt_{it-1} = 2$	$Qt_{it-1} = 1$	age_{it}	$size_{it} = 2$	$size_{it} = 3$	$Qt_{i0} = 3$	$Qt_{i0} = 2$	$Qt_{i0} = 1$	age_{i0}	$size_{i0} = 2$	$size_{i0} = 3$	$\overline{age_i}$	$\overline{size_i} = 2$	$\overline{size_i} = 3$	$Const$	$Rand.\ Eff.\ Var$
I	17713	3	2*** (0.12)	2.62*** (0.19)	2.34*** (0.32)	-0.03 (0.03)	-0.19 (0.21)	0.14 (0.46)	2.57*** (0.21)	2.99*** (0.29)	2.27*** (0.36)	-0.03 (0.06)	0.74*** (0.18)	0.93** (0.44)	0.09 (0.06)	-0.93*** (0.28)	-1.32** (0.64)	-2.32*** (0.15)	
		2	2.45*** (0.17)	5.51*** (0.22)	5.43*** (0.33)	-0.01 (0.03)	-0.32 (0.24)	-0.2 (0.53)	2.97*** (0.23)	3.92*** (0.3)	3.23*** (0.36)	-0.02 (0.06)	0.94*** (0.19)	1.31*** (0.47)	0.05 (0.07)	-1.27*** (0.31)	-1.7** (0.71)	-4.31*** (0.19)	1.68*** (0.11)
		1	1.97*** (0.25)	5.35*** (0.28)	7.62*** (0.37)	0.05 (0.04)	-0.64** (0.27)	0.05 (0.61)	2.33*** (0.26)	3.48*** (0.33)	3.73*** (0.38)	0.2*** (0.07)	0.99*** (0.21)	2.18*** (0.5)	-0.22*** (0.08)	-1.21*** (0.35)	-2.98*** (0.8)	-4.63*** (0.24)	
K	44197	3	2.23*** (0.08)	2.61*** (0.15)	1.59*** (0.27)	0.05** (0.02)	-0.5*** (0.12)	0.63* (0.36)	2.57*** (0.16)	2.86*** (0.23)	2.84*** (0.31)	-0.23*** (0.05)	0.49*** (0.11)	0.12 (0.33)	0.19*** (0.05)	0 (0.17)	-0.8 (0.49)	-2.47*** (0.1)	
		2	2.65*** (0.11)	5.67*** (0.17)	5.02*** (0.27)	0.06** (0.03)	-0.56*** (0.14)	0.97** (0.41)	3.26*** (0.17)	3.98*** (0.23)	3.81*** (0.31)	-0.21*** (0.05)	0.64*** (0.12)	0.32 (0.35)	0.17*** (0.05)	-0.24 (0.19)	-1.54*** (0.54)	-4.62*** (0.13)	1.7*** (0.08)
		1	2.13*** (0.16)	5.4*** (0.2)	7.43*** (0.29)	0.13*** (0.03)	-0.87*** (0.17)	0.65 (0.46)	2.58*** (0.19)	3.8*** (0.25)	4.46*** (0.32)	-0.09* (0.05)	0.76*** (0.14)	1.03*** (0.38)	-0.02 (0.06)	-0.46** (0.22)	-2.09*** (0.6)	-5.13*** (0.16)	
O	8519	3	1.84*** (0.16)	2.38*** (0.26)	1.97*** (0.53)	0.15*** (0.04)	-0.06 (0.24)	0.09 (0.92)	2.07*** (0.26)	2.72*** (0.37)	2.41*** (0.52)	0.27*** (0.09)	-0.47** (0.2)	-0.42 (0.69)	-0.39*** (0.1)	0.03 (0.32)	-0.31 (1.16)	-1.5*** (0.21)	
		2	2.64*** (0.23)	5.12*** (0.31)	5.07*** (0.53)	0.19*** (0.05)	-0.01 (0.28)	0.09 (1.06)	2.37*** (0.29)	3.75*** (0.39)	3.47*** (0.53)	0.34*** (0.1)	-0.72*** (0.22)	-0.72 (0.75)	-0.48*** (0.11)	-0.41 (0.37)	-0.2 (1.31)	-3.49*** (0.27)	1.3*** (0.15)
		1	1.32*** (0.33)	4.17*** (0.37)	6.76*** (0.56)	0.27*** (0.06)	-0.75** (0.32)	-1.46 (1.23)	2.39*** (0.37)	3.91*** (0.46)	4.45*** (0.57)	0.47*** (0.11)	-0.76*** (0.26)	0.5 (0.81)	-0.7*** (0.12)	0.1 (0.42)	0.08 (1.48)	-3.71*** (0.33)	

Appendix F

The production function (without error component) may be represented in the following way:

$$Y_{it} = f(X_n) * e^{-u}$$

where Y - value added, X_n - resource of type n. In this case it is labour L and capital K. f - is deterministic part of production function, u_{it} - inefficiency term.

$$\dot{\mathrm{MFP}} = \dot{\mathrm{Y}} - \sum S_n \dot{X_n},$$

where S_n - share of expenditures on resource of type n in all expenditures. Since the data on inputs prices are not available the relative elasticities are used as weights.

$$\dot{\mathrm{MFP}} = \frac{\left(\frac{\partial f}{\partial t} + \sum \frac{\partial f}{\partial X_n} * \frac{\partial X_n}{\partial t}\right) * e^{-u} + e^{-u} * \left(-\frac{\partial u}{\partial t}\right) * f}{f * e^{-u}} - \sum \frac{\varepsilon_n}{\varepsilon} * \dot{X_n},$$

$$\dot{\mathrm{MFP}} = \frac{\left(\frac{\partial f}{\partial t} + \sum \frac{\partial f}{\partial X_n} * \frac{dX_n}{dt}\right)}{f} - \frac{\partial u}{\partial t} - \sum \frac{\varepsilon_n}{\varepsilon} * \dot{X_n}$$

$$\dot{\mathrm{MFP}} = \frac{\frac{\partial f}{\partial t}}{f} + \sum \frac{\partial f}{\partial X_n} * \frac{X_n}{f} * \frac{dX_n}{dt} * \frac{1}{X_n} - \frac{\partial u}{\partial t} - \sum \frac{\varepsilon_n}{\varepsilon} * \dot{X_n}$$

$$\dot{\mathrm{MFP}} = \frac{\partial \ln(f)}{\partial t} + \sum \varepsilon_n * \dot{X_n} - \frac{\partial u}{\partial t} - \sum \frac{\varepsilon_n}{\varepsilon} * \dot{X_n}$$

$$\dot{\mathrm{MFP}} = \mathrm{T\Delta} + \mathrm{TE\Delta} + \sum \varepsilon_n * \dot{X_n} - \sum \frac{\varepsilon_n}{\varepsilon} * \dot{X_n}$$

$$\dot{\mathrm{MFP}} = \mathrm{T\Delta} + \mathrm{TE\Delta} + (\varepsilon - 1) \sum \frac{\varepsilon_n}{\varepsilon} * \dot{X_n}$$

$$\dot{MFP} = T\Delta + TE\Delta + (\varepsilon - 1)\left(\frac{\varepsilon_k}{\varepsilon}\frac{dk}{dt} + \frac{\varepsilon_l}{\varepsilon}\frac{dl}{dt}\right),$$

where $k = \ln(K)\,, l = \ln(L)\,;\ \frac{dk}{dt} = \frac{dK}{dt} * \frac{1}{K} = \dot{K};\ \frac{dl}{dt} = \frac{dL}{dt} * \frac{1}{L} = \dot{L};$

$$y_{it} = \beta_0 + \beta_1 l_{it} + \beta_2 k_{it} + \beta_3 t + \beta_4 l_{it}^2 + \beta_5 k_{it}^2 + \beta_6 t^2 + \beta_7 l_{it} k_{it} + \beta_8 l_{it} t + \beta_{89} k_{it} t + v_{it} - u_{it}$$

Appendix G

Results of Student's t-test for equality of means of technical progress in industries where divergence is found and in industries where divergence is not found.

Broader industry	Industries where divergence is found	Industries where divergence is not found	P-value (mean $T\Delta$ in non divergence industries<mean in divergence industries)	Mean $T\Delta$ in non divergence industries	Mean $T\Delta$ in divergence industries
10	101	102+103	1	-0.07	0.10
15	151 152 154 155 156 157 158 159	153	1	-0.04	0.04
17	171+172 174 175	176+177	1	-0.01	0.04
25	252	251	0.01	0.00	-0.01
26	262+263 264 266 268	261 265 267	1	0.03	0.05
27	271 273	272	1	-0.03	0.05
28	281 282 283 285 287	284 286	0.01	0.02	0.01
29	293 294 295 2911 2912 2913 2921 2922 2923 2924	297	1	-0.04	0.03
31	311 312 313 314 315	316	1	-0.04	0.05
34	342 343	341	1	-0.10	0.03
36	361	362 365 366	1	-0.03	0.04
60	601 602	603	1	-0.05	-0.02
61	612	611	0	0.02	0.01
70	702 703	701	1	-0.04	0.01
72	721 722	723	1	0.02	0.06
90	9000 9003	9001 9002	1	-0.09	-0.03
92	921 922 923+925 926 927	924	1	-0.02	-0.01
93	9301 9303	9302 9304 9305	1	-0.08	-0.01
524	5241 5242 5243 5244 5246 5247 5248	5245	1	-0.11	-0.02
4011	40115	40111	1	0.08	0.11
4013	40131 40132	40133	1	-0.07	0.08
4030	40300 40301	40302 40303 40304+40305	0.99	-0.06	-0.06

Appendix H

Estimations of productivity functions according to Battese and Coelli (1992) specification (positive γ means divergence)

Industry code	Number of observations	l	k	t	l^2	k^2	t^2	$l*k$	$l*t$	$k*t$	γ	$Const$	$ln\sigma_u^2$	$ln\sigma_v^2$
10.1	651	1.56***	-0.46	-0.18	-0.11***	0.02**	0.02	0.01	-0.01	0.01	0.05*	15.78***	1.23***	-0.47***
		(0.592)	(0.338)	(0.240)	(0.041)	(0.010)	(0.013)	(0.035)	(0.019)	(0.012)	(0.029)	(3.314)	(0.168)	(0.070)
10.2+10.3	244	2.11***	-1.03***	-0.22	-0.12*	0.04***	-0.02	-0.01	0.04	0.01	***-0.04***	18.13***	1.13***	-1.63***
		(0.805)	(0.324)	(0.256)	(0.070)	(0.013)	(0.013)	(0.055)	(0.027)	(0.015)	***(0.028)***	(2.993)	(0.218)	(0.116)
11.1	1,294	2.86***	-1.25***	0	-0.05**	0.06***	0.03***	-0.08***	-0.01	0	0.07***	18.5***	1.8***	-0.76***
		(0.295)	(0.180)	(0.129)	(0.022)	(0.005)	(0.008)	(0.018)	(0.011)	(0.007)	(0.014)	(1.827)	(0.103)	(0.047)
11.2	1,921	1.83***	0.07	-0.18**	0.06***	0.02***	0.01**	-0.11***	0.02**	0	0.07***	11.45***	1.39***	-1.39***
		(0.202)	(0.087)	(0.073)	(0.022)	(0.003)	(0.005)	(0.012)	(0.009)	(0.004)	(0.011)	(0.860)	(0.082)	(0.041)
13	1,109	2.07***	-0.6***	-0.29**	-0.03	0.03***	0.03***	-0.05***	0.01	0.01	0.05***	15.53***	1.19***	-1.08***
		(0.258)	(0.172)	(0.115)	(0.026)	(0.005)	(0.009)	(0.019)	(0.012)	(0.006)	(0.016)	(1.568)	(0.108)	(0.052)
14.1	1,151	2.49***	-0.72***	0.1	-0.16***	0.03***	-0.02***	-0.02	0.01	0	0.06***	15.53***	1.32***	-1.29***
		(0.498)	(0.258)	(0.148)	(0.039)	(0.008)	(0.007)	(0.029)	(0.013)	(0.008)	(0.014)	(2.405)	(0.101)	(0.052)
14.2	1,035	0.97**	-0.6***	-0.19	-0.17***	0.02**	0.01	0.08**	-0.01	0.01	0.04***	17.53***	1.24***	-1.05***
		(0.419)	(0.170)	(0.138)	(0.045)	(0.006)	(0.008)	(0.032)	(0.016)	(0.008)	(0.015)	(1.689)	(0.106)	(0.055)
15.1	2,401	2.37***	-0.17	-0.25***	-0.09***	0.02***	0	-0.05***	0.02**	0.01**	0.04***	11.83***	1.6***	-1.47***
		(0.219)	(0.130)	(0.075)	(0.022)	(0.004)	(0.004)	(0.013)	(0.008)	(0.004)	(0.008)	(1.142)	(0.066)	(0.036)
15.2	507	1.36***	-0.7***	0.21	-0.12**	0.02***	-0.01	0.03	0	0	0.12***	17.51***	1.39***	-1.44***
		(0.469)	(0.255)	(0.190)	(0.051)	(0.009)	(0.010)	(0.035)	(0.021)	(0.011)	(0.022)	(2.439)	(0.145)	(0.081)
15.3	472	2.32***	-0.46*	-0.21	-0.01	0.02***	-0.01	-0.06**	-0.01	0.01	***0***	14.13***	1.52***	-1.54***
		(0.601)	(0.271)	(0.191)	(0.064)	(0.009)	(0.010)	(0.028)	(0.021)	(0.011)	***(0.016)***	(2.550)	(0.152)	(0.084)
15.4	555	2.89***	-0.82***	0.4	-0.08**	0.04***	-0.05***	-0.07**	0.02	0	0.08***	14.26***	1.32***	-0.9***
		(0.550)	(0.289)	(0.270)	(0.040)	(0.010)	(0.012)	(0.030)	(0.021)	(0.014)	(0.024)	(2.651)	(0.160)	(0.075)
15.5	2,605	2.13***	-1.14***	-0.15**	-0.15***	0.04***	0.01*	-0.01	0.03***	0	0.03***	20.41***	1.57***	-1.58***
		(0.238)	(0.136)	(0.076)	(0.022)	(0.005)	(0.004)	(0.015)	(0.008)	(0.004)	(0.007)	(1.244)	(0.067)	(0.034)
15.6	1,118	1.88***	-1.31***	-0.03	-0.14***	0.04***	0.01	0	0.01	0	0.06***	21.69***	1.65***	-1.28***
		(0.388)	(0.206)	(0.146)	(0.038)	(0.007)	(0.007)	(0.024)	(0.015)	(0.008)	(0.012)	(2.004)	(0.094)	(0.052)
15.7	679	2.38***	-0.52**	-0.78***	-0.16***	0.02**	0.01	-0.01	0.07***	0.02***	0.04**	16.36***	1.56***	-1.54***
		(0.448)	(0.260)	(0.161)	(0.052)	(0.008)	(0.008)	(0.027)	(0.015)	(0.009)	(0.015)	(2.403)	(0.127)	(0.068)

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Industry code	Number of observations	l	k	t	l^2	k^2	t^2	$l*k$	$l*t$	$k*t$	γ	$Const$	$ln\sigma_u^2$	$ln\sigma_v^2$
15.8	5,807	1.67***	-0.22***	-0.21***	-0.02	0.02***	0	-0.05***	0.02***	0.01***	0.04***	13.78***	1.51***	-1.81***
		(0.109)	(0.066)	(0.040)	(0.012)	(0.002)	(0.002)	(0.008)	(0.005)	(0.002)	(0.005)	(0.570)	(0.045)	(0.024)
15.9	2,170	2.86***	-0.68***	-0.34***	-0.03	0.04***	0	-0.09***	0	0.02***	0.03***	13.91***	1.64***	-1.17***
		(0.280)	(0.182)	(0.106)	(0.027)	(0.006)	(0.005)	(0.018)	(0.010)	(0.006)	(0.008)	(1.419)	(0.071)	(0.038)
17.1+17.2	442	2.11***	-0.51**	-0.03	-0.17***	0.02***	-0.02	0.01	0.01	0.01	0.08***	15.07***	1.41***	-1.24***
		(0.450)	(0.204)	(0.179)	(0.040)	(0.007)	(0.012)	(0.021)	(0.018)	(0.010)	(0.021)	(2.023)	(0.153)	(0.086)
17.4	275	1.59**	-0.45	0.53***	-0.06	0.03**	-0.04***	-0.02	0.02	-0.02	0.08***	13.94***	1.54***	-1.67***
		(0.709)	(0.315)	(0.185)	(0.085)	(0.011)	(0.012)	(0.043)	(0.026)	(0.012)	(0.023)	(2.795)	(0.178)	(0.110)
17.5	515	2.04***	-0.71***	-0.34***	-0.08*	0.03***	-0.01**	-0.04*	0.03**	0.02***	0.04**	17.18***	0.83***	-1.99***
		(0.351)	(0.162)	(0.121)	(0.042)	(0.005)	(0.007)	(0.022)	(0.014)	(0.006)	(0.017)	(1.580)	(0.143)	(0.078)
17.6+17.7	168	2.06**	1.37*	-0.18	-0.05	-0.04	-0.03	-0.05	-0.08**	0.05**	***0.01***	0.66	0.83***	-1.19***
		(0.862)	(0.823)	(0.361)	(0.085)	(0.029)	(0.020)	(0.059)	(0.040)	(0.021)	***(0.039)***	(6.660)	(0.279)	(0.139)
18	1,567	0.88***	-0.01	-0.14*	-0.02	0	0	0.01	0.02*	0.01	0.03***	13.74***	1.78***	-1.62***
		(0.290)	(0.107)	(0.078)	(0.035)	(0.004)	(0.005)	(0.019)	(0.011)	(0.005)	(0.008)	(1.040)	(0.078)	(0.045)
19	654	1.96***	-0.41**	-0.06	-0.07**	0.03***	-0.01	-0.05**	0.04***	-0.01	0.07***	14.69***	1.44***	-1.75***
		(0.291)	(0.178)	(0.106)	(0.034)	(0.006)	(0.007)	(0.022)	(0.012)	(0.006)	(0.014)	(1.492)	(0.123)	(0.066)
20.1	1,182	1.99***	-0.9***	-0.57***	-0.08**	0.03***	0	-0.03	0	0.04***	0.04***	18.76***	1.72***	-1***
		(0.302)	(0.152)	(0.121)	(0.036)	(0.005)	(0.008)	(0.020)	(0.015)	(0.007)	(0.013)	(1.500)	(0.090)	(0.053)
20.2	533	2.54***	-0.38*	0.2	-0.08**	0.02***	0	-0.05**	-0.03**	0.01	0.1***	11.86***	1.72***	-1.32***
		(0.440)	(0.226)	(0.152)	(0.039)	(0.006)	(0.010)	(0.022)	(0.015)	(0.008)	(0.020)	(2.369)	(0.147)	(0.075)
20.3	586	1.76***	-0.25	-0.3	-0.06	0.02*	-0.02	-0.03	0.05**	0.01	0.05***	14.01***	1.43***	-1.04***
		(0.553)	(0.254)	(0.194)	(0.064)	(0.009)	(0.012)	(0.030)	(0.020)	(0.010)	(0.018)	(2.393)	(0.122)	(0.078)
20.4+20.5	168	-1.82	0.24	0.39*	-0.06	-0.03*	0	0.19***	0.1***	-0.05***	0.03*	16.96***	1.56***	-2.69***
		(1.117)	(0.399)	(0.204)	(0.081)	(0.014)	(0.010)	(0.039)	(0.025)	(0.013)	(0.018)	(3.452)	(0.199)	(0.151)
21.1	330	1.18*	-0.75*	-0.34**	0.05	0.03**	0.03***	-0.06*	-0.03*	0.02**	0.07***	20.51***	1.69***	-1.96***
		(0.612)	(0.411)	(0.153)	(0.041)	(0.014)	(0.009)	(0.036)	(0.016)	(0.009)	(0.020)	(3.073)	(0.179)	(0.097)
21.2	1,109	3.35***	-0.71***	-0.14	-0.14***	0.04***	-0.01	-0.08***	0.01	0.01***	0.05***	13.61***	1.55***	-1.82***
		(0.337)	(0.149)	(0.085)	(0.035)	(0.005)	(0.005)	(0.018)	(0.011)	(0.005)	(0.011)	(1.264)	(0.106)	(0.055)
22.1	3,597	0.36	-0.29***	0.13***	0.22***	0.02***	-0.02***	-0.06***	-0.03***	0.01***	0.03***	16.2***	2.18***	-1.5***
		(0.264)	(0.071)	(0.047)	(0.036)	(0.003)	(0.004)	(0.013)	(0.009)	(0.003)	(0.004)	(0.718)	(0.050)	(0.031)
22.2	2,150	1.83***	0.01	-0.11	0.06**	0.01***	-0.01***	-0.08***	0	0.01***	0.02***	11.35***	1.46***	-1.63***
		(0.215)	(0.101)	(0.068)	(0.026)	(0.004)	(0.004)	(0.014)	(0.010)	(0.004)	(0.008)	(0.889)	(0.066)	(0.039)

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Industry code	Number of observations	l	k	t	l^2	k^2	t^2	$l*k$	$l*t$	$k*t$	γ	$Const$	$ln\sigma_u^2$	$ln\sigma_v^2$
23.2	531	3.04***	-0.29	0.01	-0.13***	0.01***	0	-0.02*	-0.08***	0.02**	***-0.03***	11.9***	1.9***	-1.09***
		(0.389)	(0.194)	(0.172)	(0.035)	(0.005)	(0.011)	(0.012)	(0.017)	(0.009)	***(0.017)***	(1.901)	(0.157)	(0.081)
24	4,656	2.02***	-0.19***	-0.21***	-0.09***	0.01***	0	-0.02**	0.02***	0.01***	0.02***	13.2***	1.72***	-1.49***
		(0.140)	(0.064)	(0.048)	(0.014)	(0.002)	(0.003)	(0.009)	(0.005)	(0.003)	(0.005)	(0.620)	(0.050)	(0.026)
25.1	616	2.92***	-0.1	-0.38**	-0.07	0.01**	-0.01	-0.08**	-0.01	0.03***	***-0.01***	11.21***	1.46***	-1.32***
		(0.400)	(0.206)	(0.149)	(0.043)	(0.007)	(0.009)	(0.032)	(0.017)	(0.009)	***(0.018)***	(1.820)	(0.157)	(0.074)
25.2	3,822	1.65***	-0.03	-0.14***	-0.07***	0.01***	-0.01***	-0.01	0.02***	0.01***	0.02***	12.39***	1.46***	-1.77***
		(0.174)	(0.068)	(0.052)	(0.023)	(0.002)	(0.003)	(0.010)	(0.006)	(0.003)	(0.006)	(0.630)	(0.052)	(0.030)
26.1	789	2.58***	-0.76***	-0.58***	-0.14***	0.04***	0.02**	-0.05*	0.01	0.02***	***0***	16.79***	1.34***	-1.25***
		(0.355)	(0.146)	(0.128)	(0.044)	(0.005)	(0.009)	(0.025)	(0.017)	(0.007)	***(0.016)***	(1.337)	(0.119)	(0.064)
26.2+26.3	552	1.96***	0.24	-0.32**	-0.09**	0	0.01	-0.02	-0.01	0.02**	0.04**	9.37***	1.25***	-1.28***
		(0.380)	(0.196)	(0.150)	(0.035)	(0.007)	(0.010)	(0.023)	(0.015)	(0.008)	(0.018)	(1.646)	(0.142)	(0.073)
26.4	1,119	3.11***	-0.54***	-0.16	-0.18***	0.02***	-0.03***	-0.03	-0.04***	0.04***	0.08***	13.69***	1.18***	-1.48***
		(0.365)	(0.179)	(0.111)	(0.036)	(0.005)	(0.006)	(0.020)	(0.012)	(0.006)	(0.016)	(1.699)	(0.106)	(0.050)
26.5	455	1.55***	0	-0.51***	-0.17***	0	-0.02*	0.05	-0.04**	0.05***	***0.02***	12.45***	1.34***	-1.11***
		(0.545)	(0.301)	(0.179)	(0.045)	(0.010)	(0.012)	(0.032)	(0.017)	(0.009)	***(0.022)***	(2.787)	(0.192)	(0.082)
26.6	3,872	2.46***	-0.73***	-0.03	-0.14***	0.03***	-0.02***	-0.02*	-0.02**	0.02***	0.07***	16.1***	1.45***	-1.36***
		(0.186)	(0.085)	(0.063)	(0.018)	(0.003)	(0.004)	(0.010)	(0.007)	(0.003)	(0.007)	(0.833)	(0.053)	(0.029)
26.7	213	2.11*	-0.15	0.79**	-0.34***	-0.01	-0.09***	0.13***	-0.02	0.01	***-0.02***	11.08***	1.34***	-1.37***
		(1.121)	(0.418)	(0.384)	(0.107)	(0.014)	(0.018)	(0.050)	(0.039)	(0.020)	***(0.031)***	(4.056)	(0.214)	(0.134)
26.8	1,025	1.88***	0.21	0.29**	-0.02	0.01*	0	-0.06***	0.01	-0.01**	0.06***	8.55***	1.36***	-1.56***
		(0.320)	(0.203)	(0.114)	(0.030)	(0.007)	(0.006)	(0.021)	(0.012)	(0.006)	(0.012)	(1.804)	(0.104)	(0.055)
27.1	440	1.18***	-0.17	-0.32*	-0.01	0.01	-0.02	-0.02	-0.02	0.04***	0.07**	14.8***	1.34***	-1***
		(0.367)	(0.221)	(0.168)	(0.037)	(0.007)	(0.013)	(0.026)	(0.018)	(0.010)	(0.029)	(1.754)	(0.179)	(0.085)
27.2	302	0.68*	0.34	-0.1	0.06	0	-0.03**	-0.04	-0.01	0.02*	***-0.02***	12.91***	1.27***	-1.67***
		(0.409)	(0.266)	(0.200)	(0.044)	(0.008)	(0.011)	(0.033)	(0.014)	(0.010)	***(0.022)***	(2.655)	(0.204)	(0.105)
27.3	263	2.09***	0.13	-0.47*	-0.02	0.01	-0.01	-0.06	-0.01	0.04**	0.05*	9.77***	1.14***	-1.41***
		(0.546)	(0.297)	(0.269)	(0.053)	(0.012)	(0.014)	(0.047)	(0.028)	(0.016)	(0.028)	(2.466)	(0.199)	(0.114)
27.4	643	1.03***	-0.18	-0.17	0.13***	0.03***	-0.02**	-0.1***	0.01	0.01*	0.02*	14.95***	1.32***	-1.59***
		(0.338)	(0.191)	(0.118)	(0.031)	(0.006)	(0.008)	(0.018)	(0.011)	(0.006)	(0.012)	(1.747)	(0.141)	(0.069)
27.5	347	1.16**	-0.21	0.12	-0.05	0.01	0.05***	0	-0.01	-0.02*	0.14***	13.99***	1.38***	-1.59***
		(0.503)	(0.327)	(0.179)	(0.055)	(0.009)	(0.011)	(0.031)	(0.024)	(0.011)	(0.023)	(3.010)	(0.172)	(0.092)

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Industry code	Number of observations	l	k	t	l^2	k^2	t^2	$l*k$	$l*t$	$k*t$	γ	$Const$	$ln\sigma_u^2$	$ln\sigma_v^2$
28.1	2,868	2.19***	-0.37***	-0.2**	-0.08***	0.02***	-0.01**	-0.04***	0.01	0.02***	0.02**	13.98***	1.26***	-1.26***
		(0.195)	(0.088)	(0.079)	(0.023)	(0.003)	(0.005)	(0.012)	(0.010)	(0.004)	(0.009)	(0.808)	(0.058)	(0.035)
28.2	421	1.3***	0.48**	0.35**	-0.03	-0.01	0	-0.01	-0.01	-0.01	0.1***	7.8***	1***	-1.62***
		(0.404)	(0.208)	(0.167)	(0.036)	(0.007)	(0.010)	(0.024)	(0.023)	(0.011)	(0.023)	(1.892)	(0.151)	(0.085)
28.3	227	2.7***	-0.77*	-0.25	-0.04	0.04***	0	-0.09**	-0.01	0.02**	0.05*	16.48***	1.48***	-2.09***
		(0.570)	(0.419)	(0.193)	(0.053)	(0.012)	(0.011)	(0.040)	(0.021)	(0.011)	(0.024)	(3.909)	(0.203)	(0.120)
28.4	167	0.43	0.77**	0.16	-0.02	-0.02	0.05***	0.03	0.01	-0.03	***0.05***	7.15**	1.05***	-1.75***
		(0.805)	(0.379)	(0.299)	(0.070)	(0.012)	(0.015)	(0.041)	(0.036)	(0.019)	***(0.037)***	(3.574)	(0.231)	(0.141)
28.5	1,604	2.93***	-0.55***	-0.32***	-0.26***	0.02***	0.01*	0.01	0.02	0.01***	0.05***	13.82***	1.26***	-1.61***
		(0.258)	(0.111)	(0.082)	(0.030)	(0.004)	(0.005)	(0.013)	(0.010)	(0.005)	(0.010)	(1.027)	(0.077)	(0.045)
28.6	444	3.3***	-0.79***	-0.35***	-0.11**	0.04***	-0.01	-0.09***	-0.02	0.03***	***-0.01***	15.3***	1.27***	-2.12***
		(0.462)	(0.198)	(0.122)	(0.056)	(0.006)	(0.007)	(0.022)	(0.017)	(0.008)	***(0.013)***	(1.835)	(0.150)	(0.082)
28.7	1,455	2.02***	-0.17	-0.14	-0.1***	0.01**	-0.02***	-0.02	0.01	0.01**	0.04***	12.93***	1.37***	-1.63***
		(0.323)	(0.125)	(0.095)	(0.035)	(0.004)	(0.005)	(0.018)	(0.010)	(0.005)	(0.010)	(1.293)	(0.086)	(0.047)
29.11	310	0.62	-0.17	0.17	-0.04	0.01	0	0.02	-0.04*	0.01	0.09***	16.2***	1.78***	-1.31***
		(0.541)	(0.264)	(0.182)	(0.055)	(0.010)	(0.013)	(0.044)	(0.021)	(0.010)	(0.027)	(2.636)	(0.170)	(0.099)
29.12	847	1.57***	-0.25**	-0.27***	-0.12***	0.01**	0.01	0.01	-0.02	0.02***	0.04***	15.28***	1.47***	-1.55***
		(0.266)	(0.126)	(0.098)	(0.027)	(0.005)	(0.007)	(0.022)	(0.013)	(0.006)	(0.013)	(1.209)	(0.117)	(0.061)
29.13	454	3.1***	-0.64**	-0.54***	-0.08	0.03***	0.01	-0.08**	-0.02	0.04***	0.09***	14.61***	0.92***	-1.82***
		(0.517)	(0.273)	(0.168)	(0.050)	(0.010)	(0.008)	(0.034)	(0.019)	(0.010)	(0.020)	(2.401)	(0.164)	(0.080)
29.21	175	3.58***	-0.41	0.1	-0.25***	0.02***	-0.02*	-0.03	0.06**	-0.01	0.07***	10.08***	0.94***	-2.29***
		(0.816)	(0.258)	(0.202)	(0.090)	(0.009)	(0.011)	(0.059)	(0.027)	(0.012)	(0.023)	(3.112)	(0.220)	(0.132)
29.22	1,150	1.05***	-0.09	0.33***	-0.06*	0.01	-0.01	0.02	0.01	-0.01*	0.09***	13.8***	1.39***	-1.27***
		(0.284)	(0.135)	(0.110)	(0.035)	(0.005)	(0.007)	(0.021)	(0.015)	(0.007)	(0.015)	(1.147)	(0.090)	(0.053)
29.23	802	2.21***	0.04	0.16	-0.04	0.02***	-0.01*	-0.07**	0.01	0	0.04**	9.85***	1.33***	-1.68***
		(0.282)	(0.143)	(0.126)	(0.042)	(0.006)	(0.007)	(0.028)	(0.018)	(0.008)	(0.016)	(1.131)	(0.108)	(0.068)
29.24	1,505	1.44***	0.11	-0.03	-0.08**	0	-0.02***	-0.01	0.03**	0	0.03***	11.97***	1.35***	-1.32***
		(0.310)	(0.120)	(0.090)	(0.039)	(0.004)	(0.006)	(0.018)	(0.012)	(0.005)	(0.011)	(1.147)	(0.085)	(0.046)
29.3	599	1.82***	-0.14	-0.09	-0.06	0.02**	0.01	-0.04*	-0.02	0.01	0.12***	12.17***	1.56***	-1.25***
		(0.464)	(0.246)	(0.159)	(0.046)	(0.007)	(0.010)	(0.023)	(0.018)	(0.009)	(0.018)	(2.159)	(0.130)	(0.072)
29.4	560	3.08***	-0.89***	-0.1	-0.1**	0.04***	-0.01	-0.09***	0.01	0.01	0.06***	16***	1.21***	-1.56***
		(0.380)	(0.171)	(0.142)	(0.043)	(0.007)	(0.009)	(0.028)	(0.017)	(0.009)	(0.020)	(1.593)	(0.132)	(0.075)

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Industry code	Number of observations	l	k	t	l^2	k^2	t^2	$l*k$	$l*t$	$k*t$	γ	$Const$	$ln\sigma_u^2$	$ln\sigma_v^2$
29.5	2,129	1.68***	-0.13	-0.1	-0.14***	0	-0.01**	0.03*	0	0.01**	0.05***	13.2***	1.37***	-1.43***
		(0.207)	(0.104)	(0.076)	(0.022)	(0.004)	(0.005)	(0.015)	(0.009)	(0.004)	(0.009)	(0.936)	(0.072)	(0.038)
29.7	198	0.82	-0.16	0.31*	-0.14	0	-0.05***	0.05	0.04*	-0.01	***0***	16.37***	1.73***	-2.07***
		(1.063)	(0.285)	(0.182)	(0.112)	(0.011)	(0.011)	(0.058)	(0.024)	(0.011)	***(0.020)***	(2.991)	(0.249)	(0.124)
30.0	459	1.6***	-0.04	-0.57***	-0.12**	0	0.02**	0	0.1***	0	0.07***	14.39***	1.39***	-1.78***
		(0.487)	(0.169)	(0.155)	(0.051)	(0.006)	(0.009)	(0.027)	(0.019)	(0.008)	(0.018)	(1.697)	(0.142)	(0.085)
31.1	850	2.02***	-0.4**	-0.42***	-0.05*	0.03***	0.01*	-0.06***	0.03***	0.01**	0.04***	15.4***	1.47***	-1.82***
		(0.256)	(0.159)	(0.106)	(0.027)	(0.006)	(0.006)	(0.020)	(0.011)	(0.007)	(0.012)	(1.382)	(0.109)	(0.061)
31.2	1,271	1.53***	0.02	-0.07	0.02	0.02***	0.02***	-0.07***	0.03***	-0.01	0.07***	12.05***	1.39***	-1.63***
		(0.281)	(0.110)	(0.094)	(0.029)	(0.004)	(0.006)	(0.017)	(0.010)	(0.005)	(0.010)	(1.078)	(0.088)	(0.050)
31.3	531	2.21***	-0.23	0.11	-0.07*	0.02***	0.01	-0.05**	0.02	-0.01	0.09***	12.17***	1.61***	-1.84***
		(0.371)	(0.223)	(0.141)	(0.038)	(0.007)	(0.008)	(0.025)	(0.014)	(0.008)	(0.014)	(2.064)	(0.137)	(0.073)
31.4	82	9.84***	1.46	0.34	-0.37***	0	-0.03	-0.27***	-0.05	0.02	0.39***	-23.68*	0.78**	-1.97***
		(2.066)	(1.223)	(0.748)	(0.113)	(0.035)	(0.022)	(0.077)	(0.062)	(0.038)	(0.076)	(12.407)	(0.380)	(0.180)
31.5	233	0.34	0.44	0.11	-0.07	-0.02*	-0.03*	0.06*	0	0	0.05***	12.03***	1.49***	-1.73***
		(0.618)	(0.303)	(0.233)	(0.063)	(0.010)	(0.014)	(0.032)	(0.026)	(0.013)	(0.019)	(2.818)	(0.194)	(0.125)
31.6	998	1.73***	0.18	-0.14	-0.06*	0	-0.01	-0.04**	0.01	0.01	***0.02***	11.37***	1.4***	-2.01***
		(0.282)	(0.127)	(0.092)	(0.030)	(0.005)	(0.005)	(0.017)	(0.010)	(0.005)	***(0.010)***	(1.138)	(0.100)	(0.055)
32	384	1.97***	0.16	-0.04	-0.02	0.01*	-0.01	-0.07***	0.02	0	***-0.01***	10.5***	1.49***	-1.24***
		(0.496)	(0.252)	(0.202)	(0.049)	(0.008)	(0.013)	(0.025)	(0.026)	(0.011)	***(0.021)***	(2.370)	(0.168)	(0.095)
33	1,675	1.83***	0.15*	0.14**	-0.06**	0	-0.01***	-0.03*	0.02**	-0.01*	0.03***	10.8***	1.42***	-2.11***
		(0.219)	(0.089)	(0.064)	(0.026)	(0.003)	(0.004)	(0.015)	(0.009)	(0.004)	(0.008)	(0.809)	(0.077)	(0.044)
34.1	810	1.07**	-0.96***	0.02	-0.06*	0.03***	-0.03***	0.01	-0.01	0.01	***0.01***	23.22***	1.74***	-0.92***
		(0.429)	(0.203)	(0.151)	(0.035)	(0.007)	(0.010)	(0.023)	(0.015)	(0.008)	***(0.017)***	(1.714)	(0.137)	(0.064)
34.2	175	3.22***	-1.09**	-0.01	-0.23**	0.03*	-0.02**	0	0.01	0.01	0.07***	18.46***	1.12***	-2.58***
		(0.788)	(0.453)	(0.261)	(0.092)	(0.018)	(0.010)	(0.078)	(0.029)	(0.019)	(0.026)	(4.104)	(0.215)	(0.143)
34.3	1,136	1.41***	-0.05	-0.17	-0.04	0.01	0.01	-0.03	-0.04***	0.02**	0.05***	12.93***	1.13***	-1.22***
		(0.329)	(0.215)	(0.129)	(0.029)	(0.007)	(0.007)	(0.019)	(0.011)	(0.007)	(0.014)	(1.994)	(0.111)	(0.051)
35.2	720	2***	-0.49***	-0.13	-0.05*	0.02***	0	-0.04	-0.03**	0.02***	0.05***	16.2***	1.56***	-1.42***
		(0.334)	(0.162)	(0.120)	(0.030)	(0.006)	(0.008)	(0.025)	(0.012)	(0.007)	(0.015)	(1.633)	(0.134)	(0.067)
36.1	1,431	3.02***	-0.21	0.15	-0.11***	0.02***	-0.02***	-0.06***	0	0	0.09***	10.34***	1.68***	-1.57***
		(0.295)	(0.140)	(0.094)	(0.033)	(0.005)	(0.006)	(0.019)	(0.012)	(0.006)	(0.011)	(1.289)	(0.079)	(0.049)

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Industry code	Number of observations	l	k	t	l^2	k^2	t^2	$l*k$	$l*t$	$k*t$	γ	$Const$	$ln\sigma_u^2$	$ln\sigma_v^2$
36.2	458	2.89***	-0.58**	0.14	-0.33***	0.02	-0.03**	0.06	0.02	0	***0.02***	13.92***	1.69***	-1.08***
		(0.622)	(0.256)	(0.221)	(0.053)	(0.010)	(0.012)	(0.039)	(0.020)	(0.012)	***(0.018)***	(2.572)	(0.157)	(0.083)
36.5	105	2.45	-0.8	-0.05	-0.02	0.05**	0.01	-0.1	-0.03	0.01	***0.04***	15.05*	1.26***	-1.9***
		(1.908)	(0.741)	(0.443)	(0.192)	(0.025)	(0.018)	(0.132)	(0.065)	(0.027)	***(0.051)***	(8.137)	(0.319)	(0.170)
36.6	489	1.25**	-0.18	-0.16	-0.11*	0.01	-0.01*	0.01	0.01	0.01*	***0.01***	15.14***	1.74***	-2.12***
		(0.506)	(0.275)	(0.132)	(0.065)	(0.010)	(0.007)	(0.034)	(0.014)	(0.007)	***(0.014)***	(2.291)	(0.130)	(0.083)
37.1	1,230	2.27***	-0.29*	-1.07***	-0.12***	0.02***	0.07***	-0.03**	0	0.03***	0.06***	14.23***	1.6***	-1.04***
		(0.299)	(0.153)	(0.142)	(0.031)	(0.005)	(0.008)	(0.017)	(0.014)	(0.007)	(0.015)	(1.524)	(0.091)	(0.054)
40.11.1	254	1.37*	-1.14***	-0.71***	-0.32***	0.01	0.01	0.16***	-0.07***	0.06***	***0.02***	24.74***	1.36***	-1.26***
		(0.732)	(0.326)	(0.241)	(0.063)	(0.010)	(0.015)	(0.052)	(0.026)	(0.013)	***(0.024)***	(3.776)	(0.212)	(0.106)
40.11.5	582	1.52***	0.15	-0.24	-0.09**	0	0.01	0	0.06***	0	0.1***	11.77***	1.8***	-1.34***
		(0.465)	(0.182)	(0.154)	(0.041)	(0.006)	(0.010)	(0.022)	(0.019)	(0.009)	(0.017)	(1.812)	(0.146)	(0.076)
40.12	1,822	1.55***	-0.33***	-0.18**	-0.05**	0.02***	0	-0.02	0.03***	0	0.03***	14.17***	1.2***	-1.29***
		(0.229)	(0.102)	(0.077)	(0.026)	(0.004)	(0.005)	(0.017)	(0.010)	(0.005)	(0.011)	(0.932)	(0.091)	(0.040)
40.13.1	534	3.16***	-0.43*	0.08	-0.25***	0.02**	-0.01*	-0.01	0.05***	-0.01	0.03***	13.81***	2.65***	-1.47***
		(0.539)	(0.257)	(0.135)	(0.039)	(0.009)	(0.009)	(0.026)	(0.017)	(0.007)	(0.010)	(2.453)	(0.139)	(0.075)
40.13.2	731	1.21**	0.25*	-0.15	0	0.01	0.01	-0.04**	0.05**	0	0.04***	14.02***	2.52***	-0.87***
		(0.496)	(0.148)	(0.136)	(0.048)	(0.005)	(0.010)	(0.020)	(0.018)	(0.006)	(0.012)	(1.853)	(0.145)	(0.069)
40.13.3	976	2.17***	0	-0.17	-0.1**	0.01	-0.01	-0.03	0.01	0.01	***-0.01***	11.54***	1.57***	-1.49***
		(0.375)	(0.181)	(0.110)	(0.041)	(0.006)	(0.007)	(0.021)	(0.015)	(0.006)	***(0.011)***	(1.544)	(0.107)	(0.055)
40.2	944	0.86***	-0.81***	0.04	-0.06***	0.03***	0.01**	0.01	0.01	0	0.02***	24.14***	2.32***	-2.77***
		(0.316)	(0.168)	(0.075)	(0.019)	(0.005)	(0.003)	(0.021)	(0.007)	(0.004)	(0.006)	(1.791)	(0.108)	(0.054)
40.30.0	1,882	1.77***	-0.49***	-0.14	-0.07***	0.03***	0	-0.04**	0.08***	-0.02***	0.02*	15.75***	1.25***	-1.14***
		(0.245)	(0.126)	(0.094)	(0.028)	(0.004)	(0.006)	(0.016)	(0.011)	(0.005)	(0.010)	(1.078)	(0.074)	(0.042)
40.30.1	3,678	2***	-0.37***	-0.2***	-0.1***	0.02***	-0.01*	-0.02*	0.04***	0	0.01*	14***	1.26***	-1.16***
		(0.186)	(0.091)	(0.065)	(0.020)	(0.003)	(0.004)	(0.012)	(0.008)	(0.004)	(0.007)	(0.812)	(0.055)	(0.029)
40.30.2	438	1.89***	-0.6**	-0.62***	-0.21***	0.02*	0.02*	0.02	0.05**	0.01	***0.02***	17.59***	1.46***	-1.42***
		(0.507)	(0.266)	(0.164)	(0.051)	(0.010)	(0.010)	(0.033)	(0.019)	(0.009)	***(0.018)***	(2.050)	(0.150)	(0.083)
40.30.3	842	0.11	-0.33	-0.43***	-0.03	0.01	0.01	0.05*	0.03**	0.01	***0.01***	18.33***	1.09***	-1.16***
		(0.453)	(0.216)	(0.130)	(0.045)	(0.009)	(0.008)	(0.030)	(0.015)	(0.008)	***(0.016)***	(1.660)	(0.126)	(0.059)
40.30.4+40.30.5	607	0.98**	0	-0.08	-0.18***	-0.01	-0.02*	0.09***	0.01	0	***-0.01***	14.39***	1.4***	-1.19***
		(0.451)	(0.179)	(0.170)	(0.050)	(0.006)	(0.011)	(0.027)	(0.022)	(0.010)	***(0.017)***	(1.659)	(0.129)	(0.075)

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Industry code	Number of observations	l	k	t	l^2	k^2	t^2	$l*k$	$l*t$	$k*t$	γ	$Const$	$ln\sigma_u^2$	$ln\sigma_v^2$
41.0	4,305	1.38***	-0.04	-0.11**	-0.09***	0.01**	-0.01***	0.01	0.04***	0	0.01**	12.69***	1.45***	-1.58***
		(0.140)	(0.071)	(0.048)	(0.017)	(0.003)	(0.003)	(0.010)	(0.006)	(0.003)	(0.005)	(0.579)	(0.048)	(0.027)
50.1	6,988	1.49***	-0.09*	-0.08*	-0.08***	0.01***	-0.01***	-0.01	0.02***	0	0.05***	14.2***	1.59***	-1.56***
		(0.128)	(0.055)	(0.044)	(0.013)	(0.002)	(0.003)	(0.006)	(0.005)	(0.002)	(0.006)	(0.548)	(0.040)	(0.024)
50.2	2,246	2.38***	0.07	0.25***	-0.09***	0.01**	-0.02***	-0.04***	-0.04***	0	0.04***	10.18***	1.91***	-1.18***
		(0.290)	(0.103)	(0.096)	(0.035)	(0.004)	(0.006)	(0.015)	(0.012)	(0.005)	(0.008)	(1.059)	(0.060)	(0.041)
50.3	3,318	1.94***	-0.11*	-0.35***	-0.1***	0.01***	0.01	-0.02***	0.04***	0.01	0.05***	13.08***	1.56***	-1.51***
		(0.172)	(0.062)	(0.065)	(0.019)	(0.002)	(0.004)	(0.008)	(0.008)	(0.003)	(0.008)	(0.605)	(0.048)	(0.035)
50.5	1,516	2.05***	-0.02	-0.14*	-0.03	0.02***	-0.01	-0.06***	0.03***	0	0.04***	11.34***	1.83***	-1.67***
		(0.262)	(0.109)	(0.080)	(0.030)	(0.004)	(0.005)	(0.014)	(0.009)	(0.004)	(0.008)	(0.946)	(0.086)	(0.050)
51.1	6,289	1.47***	0.03	-0.14***	-0.1***	0	0	0.01**	0.04***	-0.01***	0.01***	13.67***	1.95***	-1.2***
		(0.134)	(0.046)	(0.047)	(0.016)	(0.002)	(0.003)	(0.006)	(0.006)	(0.002)	(0.005)	(0.460)	(0.035)	(0.024)
51.2	2,193	2.36***	-0.03	-0.72***	-0.17***	0	0.01	-0.02	0.08***	0.02***	0.02**	13.51***	1.86***	-0.9***
		(0.288)	(0.100)	(0.102)	(0.031)	(0.003)	(0.007)	(0.012)	(0.013)	(0.005)	(0.009)	(1.007)	(0.062)	(0.042)
51.3	12,934	2.18***	-0.03	-0.15***	-0.16***	0.01***	-0.01***	-0.01	0.05***	0	0.03***	12.59***	1.79***	-1.32***
		(0.088)	(0.034)	(0.033)	(0.010)	(0.001)	(0.002)	(0.004)	(0.004)	(0.002)	(0.004)	(0.335)	(0.026)	(0.017)
51.4	13,399	1.7***	-0.05*	-0.07**	-0.09***	0.01***	-0.01***	-0.01**	0.04***	-0.01***	0.04***	13.46***	1.75***	-1.4***
		(0.081)	(0.031)	(0.031)	(0.010)	(0.001)	(0.002)	(0.004)	(0.004)	(0.002)	(0.003)	(0.288)	(0.025)	(0.017)
51.5	17,222	2.04***	-0.17***	-0.21***	-0.13***	0.01***	0	-0.01***	0.04***	0	0.03***	13.39***	1.74***	-1.1***
		(0.074)	(0.029)	(0.032)	(0.008)	(0.001)	(0.002)	(0.004)	(0.004)	(0.002)	(0.003)	(0.282)	(0.022)	(0.015)
51.8	11,041	1.96***	0.06	-0.16***	-0.13***	0.01***	0	-0.02***	0.07***	-0.01***	0.03***	12.03***	1.62***	-1.24***
		(0.107)	(0.035)	(0.037)	(0.013)	(0.001)	(0.003)	(0.005)	(0.005)	(0.002)	(0.004)	(0.349)	(0.028)	(0.019)
51.9	8,697	2.11***	0.02	-0.15***	-0.14***	0.01***	-0.01**	-0.01*	0.04***	0	0.03***	12.28***	1.78***	-1.24***
		(0.125)	(0.041)	(0.042)	(0.013)	(0.001)	(0.003)	(0.005)	(0.005)	(0.002)	(0.004)	(0.420)	(0.030)	(0.021)
52.1	8,071	1.36***	-0.29***	-0.1***	0.02	0.02***	0	-0.05***	0.03***	0*	0.03***	14.84***	1.92***	-2.22***
		(0.138)	(0.042)	(0.028)	(0.016)	(0.002)	(0.002)	(0.006)	(0.004)	(0.002)	(0.003)	(0.445)	(0.036)	(0.023)
52.2	3,214	2.1***	-0.16**	-0.02	-0.07***	0.02***	-0.01**	-0.04***	0.03***	0*	0.03***	12.12***	1.95***	-1.81***
		(0.210)	(0.066)	(0.056)	(0.026)	(0.002)	(0.004)	(0.009)	(0.007)	(0.003)	(0.006)	(0.669)	(0.050)	(0.037)
52.3	6,302	0.19*	-0.25***	0.06***	0.08***	0.02***	-0.01***	0	0	0*	0.04***	17.08***	1.7***	-2.69***
		(0.105)	(0.035)	(0.023)	(0.015)	(0.001)	(0.001)	(0.007)	(0.004)	(0.001)	(0.003)	(0.337)	(0.041)	(0.023)
52.41	217	0.64	-0.26	-0.22	-0.06	0.01	-0.01	0.04	0.05	0.01	0.06**	16.8***	1.06***	-2.94***
		(0.655)	(0.302)	(0.188)	(0.096)	(0.012)	(0.010)	(0.042)	(0.040)	(0.015)	(0.024)	(2.288)	(0.170)	(0.128)

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Industry code	Number of observations	l	k	t	l^2	k^2	t^2	$l*k$	$l*t$	$k*t$	γ	$Const$	$ln\sigma_u^2$	$ln\sigma_v^2$
52.42	628	1.98***	0.04	-0.4***	-0.11***	0.01	0.01	-0.01	0.01	0.02***	0.03*	11.42***	1.28***	-1.81***
		(0.305)	(0.146)	(0.116)	(0.031)	(0.005)	(0.008)	(0.021)	(0.015)	(0.006)	(0.016)	(1.344)	(0.121)	(0.081)
52.43	283	1.33**	0.06	0.31	-0.19***	0	0.01	0.08**	0	-0.02	0.1***	11.74***	0.88***	-1.82***
		(0.606)	(0.236)	(0.238)	(0.060)	(0.008)	(0.014)	(0.034)	(0.026)	(0.013)	(0.036)	(2.452)	(0.184)	(0.129)
52.44	457	1.76***	-0.26	0.08	-0.21***	0.01	-0.05***	0.07**	0.07**	0	0.06**	13.72***	1.61***	-1.02***
		(0.540)	(0.192)	(0.213)	(0.070)	(0.008)	(0.015)	(0.033)	(0.027)	(0.011)	(0.024)	(1.690)	(0.132)	(0.092)
52.45	352	1.28***	-0.1	-0.52**	-0.05	0.02**	0	-0.02	0.05*	0.01	***0.02***	14.73***	1.73***	-1.13***
		(0.459)	(0.233)	(0.237)	(0.048)	(0.008)	(0.017)	(0.028)	(0.028)	(0.012)	***(0.026)***	(1.975)	(0.161)	(0.121)
52.46	652	2.46***	-0.28*	-0.47**	-0.12**	0.02***	-0.01	-0.05*	0.06***	0.01	0.05**	13.46***	1.56***	-1.49***
		(0.371)	(0.155)	(0.183)	(0.048)	(0.006)	(0.012)	(0.027)	(0.021)	(0.008)	(0.021)	(1.457)	(0.107)	(0.087)
52.47	669	1.75***	0.18	0.33***	-0.1***	0	-0.01	0.01	0.01	-0.02***	0.08***	9.76***	1.65***	-1.87***
		(0.319)	(0.146)	(0.097)	(0.036)	(0.007)	(0.007)	(0.026)	(0.015)	(0.007)	(0.013)	(1.116)	(0.122)	(0.069)
52.48	1,810	1.33***	0.02	-0.16**	-0.06*	0	0	0.01	0	0.01*	0.04***	12.85***	1.79***	-1.56***
		(0.274)	(0.100)	(0.072)	(0.034)	(0.004)	(0.005)	(0.015)	(0.011)	(0.005)	(0.008)	(0.901)	(0.066)	(0.047)
52.6	680	2.34***	-0.07	-0.04	-0.18***	0.01	-0.02*	0.01	0.09***	-0.01	0.04**	10.81***	1.74***	-1.06***
		(0.565)	(0.184)	(0.180)	(0.063)	(0.006)	(0.012)	(0.024)	(0.023)	(0.009)	(0.016)	(1.852)	(0.104)	(0.078)
52.7	308	-0.22	-0.13	-0.06	0.19	0.01	-0.02**	-0.03	0.02	0.01	0.04***	16***	2.19***	-2.32***
		(0.953)	(0.286)	(0.160)	(0.141)	(0.012)	(0.008)	(0.054)	(0.030)	(0.011)	(0.014)	(2.568)	(0.158)	(0.104)
55.1	2,518	2.11***	0.19*	0.08	-0.09***	0	-0.01	-0.03**	0	0	0.02***	9.4***	1.49***	-1.64***
		(0.238)	(0.111)	(0.065)	(0.024)	(0.003)	(0.004)	(0.012)	(0.007)	(0.003)	(0.007)	(1.138)	(0.067)	(0.036)
55.2	816	2.07***	-0.28	-0.12	0	0.02***	-0.01	-0.05*	-0.01	0.02**	0.03**	12.36***	1.38***	-1.28***
		(0.524)	(0.179)	(0.116)	(0.051)	(0.006)	(0.008)	(0.028)	(0.018)	(0.007)	(0.015)	(1.830)	(0.125)	(0.066)
55.3+55.4+55.5	5,550	1.25***	-0.11**	-0.08**	-0.03**	0.01***	0	-0.01	0.02***	0*	0.02***	13.51***	1.27***	-1.74***
		(0.139)	(0.055)	(0.040)	(0.016)	(0.002)	(0.003)	(0.007)	(0.006)	(0.002)	(0.005)	(0.499)	(0.041)	(0.026)
60.1	1,183	1.55***	-0.43***	-0.03	-0.05	0.02***	0.02***	-0.03*	0.04***	-0.02***	0.04***	16.21***	1.76***	-1.48***
		(0.280)	(0.113)	(0.090)	(0.032)	(0.004)	(0.006)	(0.014)	(0.011)	(0.005)	(0.012)	(1.025)	(0.102)	(0.052)
60.2	8,842	2.03***	-0.2***	-0.28***	-0.09***	0.01***	0.01***	-0.02***	0	0.01***	0.03***	13.01***	1.68***	-1.19***
		(0.136)	(0.061)	(0.046)	(0.014)	(0.002)	(0.003)	(0.008)	(0.005)	(0.003)	(0.004)	(0.561)	(0.032)	(0.019)
60.3	296	1.68***	-0.41**	-0.51***	0	0.03***	0.02**	-0.06**	-0.01	0.02**	***-0.03***	17.04***	1.3***	-1.86***
		(0.372)	(0.169)	(0.193)	(0.031)	(0.006)	(0.010)	(0.027)	(0.012)	(0.008)	***(0.030)***	(1.847)	(0.233)	(0.104)
61.1	503	2.32***	-0.05	-0.42**	-0.13**	0.01	0	-0.03	0.01	0.02***	***0***	12.42***	1.43***	-0.88***
		(0.545)	(0.173)	(0.179)	(0.063)	(0.006)	(0.013)	(0.025)	(0.024)	(0.007)	***(0.019)***	(1.811)	(0.154)	(0.078)

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Industry code	Number of observations	l	k	t	l^2	k^2	t^2	$l*k$	$l*t$	$k*t$	γ	$Const$	$ln\sigma_u^2$	$ln\sigma_v^2$
61.2	556	2.35***	-0.18	0	-0.07*	0.02***	0	-0.07**	0.04**	-0.01	0.12***	10.4***	1.28***	-1.54***
		(0.375)	(0.273)	(0.158)	(0.042)	(0.008)	(0.009)	(0.026)	(0.017)	(0.010)	(0.021)	(2.359)	(0.150)	(0.075)
62	658	0.77*	-0.06	-0.08	-0.02	0	-0.02	0.01	-0.01	0.01	0.11***	15.11***	1.58***	-0.98***
		(0.445)	(0.212)	(0.160)	(0.042)	(0.009)	(0.010)	(0.034)	(0.020)	(0.010)	(0.020)	(1.936)	(0.131)	(0.066)
63.11	1,160	1.75***	-0.22*	-0.51***	-0.09**	0.01*	0.01	0	0	0.03***	0.07***	14.47***	1.41***	-1.15***
		(0.282)	(0.123)	(0.107)	(0.037)	(0.004)	(0.007)	(0.018)	(0.014)	(0.006)	(0.014)	(1.211)	(0.100)	(0.052)
63.12	2,763	1.43***	-0.32***	-0.19**	-0.06**	0.01***	0.01***	-0.01	0.01	0	0.02***	15.81***	1.51***	-1.21***
		(0.248)	(0.113)	(0.086)	(0.024)	(0.004)	(0.005)	(0.013)	(0.010)	(0.004)	(0.008)	(1.071)	(0.065)	(0.035)
63.2	3,954	1.5***	-0.05	0.07	-0.01	0.01***	0	-0.04***	0	0	0.06***	12.48***	1.64***	-1.35***
		(0.165)	(0.083)	(0.056)	(0.019)	(0.003)	(0.003)	(0.011)	(0.007)	(0.003)	(0.006)	(0.721)	(0.055)	(0.028)
63.3	693	2***	0.25*	-0.2	0.01	0.01	0	-0.08***	0.06***	0	0.06***	10.16***	2.08***	-1.49***
		(0.502)	(0.135)	(0.127)	(0.068)	(0.004)	(0.009)	(0.022)	(0.020)	(0.007)	(0.012)	(1.367)	(0.103)	(0.074)
63.4	4,507	2.3***	-0.09	-0.17***	-0.19***	0.01***	0.01**	0	0.04***	-0.01***	0.02***	11.81***	1.65***	-1.01***
		(0.158)	(0.055)	(0.062)	(0.018)	(0.002)	(0.005)	(0.009)	(0.008)	(0.003)	(0.007)	(0.562)	(0.044)	(0.029)
64.1	334	1.02*	-0.26	-0.27*	-0.07	0.01	0.01	0.03	0.02	0.01	0.1***	14.63***	1.32***	-1.71***
		(0.558)	(0.197)	(0.165)	(0.087)	(0.009)	(0.012)	(0.043)	(0.030)	(0.010)	(0.027)	(1.415)	(0.157)	(0.104)
64.2	3,076	2.23***	-0.16**	-0.01	-0.05***	0.02***	0.01	-0.06***	0	0	0.02***	11.89***	1.72***	-1.42***
		(0.170)	(0.073)	(0.061)	(0.020)	(0.003)	(0.004)	(0.012)	(0.008)	(0.003)	(0.007)	(0.711)	(0.056)	(0.033)
70.1	3,245	1.66***	-0.5***	-0.17	-0.15***	0.02***	-0.02***	0.01	0.04***	0.01*	***0.01***	16.95***	1.96***	-0.54***
		(0.320)	(0.098)	(0.111)	(0.034)	(0.003)	(0.007)	(0.014)	(0.014)	(0.005)	***(0.008)***	(1.170)	(0.051)	(0.034)
70.2	16,416	1.15***	-0.5***	-0.15***	-0.02	0.02***	0	-0.02***	0	0.01***	0.02***	16.9***	1.67***	-1.21***
		(0.116)	(0.052)	(0.035)	(0.011)	(0.002)	(0.002)	(0.006)	(0.004)	(0.002)	(0.003)	(0.538)	(0.024)	(0.015)
70.3	11,990	1.37***	-0.05	-0.1***	-0.1***	0***	0	0.01	0.02***	0**	0.03***	14.13***	1.72***	-1.19***
		(0.113)	(0.039)	(0.034)	(0.012)	(0.001)	(0.002)	(0.005)	(0.004)	(0.002)	(0.004)	(0.407)	(0.027)	(0.017)
71.1	238	2.3**	-0.39	0.04	0.1	0.04**	0.02	-0.14***	0	-0.01	0.09***	13.09**	1.99***	-1***
		(1.168)	(0.513)	(0.329)	(0.121)	(0.015)	(0.020)	(0.044)	(0.041)	(0.017)	(0.026)	(5.309)	(0.215)	(0.133)
71.2	694	2.66***	-0.47**	-0.53**	-0.2***	0.02***	0.02	-0.01	0.01	0.02*	0.05***	14.34***	1.94***	-0.39***
		(0.626)	(0.227)	(0.235)	(0.069)	(0.007)	(0.015)	(0.025)	(0.030)	(0.010)	(0.019)	(2.422)	(0.116)	(0.074)
71.3	1,081	1.47***	-0.29	0	0.03	0.02***	-0.02*	-0.03	-0.04**	0.02*	0.05***	14.95***	2.18***	-0.93***
		(0.533)	(0.195)	(0.177)	(0.059)	(0.006)	(0.009)	(0.023)	(0.019)	(0.009)	(0.012)	(2.023)	(0.085)	(0.058)
72.1	474	1.47***	-0.34	-0.23	-0.19***	0.01	0.01	0.05	0.04*	0	0.03*	16.46***	1.84***	-1.19***
		(0.440)	(0.227)	(0.217)	(0.058)	(0.008)	(0.014)	(0.035)	(0.023)	(0.012)	(0.018)	(1.971)	(0.120)	(0.091)

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Industry code	Number of observations	l	k	t	l^2	k^2	t^2	$l*k$	$l*t$	$k*t$	γ	$Const$	$ln\sigma_u^2$	$ln\sigma_v^2$
72.2	3,096	0.59***	-0.02	0	0.05*	0.01***	0	-0.02*	0.02**	0	0.06***	15.28***	1.79***	-1.45***
		(0.224)	(0.070)	(0.065)	(0.029)	(0.002)	(0.004)	(0.010)	(0.009)	(0.004)	(0.008)	(0.699)	(0.053)	(0.035)
72.3	463	1.11**	-0.05	0.02	-0.14**	0	-0.01	0.06**	0.01	0	***0.01***	14.46***	1.64***	-1.88***
		(0.517)	(0.196)	(0.147)	(0.063)	(0.007)	(0.009)	(0.028)	(0.018)	(0.009)	***(0.015)***	(1.770)	(0.143)	(0.089)
72.4	1,033	0.45	-0.02	0.07	0.08	0.01*	0	-0.02	0.03*	0	0.07***	15.46***	1.95***	-1.37***
		(0.423)	(0.135)	(0.113)	(0.052)	(0.004)	(0.008)	(0.015)	(0.015)	(0.006)	(0.010)	(1.331)	(0.095)	(0.058)
72.5+72.6	1,086	2.42***	0.25**	-0.24**	0.04	0.01***	0.01	-0.13***	0.01	0.01*	0.03**	10.16***	1.92***	-1.33***
		(0.344)	(0.114)	(0.110)	(0.046)	(0.004)	(0.008)	(0.018)	(0.016)	(0.006)	(0.013)	(1.172)	(0.087)	(0.059)
73	7,797	1.2***	0.05	0.04	-0.02	0.01***	-0.01***	-0.02***	0.02***	0	0.05***	13.16***	1.83***	-1.51***
		(0.097)	(0.041)	(0.032)	(0.012)	(0.001)	(0.002)	(0.007)	(0.004)	(0.002)	(0.004)	(0.391)	(0.036)	(0.020)
74.1	7,301	1.04***	0.11***	-0.09**	0	0	-0.01***	-0.01	0.03***	0	0.03***	13.8***	2.24***	-1.03***
		(0.164)	(0.041)	(0.046)	(0.020)	(0.001)	(0.003)	(0.006)	(0.006)	(0.002)	(0.004)	(0.492)	(0.032)	(0.022)
74.20.0	2,198	1.49***	0.25***	0.15	-0.13***	0*	-0.01*	0.03**	0	0	0.06***	10.77***	1.73***	-1.02***
		(0.260)	(0.087)	(0.094)	(0.031)	(0.003)	(0.006)	(0.013)	(0.012)	(0.005)	(0.010)	(0.929)	(0.062)	(0.041)
74.20.1	5,346	1.3***	0.17***	0.14***	-0.01	0*	-0.02***	-0.02***	0	0	0.04***	11.88***	1.79***	-1.25***
		(0.163)	(0.053)	(0.048)	(0.019)	(0.002)	(0.003)	(0.008)	(0.006)	(0.002)	(0.005)	(0.581)	(0.042)	(0.025)
74.20.2	1,468	1.84***	-0.63***	0.05	-0.08***	0.03***	-0.02***	-0.03**	0.02*	0	0.09***	16.46***	1.82***	-1.2***
		(0.292)	(0.132)	(0.090)	(0.026)	(0.004)	(0.006)	(0.014)	(0.010)	(0.005)	(0.010)	(1.426)	(0.087)	(0.044)
74.20.3	1,296	2.71***	0.44***	0.33***	-0.05	0.01	-0.01	-0.09***	-0.01	-0.01**	0.06***	5.56***	1.65***	-1.28***
		(0.349)	(0.139)	(0.100)	(0.043)	(0.005)	(0.007)	(0.024)	(0.015)	(0.006)	(0.012)	(1.360)	(0.091)	(0.052)
74.3	1,523	0.76***	0.12	-0.05	-0.01	0	-0.01**	0	0.06***	-0.01	0.02**	13.82***	1.91***	-1.62***
		(0.296)	(0.097)	(0.081)	(0.043)	(0.004)	(0.005)	(0.017)	(0.012)	(0.005)	(0.008)	(0.927)	(0.073)	(0.048)
74.4	2,296	1.35***	0.07	-0.01	-0.05	0.01**	0	-0.01	0.04***	-0.01***	0.04***	13.2***	2***	-1.02***
		(0.334)	(0.077)	(0.086)	(0.043)	(0.003)	(0.006)	(0.013)	(0.012)	(0.004)	(0.009)	(0.904)	(0.062)	(0.042)
74.5	454	2.04***	-0.23	-0.59***	-0.15*	0.01	0	-0.01	0.09***	0.02*	0.05**	16.24***	2.06***	-1.36***
		(0.665)	(0.192)	(0.177)	(0.087)	(0.006)	(0.013)	(0.030)	(0.025)	(0.008)	(0.021)	(1.949)	(0.129)	(0.098)
74.6	3,077	0.54***	0.02	-0.18***	0.08***	0.01***	-0.01***	-0.03***	0.05***	0	0.04***	15.93***	1.62***	-2.44***
		(0.195)	(0.054)	(0.038)	(0.025)	(0.002)	(0.002)	(0.008)	(0.006)	(0.002)	(0.005)	(0.555)	(0.056)	(0.032)
74.7	1,048	0.56	0.01	-0.2*	0.03	0	-0.02**	-0.01	0.04**	0.01	0.05***	15.09***	1.5***	-1.33***
		(0.424)	(0.153)	(0.117)	(0.054)	(0.005)	(0.008)	(0.022)	(0.018)	(0.007)	(0.015)	(1.453)	(0.088)	(0.059)
74.8	1,727	1.76***	0.44***	0.06	-0.06*	-0.01**	-0.01**	-0.03*	0.02	0	0.04***	9.55***	2.05***	-1.12***
		(0.291)	(0.090)	(0.094)	(0.035)	(0.003)	(0.007)	(0.014)	(0.013)	(0.005)	(0.009)	(0.950)	(0.067)	(0.048)

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Industry code	Number of observations	l	k	t	l^2	k^2	t^2	$l*k$	$l*t$	$k*t$	γ	$Const$	$ln\sigma_u^2$	$ln\sigma_v^2$
90.00	532	2.52***	-0.33	-0.42**	-0.27***	0.01*	0.02**	0.02	0.03	0.01	0.09***	12.75***	1.37***	-1.23***
		(0.498)	(0.230)	(0.177)	(0.054)	(0.008)	(0.011)	(0.027)	(0.022)	(0.009)	(0.019)	(2.077)	(0.133)	(0.079)
90.01	540	2.06***	-0.21	-0.39***	0.13*	0.03***	0	-0.13***	-0.02	0.02***	***0***	12.99***	1.16***	-1.57***
		(0.514)	(0.158)	(0.139)	(0.068)	(0.005)	(0.009)	(0.029)	(0.020)	(0.007)	***(0.016)***	(1.700)	(0.140)	(0.076)
90.02	1,367	1.54***	-0.38***	-0.39***	-0.06**	0.02***	0.01	-0.01	0	0.02***	***-0.02***	15.19***	0.67***	-1.57***
		(0.294)	(0.131)	(0.103)	(0.028)	(0.004)	(0.006)	(0.017)	(0.012)	(0.006)	***(0.012)***	(1.261)	(0.095)	(0.048)
90.03	2,190	1.16***	-0.09	-0.24***	-0.06**	0	0	0.02	-0.01	0.01***	0.02**	13.73***	1***	-1.59***
		(0.263)	(0.102)	(0.074)	(0.027)	(0.004)	(0.004)	(0.017)	(0.010)	(0.004)	(0.009)	(0.955)	(0.074)	(0.038)
92.1	990	1.17***	-0.2	-0.14	0.02	0.02***	0.01	-0.04***	-0.01	0	0.05***	14.5***	1.71***	-0.78***
		(0.389)	(0.154)	(0.154)	(0.038)	(0.005)	(0.011)	(0.015)	(0.019)	(0.007)	(0.014)	(1.568)	(0.100)	(0.061)
92.2	2,000	2.03***	0.01	-0.01	0.03	0.02***	0	-0.08***	0	0	0.03***	10.2***	1.73***	-1.5***
		(0.259)	(0.098)	(0.068)	(0.036)	(0.003)	(0.005)	(0.015)	(0.011)	(0.004)	(0.007)	(0.910)	(0.079)	(0.042)
92.3+92.5	908	0.39	-0.16	-0.05	0.1*	0.01**	0	-0.01	-0.01	0	0.05***	15.3***	1.67***	-1.56***
		(0.494)	(0.161)	(0.104)	(0.062)	(0.005)	(0.007)	(0.022)	(0.018)	(0.006)	(0.011)	(1.585)	(0.096)	(0.064)
92.4	224	1.23*	-0.21	-0.15	0.04	0.01*	0.01	-0.02	0.01	0	***0.02***	14.27***	1.47***	-2.47***
		(0.631)	(0.185)	(0.125)	(0.076)	(0.007)	(0.009)	(0.031)	(0.026)	(0.009)	***(0.017)***	(1.884)	(0.180)	(0.122)
92.6	1,166	0.79	-0.12	0.04	-0.08	0	0	0.04**	0.01	-0.01	0.02**	15.83***	2.28***	-1.36***
		(0.492)	(0.131)	(0.106)	(0.064)	(0.004)	(0.007)	(0.019)	(0.014)	(0.005)	(0.009)	(1.416)	(0.091)	(0.058)
92.7	255	2.23***	0.19	0.33	-0.08*	0.01	-0.03	-0.04	-0.04	0.02	0.14***	7.82***	1.88***	-0.97***
		(0.446)	(0.283)	(0.260)	(0.041)	(0.009)	(0.020)	(0.027)	(0.029)	(0.015)	(0.036)	(2.597)	(0.190)	(0.136)
93.01	451	1.93**	0.53*	-0.01	-0.11	-0.02*	0.01	0.03	-0.06**	0.01	0.06***	6.58**	1.84***	-1.85***
		(0.851)	(0.273)	(0.176)	(0.088)	(0.010)	(0.009)	(0.049)	(0.025)	(0.010)	(0.016)	(2.601)	(0.159)	(0.092)
93.02	490	0.16	0.33	-0.2	0.04	-0.01	0	0.01	0.11***	-0.02**	***0***	12.46***	1.56***	-1.74***
		(0.958)	(0.337)	(0.204)	(0.141)	(0.011)	(0.009)	(0.051)	(0.039)	(0.011)	***(0.016)***	(3.182)	(0.135)	(0.088)
93.03	1,330	-0.08	0.11	0.06	0.15***	0	0	-0.02	0.03***	-0.01***	0.04***	13.67***	1.12***	-2.15***
		(0.322)	(0.109)	(0.068)	(0.036)	(0.004)	(0.004)	(0.020)	(0.012)	(0.004)	(0.009)	(1.087)	(0.095)	(0.047)
93.04	1,010	-0.36	-0.47**	-0.23**	0.19***	0.02***	0.01	-0.02	0.01	0.01	***-0.01***	19.47***	1.82***	-1.56***
		(0.469)	(0.225)	(0.108)	(0.064)	(0.007)	(0.006)	(0.028)	(0.016)	(0.006)	***(0.009)***	(2.038)	(0.105)	(0.054)
93.05	165	-1.54	0.7*	0.46	0.1	-0.04***	-0.03**	0.14**	0	-0.02	***0.01***	12.68***	1.48***	-2***
		(1.140)	(0.397)	(0.305)	(0.155)	(0.016)	(0.014)	(0.060)	(0.043)	(0.019)	***(0.023)***	(3.102)	(0.238)	(0.148)

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Appendix I

Estimations of productivity functions according to modified Kumbhakar (1990) specification (positive year dummy means improvement is technical efficiency)

Industry code	l	k	t	l^2	k^2	t^2	$l*k$	$l*t$	$k*t$	$year$					$const$
										2012	2013	2014	2015	2016	
10.1	1.64***	-0.49	-0.08	-0.11***	0.02**	-0.01	0	-0.01	0.01	-0.01	-0.15	-0.15	-0.01	0.12	15.87***
	(0.603)	(0.339)	(0.290)	(0.042)	(0.010)	(0.026)	(0.036)	(0.019)	(0.012)	(0.201)	(0.272)	(0.302)	(0.284)	(0.301)	(3.323)
10.2+10.3	2.14***	-1.18***	-0.46	-0.11*	0.05***	-0.01	-0.02	0.04	0.01	0.19	0.34*	0.57***	0.34	0.71***	19.96***
	(0.758)	(0.316)	(0.292)	(0.069)	(0.012)	(0.023)	(0.053)	(0.027)	(0.015)	(0.148)	(0.187)	(0.202)	(0.216)	(0.219)	(2.885)
11.1	2.91***	-1.29***	0.27*	-0.04*	0.06***	-0.01	-0.09***	-0.02	0	-0.23*	-0.41**	-0.85***	-0.91***	-0.6***	18.45***
	(0.297)	(0.179)	(0.159)	(0.022)	(0.005)	(0.015)	(0.018)	(0.010)	(0.006)	(0.134)	(0.182)	(0.257)	(0.268)	(0.222)	(1.820)
11.2	1.9***	0.09	0	0.05**	0.02***	-0.01	-0.11***	0.02**	0	-0.47***	-0.71***	-0.78***	-0.92***	-0.97***	10.92***
	(0.202)	(0.086)	(0.094)	(0.022)	(0.003)	(0.010)	(0.012)	(0.008)	(0.004)	(0.124)	(0.175)	(0.199)	(0.218)	(0.226)	(0.858)
13	2.12***	-0.61***	-0.51***	-0.02	0.03***	0.06***	-0.06***	0	0.01	0.13	0.01	0.01	-0.18	-0.6***	15.7***
	(0.258)	(0.171)	(0.145)	(0.026)	(0.005)	(0.016)	(0.018)	(0.012)	(0.006)	(0.101)	(0.130)	(0.136)	(0.148)	(0.217)	(1.558)
14.1	2.55***	-0.76***	-0.05	-0.17***	0.03***	0	-0.02	0.01	0	0.14	0.1	-0.06	-0.3*	-0.42**	15.92***
	(0.490)	(0.259)	(0.171)	(0.039)	(0.008)	(0.013)	(0.028)	(0.013)	(0.008)	(0.108)	(0.139)	(0.158)	(0.177)	(0.186)	(2.397)
14.2	1.04**	-0.56***	0	-0.16***	0.01**	-0.02	0.07**	-0.01	0.01	-0.19	-0.4**	-0.44**	-0.55**	-0.31	16.84***
	(0.420)	(0.171)	(0.165)	(0.045)	(0.006)	(0.014)	(0.032)	(0.016)	(0.008)	(0.148)	(0.197)	(0.225)	(0.239)	(0.210)	(1.707)
15.1	2.4***	-0.18	-0.06	-0.09***	0.02***	-0.03***	-0.05***	0.02**	0.01***	-0.25***	-0.27***	-0.54***	-0.53***	-0.36***	11.71***
	(0.220)	(0.130)	(0.090)	(0.022)	(0.004)	(0.009)	(0.013)	(0.008)	(0.004)	(0.070)	(0.090)	(0.113)	(0.112)	(0.104)	(1.137)
15.3	2.48***	-0.47*	-0.14	-0.03	0.02***	-0.02	-0.06**	-0.01	0.02	-0.01	-0.17	-0.04	0.03	0.05	13.84***
	(0.624)	(0.273)	(0.227)	(0.067)	(0.009)	(0.020)	(0.028)	(0.021)	(0.011)	(0.117)	(0.160)	(0.167)	(0.163)	(0.170)	(2.613)
15.4	2.61***	-0.84***	0.47	-0.08**	0.04***	-0.06***	-0.06**	0.02	0	0.01	-0.67*	-0.15	-0.96**	-0.64*	15.21***
	(0.555)	(0.286)	(0.297)	(0.040)	(0.010)	(0.021)	(0.029)	(0.020)	(0.014)	(0.196)	(0.346)	(0.282)	(0.452)	(0.379)	(2.700)
15.6	1.96***	-1.29***	0.31*	-0.14***	0.05***	-0.03***	0	0.01	0	-0.4***	-0.91***	-0.85***	-0.77***	-0.88***	20.81***
	(0.394)	(0.202)	(0.164)	(0.038)	(0.007)	(0.012)	(0.024)	(0.014)	(0.008)	(0.128)	(0.215)	(0.225)	(0.218)	(0.235)	(1.991)
15.7	2.45***	-0.59**	-0.71***	-0.17***	0.02**	-0.01	-0.01	0.07***	0.02***	-0.09	-0.25*	-0.22	-0.2	-0.2	16.75***
	(0.456)	(0.260)	(0.189)	(0.053)	(0.008)	(0.015)	(0.027)	(0.015)	(0.009)	(0.106)	(0.143)	(0.154)	(0.161)	(0.172)	(2.416)
15.8	1.7***	-0.21***	-0.05	-0.02**	0.02***	-0.03***	-0.05***	0.02***	0.01***	-0.19***	-0.39***	-0.35***	-0.4***	-0.33***	13.48***
	(0.110)	(0.066)	(0.053)	(0.012)	(0.002)	(0.005)	(0.008)	(0.004)	(0.002)	(0.037)	(0.054)	(0.059)	(0.062)	(0.062)	(0.572)
15.9	2.86***	-0.68***	-0.32***	-0.04	0.04***	0	-0.09***	0	0.02***	-0.07	-0.12	-0.16	-0.19*	-0.17*	13.98***
	(0.280)	(0.180)	(0.122)	(0.028)	(0.006)	(0.010)	(0.018)	(0.010)	(0.006)	(0.064)	(0.084)	(0.095)	(0.096)	(0.098)	(1.417)

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Industry code	l	k	t	l^2	k^2	t^2	$l*k$	$l*t$	$k*t$	$year$ 2012	2013	2014	2015	2016	$const$
17.1+17.2	2.15***	-0.48**	-0.24	-0.18***	0.02***	0.01	0.01	0.01	0.01	0.11	0.15	-0.1	-0.11	-0.52*	15.17***
	(0.444)	(0.201)	(0.221)	(0.040)	(0.007)	(0.021)	(0.021)	(0.018)	(0.010)	(0.146)	(0.177)	(0.225)	(0.223)	(0.276)	(2.005)
17.4	1.51**	-0.53*	0.63**	-0.05	0.03**	-0.05**	-0.01	0.02	-0.02	-0.32	-0.6*	-0.66	-1.24**	-1.26**	14.43***
	(0.729)	(0.317)	(0.248)	(0.088)	(0.011)	(0.024)	(0.044)	(0.026)	(0.012)	(0.230)	(0.356)	(0.405)	(0.616)	(0.620)	(2.831)
17.5	2.03***	-0.67***	-0.34**	-0.07	0.03***	-0.01	-0.05**	0.03**	0.02***	0.09	-0.07	-0.11	-0.31	-0.26	16.89***
	(0.355)	(0.162)	(0.151)	(0.044)	(0.005)	(0.014)	(0.022)	(0.014)	(0.006)	(0.138)	(0.182)	(0.203)	(0.225)	(0.215)	(1.573)
17.6+17.7	2.19**	1.64**	0.02	-0.08	-0.05*	-0.06	-0.03	-0.08**	0.05**	-0.07	-0.33	-0.14	-0.09	0.23	-1.96
	(0.897)	(0.763)	(0.406)	(0.091)	(0.027)	(0.036)	(0.057)	(0.040)	(0.021)	(0.322)	(0.448)	(0.467)	(0.465)	(0.423)	(6.221)
18	0.86***	-0.02	-0.15	-0.02	0	-0.01	0.02	0.02	0.01*	-0.07	-0.19**	-0.13*	-0.17**	-0.24***	13.98***
	(0.293)	(0.107)	(0.098)	(0.036)	(0.004)	(0.010)	(0.019)	(0.011)	(0.005)	(0.054)	(0.073)	(0.080)	(0.085)	(0.093)	(1.045)
19	2.03***	-0.4**	-0.28**	-0.06*	0.03***	0.02	-0.06***	0.04***	0	0.11	-0.03	0.01	-0.24	-0.56***	14.78***
	(0.286)	(0.176)	(0.135)	(0.034)	(0.006)	(0.013)	(0.022)	(0.012)	(0.006)	(0.089)	(0.119)	(0.130)	(0.148)	(0.185)	(1.474)
20.1	1.89***	-0.91***	-0.52***	-0.07*	0.03***	-0.02	-0.03	0	0.04***	-0.15	-0.12	-0.12	-0.08	0	19.09***
	(0.304)	(0.149)	(0.156)	(0.037)	(0.005)	(0.015)	(0.020)	(0.015)	(0.007)	(0.096)	(0.124)	(0.136)	(0.140)	(0.143)	(1.493)
20.2	2.57***	-0.31	0.15	-0.08**	0.02***	0.01	-0.05**	-0.03**	0.01	-0.4**	-0.34	-0.47*	-0.92***	-1.29***	11.36***
	(0.442)	(0.222)	(0.186)	(0.040)	(0.006)	(0.018)	(0.022)	(0.015)	(0.008)	(0.179)	(0.211)	(0.249)	(0.336)	(0.453)	(2.329)
20.3	1.91***	-0.39	-0.34	-0.08	0.02**	-0.02	-0.03	0.05**	0.01	-0.53***	-0.21	-0.12	-0.6**	-0.51**	14.88***
	(0.537)	(0.253)	(0.225)	(0.062)	(0.009)	(0.019)	(0.029)	(0.020)	(0.009)	(0.180)	(0.190)	(0.202)	(0.256)	(0.248)	(2.361)
20.4+20.5	-1.41	0.35	0.68***	-0.09	-0.03**	-0.04**	0.18***	0.11***	-0.06***	-0.31*	-0.63**	-0.65**	-0.91**	-0.56**	14.95***
	(0.986)	(0.378)	(0.218)	(0.072)	(0.013)	(0.016)	(0.035)	(0.023)	(0.012)	(0.182)	(0.264)	(0.289)	(0.375)	(0.285)	(3.367)
21.1	1.34**	-0.99**	-0.21	0.07	0.04***	0	-0.08**	-0.03**	0.02***	-0.2	-0.59***	-0.54**	-0.59**	-0.65**	22.09***
	(0.654)	(0.435)	(0.182)	(0.045)	(0.015)	(0.017)	(0.038)	(0.016)	(0.009)	(0.139)	(0.223)	(0.247)	(0.272)	(0.295)	(3.205)
21.2	3.37***	-0.7***	-0.22*	-0.15***	0.04***	0	-0.07***	0.01	0.02***	-0.1	-0.14	-0.18	-0.32**	-0.51***	13.67***
	(0.338)	(0.148)	(0.113)	(0.035)	(0.005)	(0.011)	(0.017)	(0.011)	(0.005)	(0.084)	(0.111)	(0.123)	(0.131)	(0.147)	(1.269)
22.1	0.43	-0.3***	0.22***	0.21***	0.02***	-0.03***	-0.06***	-0.04***	0.01***	-0.15***	-0.19***	-0.23***	-0.24***	-0.28***	15.99***
	(0.269)	(0.070)	(0.067)	(0.036)	(0.003)	(0.007)	(0.013)	(0.008)	(0.003)	(0.035)	(0.044)	(0.051)	(0.052)	(0.055)	(0.728)
22.2	1.88***	0.01	0.04	0.05**	0.01***	-0.03***	-0.09***	0	0.01***	-0.13**	-0.24***	-0.3***	-0.25***	-0.2**	11.05***
	(0.217)	(0.101)	(0.094)	(0.027)	(0.004)	(0.009)	(0.014)	(0.010)	(0.004)	(0.063)	(0.085)	(0.099)	(0.098)	(0.098)	(0.909)
23.2	3.02***	-0.29	0.41*	-0.13***	0.01***	-0.06***	-0.02*	-0.08***	0.02**	-0.22	-0.26	-0.17	-0.07	0.29	11.47***
	(0.388)	(0.194)	(0.234)	(0.035)	(0.005)	(0.024)	(0.012)	(0.016)	(0.009)	(0.151)	(0.197)	(0.210)	(0.203)	(0.182)	(1.909)
24	2.08***	-0.19***	-0.02	-0.09***	0.01***	-0.03***	-0.02**	0.02***	0.01***	-0.17***	-0.28***	-0.32***	-0.31***	-0.19***	12.79***
	(0.141)	(0.064)	(0.065)	(0.014)	(0.002)	(0.007)	(0.009)	(0.005)	(0.003)	(0.046)	(0.063)	(0.071)	(0.071)	(0.066)	(0.623)

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Industry code	l	k	t	l^2	k^2	t^2	$l*k$	$l*t$	$k*t$	$year$					$const$
										2012	2013	2014	2015	2016	
25.1	2.91***	-0.11	-0.16	-0.08*	0.01**	-0.05**	-0.07**	-0.01	0.03***	-0.14	-0.16	-0.13	-0.05	0.2	11.06***
	(0.399)	(0.201)	(0.202)	(0.043)	(0.007)	(0.022)	(0.032)	(0.017)	(0.008)	(0.132)	(0.178)	(0.200)	(0.196)	(0.187)	(1.851)
25.2	1.69***	-0.03	-0.11*	-0.07***	0.01***	-0.02***	-0.01	0.02**	0.01***	-0.04	-0.09	-0.15**	-0.12*	-0.13*	12.32***
	(0.174)	(0.067)	(0.066)	(0.023)	(0.002)	(0.006)	(0.010)	(0.006)	(0.003)	(0.045)	(0.060)	(0.068)	(0.068)	(0.069)	(0.635)
26.2+26.3	2.02***	0.18	-0.07	-0.09**	0	-0.02	-0.02	-0.01	0.02**	-0.13	-0.59**	-0.66**	-0.49*	-0.3	9.37***
	(0.377)	(0.198)	(0.176)	(0.036)	(0.007)	(0.017)	(0.023)	(0.014)	(0.008)	(0.166)	(0.266)	(0.301)	(0.278)	(0.261)	(1.653)
26.4	3.2***	-0.5***	-0.36***	-0.17***	0.02***	-0.01	-0.04**	-0.04***	0.04***	0.01	0.01	-0.08	-0.3*	-0.62***	13.47***
	(0.372)	(0.179)	(0.130)	(0.037)	(0.005)	(0.012)	(0.020)	(0.012)	(0.006)	(0.104)	(0.132)	(0.149)	(0.172)	(0.216)	(1.687)
26.5	1.4**	0.08	-0.12	-0.18***	0	-0.08***	0.06*	-0.03**	0.05***	-0.2	-0.61*	-0.77*	-0.47	-0.25	11.82***
	(0.569)	(0.302)	(0.232)	(0.045)	(0.010)	(0.023)	(0.033)	(0.016)	(0.009)	(0.216)	(0.344)	(0.418)	(0.350)	(0.317)	(2.853)
26.6	2.49***	-0.71***	-0.01	-0.14***	0.03***	-0.03***	-0.02*	-0.02***	0.02***	-0.13**	-0.25***	-0.43***	-0.58***	-0.75***	15.88***
	(0.187)	(0.085)	(0.078)	(0.018)	(0.003)	(0.007)	(0.010)	(0.007)	(0.003)	(0.065)	(0.088)	(0.105)	(0.115)	(0.126)	(0.838)
26.7	2*	-0.1	0.85*	-0.34***	-0.01	-0.11***	0.14***	-0.03	0.01	-0.38	0.01	0.08	0.18	0.35	11.04***
	(1.168)	(0.407)	(0.472)	(0.108)	(0.014)	(0.034)	(0.050)	(0.041)	(0.021)	(0.280)	(0.297)	(0.314)	(0.302)	(0.281)	(3.930)
26.8	1.84***	0.22	0.28**	-0.02	0.01*	0	-0.06***	0.01	-0.01**	-0.07	-0.19	-0.31**	-0.5***	-0.56***	8.62***
	(0.322)	(0.202)	(0.131)	(0.030)	(0.007)	(0.011)	(0.021)	(0.012)	(0.007)	(0.100)	(0.130)	(0.149)	(0.169)	(0.178)	(1.810)
27.1	1.15***	-0.23	-0.69***	-0.03	0.01*	0.03	-0.01	-0.03	0.03***	0.03	0.46**	0.46*	0.29	-0.04	15.94***
	(0.358)	(0.217)	(0.226)	(0.035)	(0.007)	(0.024)	(0.025)	(0.018)	(0.010)	(0.191)	(0.229)	(0.250)	(0.256)	(0.284)	(1.729)
27.2	0.69*	0.37	-0.02	0.06	0	-0.04*	-0.04	-0.01	0.02*	-0.23	-0.12	0	0.02	0.14	12.64***
	(0.413)	(0.263)	(0.250)	(0.043)	(0.008)	(0.021)	(0.032)	(0.015)	(0.010)	(0.191)	(0.237)	(0.249)	(0.249)	(0.240)	(2.677)
27.3	2.05***	0.19	-0.23	-0.02	0.01	-0.04	-0.06	-0.01	0.04**	-0.25	-0.45	-0.61	-0.86	-0.47	9.1***
	(0.551)	(0.300)	(0.302)	(0.054)	(0.012)	(0.025)	(0.047)	(0.027)	(0.016)	(0.290)	(0.406)	(0.483)	(0.576)	(0.452)	(2.506)
27.4	0.98***	-0.2	-0.01	0.12***	0.03***	-0.04***	-0.1***	0.02	0.01**	-0.43***	-0.31**	-0.33**	-0.51***	-0.25*	14.94***
	(0.322)	(0.186)	(0.134)	(0.030)	(0.005)	(0.012)	(0.018)	(0.011)	(0.006)	(0.129)	(0.143)	(0.157)	(0.171)	(0.151)	(1.705)
27.5	0.86	-0.26	0.32	-0.02	0.01	0.02	0	-0.02	-0.02*	-0.16	-0.66**	-2.11*	-1.92**	-1.74**	15.02***
	(0.525)	(0.318)	(0.197)	(0.057)	(0.009)	(0.017)	(0.031)	(0.022)	(0.010)	(0.211)	(0.324)	(1.080)	(0.868)	(0.800)	(2.995)
28.1	2.21***	-0.37***	-0.2**	-0.08***	0.02***	-0.01	-0.04***	0	0.02***	0.04	0.01	-0.02	-0.16	-0.03	13.99***
	(0.195)	(0.087)	(0.096)	(0.023)	(0.003)	(0.009)	(0.012)	(0.009)	(0.004)	(0.065)	(0.083)	(0.092)	(0.098)	(0.094)	(0.809)
28.2	1.3***	0.45**	0.52***	-0.03	-0.01	-0.02	-0.01	-0.02	-0.02	-0.18	-0.5	-0.99**	-1.31**	-1.22**	7.79***
	(0.413)	(0.214)	(0.189)	(0.036)	(0.008)	(0.016)	(0.024)	(0.023)	(0.011)	(0.211)	(0.305)	(0.452)	(0.585)	(0.552)	(1.947)
28.3	2.77***	-0.74*	-0.16	-0.04	0.04***	-0.01	-0.09**	-0.01	0.02**	-0.14	-0.23	-0.36	-0.44	-0.39	15.99***
	(0.606)	(0.428)	(0.236)	(0.055)	(0.013)	(0.021)	(0.041)	(0.021)	(0.011)	(0.179)	(0.243)	(0.291)	(0.311)	(0.315)	(4.033)

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Industry code	l	k	t	l^2	k^2	t^2	$l*k$	$l*t$	$k*t$	$year$					$const$
										2012	2013	2014	2015	2016	
28.5	2.86***	-0.55***	-0.35***	-0.26***	0.02***	0.01	0.01	0.02	0.01***	0.13	-0.06	-0.18	-0.38***	-0.4***	14.01***
	(0.264)	(0.110)	(0.100)	(0.031)	(0.004)	(0.009)	(0.013)	(0.010)	(0.005)	(0.080)	(0.108)	(0.124)	(0.139)	(0.136)	(1.033)
28.6	3.49***	-0.67***	-0.08	-0.14**	0.04***	-0.05***	-0.09***	-0.02	0.03***	-0.29***	-0.36***	-0.26*	-0.04	0.17	13.7***
	(0.467)	(0.188)	(0.145)	(0.056)	(0.006)	(0.014)	(0.021)	(0.016)	(0.007)	(0.112)	(0.135)	(0.139)	(0.129)	(0.151)	(1.813)
28.7	2.05***	-0.18	-0.27**	-0.11***	0.01**	0	-0.02	0.01	0.01**	0.03	0.03	-0.01	-0.1	-0.21*	13.16***
	(0.324)	(0.125)	(0.117)	(0.036)	(0.004)	(0.010)	(0.018)	(0.010)	(0.005)	(0.070)	(0.088)	(0.101)	(0.106)	(0.114)	(1.291)
29.11	0.64	-0.08	0.62***	-0.01	0.01	-0.07***	0	-0.03	0.01	-0.47	-1.01*	-1.63	-1.65	-0.91	14.93***
	(0.538)	(0.249)	(0.233)	(0.058)	(0.010)	(0.026)	(0.044)	(0.021)	(0.010)	(0.337)	(0.600)	(0.992)	(1.026)	(0.585)	(2.539)
29.12	1.52***	-0.25*	-0.19	-0.12***	0.01**	-0.01	0.01	-0.02	0.02***	-0.13	-0.21	-0.28*	-0.35**	-0.24	15.34***
	(0.270)	(0.125)	(0.128)	(0.028)	(0.005)	(0.013)	(0.023)	(0.013)	(0.006)	(0.111)	(0.138)	(0.165)	(0.171)	(0.166)	(1.220)
29.13	3.12***	-0.64**	-0.63***	-0.09*	0.03***	0.02	-0.07**	-0.02	0.04***	0	-0.25	-0.39	-0.47	-0.92**	14.74***
	(0.516)	(0.272)	(0.197)	(0.049)	(0.010)	(0.015)	(0.034)	(0.019)	(0.010)	(0.182)	(0.232)	(0.278)	(0.284)	(0.370)	(2.396)
29.21	3.47***	-0.44	0.06	-0.25***	0.02***	-0.01	-0.02	0.05*	-0.01	0.05	-0.17	-0.28	-0.34	-0.65**	10.63***
	(0.837)	(0.270)	(0.229)	(0.092)	(0.009)	(0.019)	(0.060)	(0.027)	(0.012)	(0.180)	(0.226)	(0.253)	(0.267)	(0.326)	(3.173)
29.22	1.15***	-0.11	0.43***	-0.07*	0.01	-0.02	0.02	0	-0.01**	-0.43***	-0.61***	-0.5**	-0.93***	-1.08***	13.53***
	(0.283)	(0.135)	(0.135)	(0.035)	(0.005)	(0.013)	(0.022)	(0.015)	(0.007)	(0.163)	(0.220)	(0.227)	(0.299)	(0.328)	(1.155)
29.23	2.18***	0.08	0.24	-0.05	0.01**	-0.03*	-0.06**	0	0	-0.23	-0.16	-0.25	-0.45*	-0.26	9.59***
	(0.278)	(0.140)	(0.163)	(0.042)	(0.006)	(0.014)	(0.027)	(0.017)	(0.008)	(0.150)	(0.185)	(0.211)	(0.240)	(0.217)	(1.151)
29.24	1.52***	0.12	-0.04	-0.09**	0	-0.02*	0	0.03**	0	0	-0.01	-0.04	-0.1	-0.03	11.78***
	(0.303)	(0.118)	(0.115)	(0.038)	(0.004)	(0.012)	(0.018)	(0.012)	(0.005)	(0.079)	(0.102)	(0.116)	(0.119)	(0.122)	(1.139)
29.4	3.03***	-0.91***	0.19	-0.11***	0.04***	-0.04***	-0.08***	0.01	0.01	-0.22	-0.9**	-1.2**	-0.96**	-1.05**	15.77***
	(0.375)	(0.172)	(0.174)	(0.041)	(0.006)	(0.016)	(0.027)	(0.016)	(0.008)	(0.214)	(0.393)	(0.526)	(0.450)	(0.467)	(1.587)
29.5	1.69***	-0.12	-0.08	-0.15***	0	-0.01	0.03*	0	0.01**	-0.1	-0.19**	-0.3***	-0.38***	-0.48***	13.14***
	(0.209)	(0.104)	(0.094)	(0.022)	(0.004)	(0.009)	(0.015)	(0.009)	(0.004)	(0.074)	(0.096)	(0.112)	(0.118)	(0.126)	(0.945)
29.7	0.39	-0.1	0.03	-0.1	0	-0.01	0.05	0.04*	-0.01	0.26**	0.27*	0.2	0.18	0.1	17.21***
	(1.093)	(0.285)	(0.246)	(0.119)	(0.011)	(0.026)	(0.057)	(0.024)	(0.011)	(0.108)	(0.142)	(0.156)	(0.162)	(0.175)	(2.985)
30.0	1.43***	-0.02	-0.23	-0.09*	0	-0.03**	0	0.1***	0	-0.35*	-0.9***	-1.56***	-1.27***	-1.02***	14.25***
	(0.475)	(0.165)	(0.168)	(0.050)	(0.006)	(0.015)	(0.026)	(0.017)	(0.007)	(0.194)	(0.310)	(0.561)	(0.448)	(0.391)	(1.699)
31.1	2***	-0.41***	-0.25*	-0.06**	0.03***	-0.01	-0.06***	0.03***	0.01**	-0.13	-0.43***	-0.47**	-0.5***	-0.4**	15.29***
	(0.258)	(0.157)	(0.130)	(0.027)	(0.006)	(0.012)	(0.020)	(0.011)	(0.007)	(0.105)	(0.161)	(0.181)	(0.185)	(0.176)	(1.381)
31.2	1.57***	0.04	0.05	0.02	0.02***	0	-0.07***	0.03**	-0.01	-0.14	-0.58***	-0.64***	-0.83***	-0.94***	11.58***
	(0.282)	(0.110)	(0.109)	(0.029)	(0.004)	(0.010)	(0.017)	(0.010)	(0.005)	(0.097)	(0.147)	(0.161)	(0.177)	(0.194)	(1.076)

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Industry code	l	k	t	l^2	k^2	t^2	$l*k$	$l*t$	$k*t$	$year$					$const$
										2012	2013	2014	2015	2016	
31.3	2.38***	-0.2	0.05	-0.09**	0.02***	0.01	-0.05**	0.02	-0.01	-0.15	-0.17	-0.43**	-0.68***	-0.77***	11.71***
	(0.372)	(0.225)	(0.163)	(0.039)	(0.007)	(0.014)	(0.025)	(0.014)	(0.008)	(0.110)	(0.144)	(0.180)	(0.209)	(0.225)	(2.108)
31.5	0.3	0.43	0.19	-0.05	-0.02*	-0.04	0.05	0	0	-0.11	-0.36	-0.4	-0.69*	-0.65*	12.11***
	(0.622)	(0.307)	(0.278)	(0.064)	(0.010)	(0.024)	(0.032)	(0.026)	(0.013)	(0.201)	(0.276)	(0.305)	(0.363)	(0.343)	(2.883)
31.6	1.7***	0.18	-0.18	-0.06*	0	0	-0.03**	0.01	0.01	0.05	-0.05	-0.03	-0.05	-0.14	11.48***
	(0.281)	(0.126)	(0.116)	(0.030)	(0.005)	(0.011)	(0.017)	(0.010)	(0.005)	(0.074)	(0.097)	(0.109)	(0.110)	(0.114)	(1.139)
32	1.99***	0.22	-0.15	-0.02	0.01	0	-0.08***	0.02	0	0.01	0.12	0.14	0.15	0.04	10.18***
	(0.493)	(0.249)	(0.253)	(0.049)	(0.007)	(0.025)	(0.025)	(0.026)	(0.011)	(0.161)	(0.184)	(0.203)	(0.202)	(0.212)	(2.321)
33	1.84***	0.18**	0.33***	-0.05**	0	-0.03***	-0.03*	0.02**	-0.01**	-0.19***	-0.29***	-0.46***	-0.47***	-0.36***	10.27***
	(0.222)	(0.090)	(0.086)	(0.027)	(0.003)	(0.008)	(0.015)	(0.008)	(0.004)	(0.063)	(0.088)	(0.108)	(0.112)	(0.105)	(0.821)
34.1	1.16***	-0.94***	0.08	-0.06*	0.03***	-0.06***	0	-0.01	0.01*	-0.07	-0.03	-0.03	0.03	0.3*	22.93***
	(0.435)	(0.202)	(0.197)	(0.036)	(0.007)	(0.020)	(0.024)	(0.015)	(0.008)	(0.122)	(0.157)	(0.181)	(0.180)	(0.174)	(1.744)
34.2	3.3***	-1.07**	-0.06	-0.25***	0.03	-0.02	0.01	0.01	0.01	0.11	-0.06	-0.21	-0.65*	-0.54	18.26***
	(0.750)	(0.439)	(0.321)	(0.091)	(0.018)	(0.019)	(0.075)	(0.029)	(0.019)	(0.170)	(0.255)	(0.300)	(0.387)	(0.370)	(4.014)
34.3	1.46***	-0.1	0	-0.03	0.01*	-0.02	-0.03	-0.04***	0.02***	-0.05	-0.26	-0.66***	-0.49**	-0.35*	13.05***
	(0.332)	(0.217)	(0.151)	(0.029)	(0.007)	(0.013)	(0.020)	(0.011)	(0.007)	(0.123)	(0.167)	(0.227)	(0.209)	(0.199)	(2.002)
35.2	2***	-0.46***	0.1	-0.06*	0.02***	-0.03*	-0.03	-0.03**	0.02***	-0.19	-0.4*	-0.56**	-0.64**	-0.4*	15.71***
	(0.334)	(0.160)	(0.163)	(0.030)	(0.006)	(0.017)	(0.025)	(0.012)	(0.006)	(0.147)	(0.211)	(0.250)	(0.264)	(0.228)	(1.649)
36.1	3.05***	-0.19	0.17	-0.11***	0.02***	-0.02**	-0.06***	-0.01	0	-0.24***	-0.33***	-0.45***	-0.82***	-0.9***	10.1***
	(0.304)	(0.142)	(0.118)	(0.035)	(0.005)	(0.011)	(0.019)	(0.012)	(0.006)	(0.082)	(0.110)	(0.134)	(0.176)	(0.195)	(1.319)
36.2	2.85***	-0.53**	0.12	-0.33***	0.01	-0.03	0.07*	0.02	0	-0.22	-0.23	-0.04	-0.11	-0.23	13.75***
	(0.618)	(0.248)	(0.265)	(0.054)	(0.010)	(0.023)	(0.039)	(0.020)	(0.012)	(0.147)	(0.189)	(0.193)	(0.195)	(0.215)	(2.507)
36.6	1.23**	-0.22	-0.1	-0.12*	0.01	-0.02	0.02	0.01	0.01*	-0.07	-0.11	-0.07	-0.21	-0.08	15.36***
	(0.505)	(0.274)	(0.165)	(0.064)	(0.010)	(0.015)	(0.033)	(0.014)	(0.007)	(0.095)	(0.126)	(0.140)	(0.154)	(0.151)	(2.304)
37.1	2.3***	-0.22	-0.7***	-0.13***	0.01***	0.02	-0.03*	0	0.03***	-0.64***	-0.59***	-0.69***	-0.52**	-0.38*	13.22***
	(0.298)	(0.149)	(0.167)	(0.031)	(0.005)	(0.015)	(0.017)	(0.013)	(0.007)	(0.164)	(0.206)	(0.242)	(0.219)	(0.205)	(1.500)
40.11.1	1.33*	-1.15***	-0.59**	-0.33***	0.01	-0.02	0.16***	-0.07***	0.06***	-0.56*	-0.29	-0.47	-0.42	-0.19	24.79***
	(0.711)	(0.332)	(0.270)	(0.066)	(0.010)	(0.024)	(0.052)	(0.025)	(0.012)	(0.298)	(0.302)	(0.340)	(0.337)	(0.301)	(3.778)
40.11.5	1.4***	0.16	-0.06	-0.1**	0	-0.02	0.01	0.06***	0	-0.15	-0.72**	-1.13***	-1.57***	-1.73**	11.72***
	(0.477)	(0.182)	(0.182)	(0.041)	(0.006)	(0.019)	(0.022)	(0.020)	(0.009)	(0.169)	(0.296)	(0.430)	(0.593)	(0.692)	(1.841)
40.12	1.52***	-0.32***	-0.06	-0.06**	0.02***	-0.02*	-0.02	0.03***	0	-0.08	-0.17	-0.3**	-0.37**	-0.19	13.97***
	(0.230)	(0.102)	(0.106)	(0.026)	(0.004)	(0.011)	(0.017)	(0.009)	(0.005)	(0.087)	(0.117)	(0.137)	(0.143)	(0.130)	(0.948)

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

	l	k	t	l^2	k^2	t^2	$l*k$	$l*t$	$k*t$	$year$					
Industry code										2012	2013	2014	2015	2016	$const$
40.13.1	3.19***	-0.44*	0.25	-0.25***	0.02**	-0.04*	-0.01	0.05***	-0.01	-0.1	-0.25**	-0.29**	-0.38***	-0.35***	13.5***
	(0.545)	(0.256)	(0.184)	(0.039)	(0.009)	(0.020)	(0.026)	(0.017)	(0.007)	(0.078)	(0.114)	(0.133)	(0.139)	(0.132)	(2.444)
40.13.2	1.23**	0.25*	-0.07	0	0.01	0	-0.04**	0.05**	0	-0.06	-0.26*	-0.3*	-0.39**	-0.48***	13.76***
	(0.499)	(0.149)	(0.203)	(0.049)	(0.005)	(0.023)	(0.020)	(0.018)	(0.006)	(0.098)	(0.141)	(0.159)	(0.168)	(0.176)	(1.885)
40.13.3	2.22***	0	-0.17	-0.11***	0.01	-0.01	-0.03	0.01	0.01	0.07	0.1	0.02	0.17	0.15	11.48***
	(0.374)	(0.180)	(0.133)	(0.041)	(0.006)	(0.013)	(0.021)	(0.015)	(0.006)	(0.072)	(0.090)	(0.106)	(0.103)	(0.109)	(1.533)
40.2	0.82***	-0.76***	0.12	-0.06***	0.02***	0	0.01	0.01	0	-0.01	-0.11**	-0.17***	-0.16**	-0.17**	23.68***
	(0.313)	(0.167)	(0.090)	(0.019)	(0.005)	(0.008)	(0.020)	(0.007)	(0.004)	(0.037)	(0.051)	(0.059)	(0.063)	(0.069)	(1.776)
40.30.0	1.74***	-0.47***	-0.16	-0.07***	0.03***	0	-0.03**	0.08***	-0.01***	0.1	0.07	0	-0.07	0.04	15.74***
	(0.246)	(0.125)	(0.118)	(0.028)	(0.004)	(0.011)	(0.016)	(0.011)	(0.005)	(0.075)	(0.094)	(0.108)	(0.109)	(0.107)	(1.079)
40.30.1	2.01***	-0.39***	-0.2**	-0.11***	0.02***	-0.01*	-0.02	0.04***	0	-0.08	-0.04	-0.03	0.05	0.06	14.22***
	(0.186)	(0.091)	(0.083)	(0.020)	(0.003)	(0.008)	(0.012)	(0.008)	(0.004)	(0.056)	(0.069)	(0.077)	(0.075)	(0.076)	(0.818)
40.30.2	1.87***	-0.57**	-0.38*	-0.2***	0.02*	-0.02	0.02	0.05**	0.02*	-0.39**	-0.38	-0.37	-0.4	-0.06	17.11***
	(0.507)	(0.261)	(0.203)	(0.052)	(0.010)	(0.020)	(0.033)	(0.019)	(0.009)	(0.186)	(0.233)	(0.256)	(0.258)	(0.230)	(2.050)
40.30.3	0.25	-0.4*	-0.31*	-0.04	0.01	-0.01	0.05	0.03*	0.01	-0.22*	-0.1	-0.16	0.15	0.22	18.57***
	(0.454)	(0.216)	(0.166)	(0.045)	(0.009)	(0.015)	(0.031)	(0.015)	(0.008)	(0.126)	(0.155)	(0.176)	(0.159)	(0.166)	(1.655)
40.30.4+40.30.5	0.97**	0	-0.2	-0.18***	-0.01	0	0.09***	0.01	0	0.05	0.12	0.23	0.16	0.15	14.61***
	(0.450)	(0.178)	(0.214)	(0.050)	(0.006)	(0.021)	(0.026)	(0.022)	(0.010)	(0.132)	(0.163)	(0.174)	(0.177)	(0.179)	(1.678)
41.0	1.39***	-0.05	-0.09	-0.09***	0.01**	-0.02***	0.01	0.04***	0	-0.07	-0.1*	-0.09	-0.06	-0.11*	12.68***
	(0.141)	(0.071)	(0.062)	(0.017)	(0.003)	(0.006)	(0.010)	(0.006)	(0.003)	(0.044)	(0.057)	(0.062)	(0.061)	(0.062)	(0.579)
50.1	1.57***	-0.09	-0.19***	-0.09***	0.01***	0	-0.01	0.01***	0	0.02	0	-0.05	-0.18***	-0.27***	14.2***
	(0.128)	(0.055)	(0.058)	(0.013)	(0.002)	(0.005)	(0.006)	(0.005)	(0.002)	(0.037)	(0.048)	(0.056)	(0.061)	(0.066)	(0.547)
50.2	2.38***	0.07	0.43***	-0.09***	0.01**	-0.04***	-0.04***	-0.04***	0	-0.18**	-0.29***	-0.38***	-0.46***	-0.4***	9.92***
	(0.289)	(0.103)	(0.122)	(0.035)	(0.004)	(0.011)	(0.015)	(0.012)	(0.005)	(0.074)	(0.098)	(0.116)	(0.125)	(0.121)	(1.072)
50.3	1.96***	-0.1*	-0.32***	-0.1***	0.01***	0	-0.02***	0.04***	0.01	-0.04	-0.14*	-0.23**	-0.28***	-0.34***	12.97***
	(0.173)	(0.062)	(0.083)	(0.020)	(0.002)	(0.008)	(0.008)	(0.008)	(0.003)	(0.063)	(0.082)	(0.094)	(0.098)	(0.101)	(0.615)
50.5	2.06***	-0.02	-0.01	-0.03	0.02***	-0.02**	-0.06***	0.03***	0	-0.19**	-0.32***	-0.46***	-0.52***	-0.55***	11.14***
	(0.265)	(0.110)	(0.105)	(0.030)	(0.004)	(0.011)	(0.014)	(0.009)	(0.004)	(0.078)	(0.106)	(0.126)	(0.130)	(0.132)	(0.955)
51.1	1.5***	0.03	-0.2***	-0.1***	0	0	0.01*	0.04***	-0.01**	0.1***	0.11***	0.06	0.02	0.08	13.82***
	(0.134)	(0.046)	(0.062)	(0.016)	(0.002)	(0.006)	(0.006)	(0.006)	(0.002)	(0.034)	(0.041)	(0.047)	(0.048)	(0.048)	(0.463)
51.2	2.41***	-0.02	-0.67***	-0.17***	0	0	-0.02	0.08***	0.02***	0.04	-0.17*	-0.07	-0.08	-0.05	13.35***
	(0.288)	(0.100)	(0.128)	(0.031)	(0.003)	(0.012)	(0.012)	(0.013)	(0.005)	(0.072)	(0.099)	(0.106)	(0.106)	(0.104)	(1.017)

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Industry code	l	k	t	l^2	k^2	t^2	$l*k$	$l*t$	$k*t$	$year$					$const$
										2012	2013	2014	2015	2016	
51.3	2.24***	-0.03	-0.06	-0.17***	0.01***	-0.02***	-0.01	0.04***	0	-0.19***	-0.16***	-0.21***	-0.34***	-0.21***	12.41***
	(0.088)	(0.034)	(0.042)	(0.010)	(0.001)	(0.004)	(0.004)	(0.004)	(0.002)	(0.027)	(0.034)	(0.040)	(0.043)	(0.042)	(0.337)
51.4	1.73***	-0.05	-0.05	-0.1***	0.01***	-0.01***	-0.01**	0.04***	-0.01***	0.01	-0.07**	-0.15***	-0.26***	-0.21***	13.39***
	(0.081)	(0.031)	(0.041)	(0.010)	(0.001)	(0.004)	(0.004)	(0.004)	(0.002)	(0.026)	(0.034)	(0.039)	(0.043)	(0.042)	(0.292)
51.5	2.09***	-0.16***	-0.22***	-0.13***	0.01***	0	-0.01***	0.04***	0	0.01	-0.01	-0.03	-0.13***	-0.08**	13.35***
	(0.075)	(0.029)	(0.042)	(0.008)	(0.001)	(0.004)	(0.004)	(0.004)	(0.002)	(0.027)	(0.034)	(0.038)	(0.040)	(0.039)	(0.285)
51.8	2.02***	0.05	-0.2***	-0.13***	0.01***	0	-0.02***	0.06***	-0.01***	0.07**	0.05	-0.01	-0.11**	-0.06	12.09***
	(0.106)	(0.035)	(0.050)	(0.013)	(0.001)	(0.005)	(0.005)	(0.005)	(0.002)	(0.032)	(0.041)	(0.047)	(0.050)	(0.048)	(0.352)
51.9	2.13***	0.02	-0.16***	-0.14***	0.01***	-0.01	-0.01*	0.03***	0	0.03	-0.02	-0.06	-0.16***	-0.14***	12.25***
	(0.125)	(0.040)	(0.054)	(0.014)	(0.001)	(0.005)	(0.005)	(0.005)	(0.002)	(0.035)	(0.043)	(0.049)	(0.051)	(0.050)	(0.422)
52.1	1.4***	-0.29***	-0.04	0.01	0.02***	-0.01**	-0.05***	0.02***	0	-0.12***	-0.19***	-0.23***	-0.32***	-0.36***	14.7***
	(0.139)	(0.042)	(0.040)	(0.016)	(0.002)	(0.004)	(0.006)	(0.004)	(0.002)	(0.024)	(0.033)	(0.038)	(0.041)	(0.042)	(0.451)
52.2	2.1***	-0.16**	0.07	-0.07***	0.02***	-0.02***	-0.04***	0.03***	0*	-0.13***	-0.22***	-0.25***	-0.31***	-0.33***	12.03***
	(0.213)	(0.066)	(0.073)	(0.027)	(0.002)	(0.007)	(0.009)	(0.007)	(0.003)	(0.047)	(0.063)	(0.071)	(0.075)	(0.076)	(0.677)
52.3	0.24**	-0.26***	0.18***	0.07***	0.02***	-0.02***	0	0	0	-0.18***	-0.29***	-0.33***	-0.43***	-0.42***	16.85***
	(0.105)	(0.035)	(0.034)	(0.015)	(0.001)	(0.004)	(0.007)	(0.004)	(0.001)	(0.021)	(0.031)	(0.036)	(0.040)	(0.042)	(0.342)
52.41	0.58	-0.18	-0.17	-0.04	0.01	-0.01	0.03	0.05	0.01	-0.3	-0.41	-0.5	-0.69	-0.89	16.22***
	(0.664)	(0.315)	(0.242)	(0.101)	(0.012)	(0.016)	(0.045)	(0.041)	(0.015)	(0.309)	(0.439)	(0.516)	(0.581)	(0.644)	(2.414)
52.42	1.96***	0.05	-0.33**	-0.11***	0.01	0	0	0.01	0.02**	0.14	-0.09	-0.25	-0.23	-0.27	11.2***
	(0.304)	(0.144)	(0.155)	(0.030)	(0.005)	(0.015)	(0.021)	(0.015)	(0.006)	(0.125)	(0.184)	(0.216)	(0.219)	(0.217)	(1.345)
52.44	1.66***	-0.22	-0.24	-0.21***	0	-0.01	0.07**	0.07***	-0.01	0.11	0.22	0.23	0.09	-0.09	14.37***
	(0.536)	(0.192)	(0.300)	(0.071)	(0.008)	(0.030)	(0.033)	(0.027)	(0.011)	(0.194)	(0.221)	(0.241)	(0.253)	(0.267)	(1.712)
52.45	1.1**	-0.12	-0.42	-0.05	0.02**	-0.01	-0.02	0.06**	0.01	-0.08	-0.19	-0.34	-0.49	-0.44	15.07***
	(0.467)	(0.237)	(0.305)	(0.048)	(0.008)	(0.030)	(0.027)	(0.028)	(0.012)	(0.265)	(0.328)	(0.378)	(0.424)	(0.413)	(2.014)
52.46	2.47***	-0.23	-0.32	-0.11**	0.02***	-0.03	-0.05**	0.05***	0.01	0.19	-0.26	-0.28	-0.32	-0.28	12.98***
	(0.374)	(0.152)	(0.224)	(0.048)	(0.006)	(0.020)	(0.027)	(0.021)	(0.008)	(0.173)	(0.266)	(0.301)	(0.308)	(0.295)	(1.440)
52.47	1.76***	0.21	0.42***	-0.11***	0	-0.02	0.01	0.01	-0.02***	-0.23*	-0.39**	-0.59***	-0.83***	-0.93***	9.34***
	(0.323)	(0.146)	(0.145)	(0.037)	(0.007)	(0.015)	(0.026)	(0.015)	(0.007)	(0.120)	(0.171)	(0.212)	(0.249)	(0.268)	(1.166)
52.48	1.34***	0.04	-0.15	-0.07*	0	0	0.01	0	0.01*	-0.16**	-0.14	-0.23**	-0.3***	-0.4***	12.7***
	(0.275)	(0.099)	(0.104)	(0.034)	(0.004)	(0.011)	(0.015)	(0.011)	(0.005)	(0.067)	(0.088)	(0.102)	(0.108)	(0.113)	(0.910)
52.6	2.4***	-0.07	0.09	-0.19***	0.01	-0.04*	0.01	0.09***	-0.01	-0.1	-0.13	-0.34	-0.41*	-0.3	10.56***
	(0.566)	(0.185)	(0.237)	(0.064)	(0.006)	(0.024)	(0.024)	(0.022)	(0.009)	(0.138)	(0.189)	(0.234)	(0.247)	(0.224)	(1.887)

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Industry code	l	k	t	l^2	k^2	t^2	$l*k$	$l*t$	$k*t$	$year$ 2012	2013	2014	2015	2016	$const$
52.7	-0.02	-0.16	0.02	0.17	0.01	-0.03*	-0.03	0.02	0.01	-0.2**	-0.28**	-0.29**	-0.42***	-0.45**	15.92***
	(0.947)	(0.284)	(0.206)	(0.140)	(0.012)	(0.018)	(0.053)	(0.030)	(0.011)	(0.082)	(0.119)	(0.144)	(0.164)	(0.181)	(2.544)
55.1	2.1***	0.19*	0.07	-0.09***	0	-0.01	-0.03**	0	0	-0.05	-0.03	-0.1	-0.16**	-0.14*	9.48***
	(0.238)	(0.111)	(0.081)	(0.024)	(0.003)	(0.008)	(0.012)	(0.007)	(0.003)	(0.054)	(0.068)	(0.076)	(0.079)	(0.082)	(1.144)
55.2	2.13***	-0.31*	0.07	-0.01	0.02***	-0.03*	-0.05*	-0.01	0.02**	-0.29**	-0.27	-0.38*	-0.54**	-0.32	12.12***
	(0.526)	(0.182)	(0.165)	(0.051)	(0.006)	(0.018)	(0.028)	(0.017)	(0.007)	(0.145)	(0.182)	(0.214)	(0.236)	(0.216)	(1.848)
55.3+55.4+55.5	1.24***	-0.11**	-0.11**	-0.03**	0.01***	0	-0.01	0.02***	0	-0.02	0.03	-0.05	-0.15***	-0.14**	13.57***
	(0.139)	(0.055)	(0.052)	(0.016)	(0.002)	(0.005)	(0.007)	(0.006)	(0.002)	(0.040)	(0.050)	(0.057)	(0.059)	(0.060)	(0.503)
60.1	1.59***	-0.44***	0.06	-0.05	0.02***	0.01	-0.03**	0.04***	-0.02***	0.09	-0.22	-0.25	-0.36**	-0.3*	16.09***
	(0.277)	(0.112)	(0.134)	(0.032)	(0.004)	(0.015)	(0.015)	(0.011)	(0.005)	(0.089)	(0.141)	(0.157)	(0.165)	(0.159)	(1.041)
60.2	2.01***	-0.2***	-0.24***	-0.09***	0.01***	0	-0.02**	0	0.01***	-0.02	-0.12***	-0.16***	-0.21***	-0.13***	13.05***
	(0.137)	(0.060)	(0.057)	(0.014)	(0.002)	(0.005)	(0.008)	(0.005)	(0.003)	(0.030)	(0.041)	(0.046)	(0.048)	(0.047)	(0.565)
60.3	1.75***	-0.48***	-0.46**	0.01	0.03***	0.02	-0.07**	-0.01	0.02**	0.14	0.07	0.23	0.18	0.42*	17.55***
	(0.379)	(0.174)	(0.221)	(0.030)	(0.007)	(0.016)	(0.026)	(0.012)	(0.008)	(0.164)	(0.203)	(0.219)	(0.243)	(0.253)	(1.951)
61.1	2.2***	-0.03	0.07	-0.14**	0	-0.07***	-0.01	0.01	0.02***	-0.19	-0.75**	-0.53*	-0.3	0.09	11.99***
	(0.534)	(0.170)	(0.226)	(0.061)	(0.006)	(0.024)	(0.024)	(0.022)	(0.007)	(0.186)	(0.311)	(0.297)	(0.265)	(0.231)	(1.846)
61.2	2.38***	-0.17	0.09	-0.06	0.02***	-0.02	-0.07***	0.03**	-0.01	-0.31*	-0.56**	-0.73**	-1.68**	-1.19**	10.24***
	(0.390)	(0.282)	(0.194)	(0.045)	(0.008)	(0.016)	(0.027)	(0.016)	(0.010)	(0.182)	(0.272)	(0.326)	(0.664)	(0.472)	(2.465)
62	0.85*	0	-0.26	0	0	0.01	0	-0.01	0.01	0.25*	-0.02	-0.05	-0.71**	-0.71**	14.59***
	(0.443)	(0.206)	(0.200)	(0.044)	(0.008)	(0.019)	(0.034)	(0.019)	(0.010)	(0.137)	(0.196)	(0.223)	(0.304)	(0.291)	(1.882)
63.11	1.73***	-0.18	-0.22	-0.08**	0.01*	-0.03**	0	0	0.03***	-0.07	-0.6***	-0.79***	-0.85***	-0.66***	13.75***
	(0.283)	(0.122)	(0.142)	(0.037)	(0.004)	(0.014)	(0.018)	(0.013)	(0.006)	(0.128)	(0.212)	(0.264)	(0.279)	(0.248)	(1.232)
63.12	1.51***	-0.32***	0	-0.07***	0.01***	-0.02*	-0.01	0.01	0	-0.13*	-0.37***	-0.29***	-0.26**	-0.18*	15.4***
	(0.248)	(0.112)	(0.109)	(0.024)	(0.004)	(0.010)	(0.013)	(0.009)	(0.004)	(0.069)	(0.100)	(0.107)	(0.106)	(0.102)	(1.081)
63.2	1.49***	-0.05	0.18**	-0.01	0.01***	-0.01*	-0.03***	0	0	-0.15***	-0.4***	-0.5***	-0.64***	-0.69***	12.33***
	(0.168)	(0.083)	(0.075)	(0.019)	(0.003)	(0.007)	(0.011)	(0.007)	(0.003)	(0.054)	(0.081)	(0.095)	(0.104)	(0.109)	(0.729)
63.3	2.09***	0.26*	0.21	0	0.01	-0.05***	-0.08***	0.06***	0	-0.42***	-0.68***	-0.72***	-0.81***	-0.66***	9.29***
	(0.520)	(0.135)	(0.167)	(0.072)	(0.004)	(0.017)	(0.022)	(0.018)	(0.006)	(0.112)	(0.165)	(0.188)	(0.209)	(0.199)	(1.391)
63.4	2.33***	-0.09*	-0.13	-0.19***	0.01***	0	0	0.04***	-0.01***	-0.02	-0.15*	-0.03	-0.08	-0.03	11.81***
	(0.158)	(0.055)	(0.085)	(0.018)	(0.002)	(0.009)	(0.009)	(0.008)	(0.003)	(0.060)	(0.080)	(0.085)	(0.087)	(0.083)	(0.572)
64.2	2.21***	-0.15**	-0.11	-0.06***	0.02***	0.02*	-0.06***	0	0	0.03	0.02	-0.03	-0.02	-0.13*	12.04***
	(0.170)	(0.073)	(0.082)	(0.020)	(0.002)	(0.008)	(0.011)	(0.008)	(0.003)	(0.046)	(0.061)	(0.069)	(0.071)	(0.076)	(0.716)

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Industry code	l	k	t	l^2	k^2	t^2	$l*k$	$l*t$	$k*t$	$year$					$const$
										2012	2013	2014	2015	2016	
70.1	1.67***	-0.52***	-0.11	-0.15***	0.02***	-0.03***	0.02	0.03**	0.01**	-0.09	-0.13	-0.05	-0.04	0.02	17.17***
	(0.320)	(0.098)	(0.145)	(0.034)	(0.003)	(0.013)	(0.014)	(0.014)	(0.005)	(0.079)	(0.098)	(0.105)	(0.107)	(0.102)	(1.184)
70.2	1.18***	-0.5***	0	-0.02*	0.02***	-0.02***	-0.02***	0	0.01***	-0.17***	-0.23***	-0.26***	-0.25***	-0.15***	16.75***
	(0.116)	(0.052)	(0.044)	(0.011)	(0.002)	(0.004)	(0.006)	(0.004)	(0.002)	(0.027)	(0.035)	(0.040)	(0.040)	(0.039)	(0.543)
70.3	1.38***	-0.04	0.03	-0.1***	0***	-0.02***	0.01	0.01***	0**	-0.19***	-0.23***	-0.26***	-0.29***	-0.21***	13.95***
	(0.114)	(0.038)	(0.046)	(0.012)	(0.001)	(0.004)	(0.005)	(0.004)	(0.002)	(0.030)	(0.039)	(0.044)	(0.045)	(0.044)	(0.413)
71.2	2.69***	-0.41*	-0.55*	-0.19***	0.02***	0.03	-0.01	0	0.01	-0.1	0	-0.19	-0.13	-0.25	13.86***
	(0.641)	(0.225)	(0.305)	(0.072)	(0.007)	(0.030)	(0.025)	(0.030)	(0.010)	(0.152)	(0.188)	(0.236)	(0.232)	(0.237)	(2.408)
71.3	1.47***	-0.32	-0.01	0.03	0.02***	-0.02	-0.03	-0.04**	0.02*	-0.07	-0.12	-0.23*	-0.32**	-0.33**	15.34***
	(0.541)	(0.197)	(0.229)	(0.060)	(0.006)	(0.019)	(0.023)	(0.019)	(0.009)	(0.086)	(0.118)	(0.142)	(0.154)	(0.155)	(2.092)
72.1	1.48***	-0.41*	0.12	-0.19***	0.01*	-0.04	0.05	0.04*	0	-0.13	-0.53*	-0.73**	-0.73*	-0.5	16.33***
	(0.441)	(0.226)	(0.252)	(0.057)	(0.008)	(0.023)	(0.035)	(0.022)	(0.012)	(0.192)	(0.292)	(0.371)	(0.376)	(0.316)	(1.960)
72.2	0.58**	-0.03	0.08	0.06**	0.01***	-0.02**	-0.02*	0.01*	0	-0.2***	-0.37***	-0.36***	-0.49***	-0.51***	15.36***
	(0.228)	(0.070)	(0.086)	(0.030)	(0.002)	(0.008)	(0.010)	(0.009)	(0.004)	(0.065)	(0.091)	(0.102)	(0.113)	(0.115)	(0.708)
72.3	1.08**	-0.07	0.25	-0.15**	0	-0.04**	0.07**	0.01	0	-0.27**	-0.35*	-0.24	-0.18	-0.14	14.35***
	(0.505)	(0.192)	(0.201)	(0.061)	(0.007)	(0.019)	(0.027)	(0.017)	(0.009)	(0.126)	(0.179)	(0.194)	(0.196)	(0.188)	(1.740)
72.4	0.6	0	0.33**	0.07	0.01*	-0.04***	-0.02	0.02	0	-0.37***	-0.63***	-0.73***	-0.95***	-0.9***	14.69***
	(0.425)	(0.134)	(0.144)	(0.053)	(0.004)	(0.014)	(0.015)	(0.015)	(0.006)	(0.120)	(0.169)	(0.195)	(0.225)	(0.218)	(1.339)
72.5+72.6	2.4***	0.25**	-0.33**	0.04	0.01***	0.02	-0.12***	0.01	0.01*	-0.04	-0.1	0	-0.06	-0.14	10.51***
	(0.345)	(0.112)	(0.155)	(0.047)	(0.004)	(0.016)	(0.018)	(0.016)	(0.006)	(0.093)	(0.127)	(0.137)	(0.143)	(0.145)	(1.190)
73	1.16***	0.06	0.1**	-0.02	0.01***	-0.02***	-0.02***	0.02***	0	-0.05	-0.23***	-0.38***	-0.46***	-0.48***	13.1***
	(0.098)	(0.041)	(0.046)	(0.012)	(0.001)	(0.005)	(0.007)	(0.004)	(0.002)	(0.031)	(0.043)	(0.051)	(0.054)	(0.056)	(0.399)
74.1	1.08***	0.1**	-0.04	-0.01	0	-0.02***	-0.01	0.03***	0*	-0.08**	-0.16***	-0.16***	-0.25***	-0.22***	13.75***
	(0.164)	(0.041)	(0.062)	(0.020)	(0.001)	(0.006)	(0.006)	(0.006)	(0.002)	(0.033)	(0.042)	(0.047)	(0.049)	(0.048)	(0.497)
74.20.0	1.56***	0.25***	0.28**	-0.13***	0*	-0.03***	0.02*	-0.01	0	-0.14	-0.34***	-0.49***	-0.46***	-0.51***	10.49***
	(0.259)	(0.087)	(0.126)	(0.031)	(0.003)	(0.012)	(0.013)	(0.012)	(0.005)	(0.091)	(0.124)	(0.151)	(0.152)	(0.152)	(0.943)
74.20.1	1.31***	0.16***	0.13**	-0.02	0**	-0.02***	-0.02***	0	0	-0.14***	-0.19***	-0.2***	-0.31***	-0.37***	12***
	(0.165)	(0.053)	(0.066)	(0.019)	(0.002)	(0.007)	(0.008)	(0.006)	(0.002)	(0.042)	(0.056)	(0.063)	(0.067)	(0.070)	(0.589)
74.20.2	1.87***	-0.6***	0.13	-0.08***	0.03***	-0.03***	-0.03*	0.02**	0	-0.21**	-0.49***	-0.6***	-0.87***	-1.01***	16.08***
	(0.304)	(0.134)	(0.111)	(0.027)	(0.004)	(0.011)	(0.015)	(0.010)	(0.004)	(0.087)	(0.126)	(0.146)	(0.174)	(0.198)	(1.473)
74.20.3	2.62***	0.44***	0.52***	-0.05	0.01	-0.03**	-0.09***	-0.01	-0.02**	-0.44***	-0.52***	-0.69***	-0.82***	-0.91***	5.37***
	(0.359)	(0.141)	(0.139)	(0.044)	(0.005)	(0.014)	(0.024)	(0.015)	(0.006)	(0.131)	(0.174)	(0.212)	(0.230)	(0.247)	(1.392)
74.3	0.78***	0.1	-0.08	-0.01	0	-0.01	0	0.05***	0	0.03	-0.06	-0.05	-0.07	-0.1	13.96***
	(0.298)	(0.097)	(0.114)	(0.043)	(0.004)	(0.011)	(0.017)	(0.012)	(0.005)	(0.059)	(0.077)	(0.088)	(0.090)	(0.091)	(0.943)

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Industry code	l	k	t	l^2	k^2	t^2	$l*k$	$l*t$	$k*t$	$year$					$const$
										2012	2013	2014	2015	2016	
74.4	1.34***	0.05	0.09	-0.05	0.01**	-0.02	0	0.03**	-0.01**	0.03	-0.16*	-0.25**	-0.31***	-0.22**	13.28***
	(0.336)	(0.077)	(0.116)	(0.043)	(0.003)	(0.012)	(0.013)	(0.012)	(0.004)	(0.064)	(0.090)	(0.106)	(0.111)	(0.107)	(0.920)
74.5	2.22***	-0.26	-0.27	-0.16*	0.01*	-0.05*	-0.02	0.07***	0.02**	-0.18	-0.34	-0.52*	-0.56*	-0.31	15.72***
	(0.668)	(0.192)	(0.252)	(0.086)	(0.006)	(0.026)	(0.029)	(0.024)	(0.008)	(0.152)	(0.225)	(0.289)	(0.308)	(0.270)	(1.994)
74.6	0.62***	0.03	0.04	0.07***	0***	-0.04***	-0.03***	0.05***	0	-0.22***	-0.4***	-0.58***	-0.6***	-0.53***	15.38***
	(0.194)	(0.054)	(0.054)	(0.024)	(0.002)	(0.006)	(0.008)	(0.006)	(0.002)	(0.042)	(0.064)	(0.080)	(0.083)	(0.081)	(0.565)
74.8	1.75***	0.43***	0.19	-0.06*	-0.01**	-0.03**	-0.03*	0.01	0	-0.15**	-0.25***	-0.32***	-0.42***	-0.37***	9.43***
	(0.294)	(0.090)	(0.133)	(0.035)	(0.003)	(0.013)	(0.014)	(0.013)	(0.005)	(0.072)	(0.096)	(0.115)	(0.125)	(0.119)	(0.979)
90.00	2.47***	-0.29	-0.4*	-0.26***	0.01	0.02	0.02	0.03	0.01	-0.22	-0.34	-0.57*	-0.91**	-1.22***	12.44***
	(0.497)	(0.225)	(0.222)	(0.054)	(0.008)	(0.020)	(0.027)	(0.022)	(0.009)	(0.191)	(0.258)	(0.318)	(0.394)	(0.470)	(2.085)
90.01	2.03***	-0.19	-0.35**	0.14*	0.02***	-0.01	-0.13***	-0.01	0.02***	0.06	-0.03	0.04	0.01	0.1	12.84***
	(0.512)	(0.159)	(0.175)	(0.069)	(0.005)	(0.017)	(0.029)	(0.020)	(0.007)	(0.136)	(0.168)	(0.181)	(0.173)	(0.173)	(1.721)
90.02	1.59***	-0.35***	-0.44***	-0.06**	0.02***	0.01	-0.01	0	0.02***	0.13	0.29***	0.16	0.27**	0.38***	15.02***
	(0.292)	(0.129)	(0.125)	(0.028)	(0.004)	(0.010)	(0.017)	(0.012)	(0.006)	(0.085)	(0.104)	(0.114)	(0.111)	(0.111)	(1.249)
90.03	1.08***	-0.1	-0.3***	-0.06**	0	0	0.02	-0.01	0.01***	-0.03	0.06	0.01	0	0.02	14.09***
	(0.262)	(0.103)	(0.091)	(0.027)	(0.004)	(0.008)	(0.017)	(0.010)	(0.004)	(0.068)	(0.080)	(0.092)	(0.093)	(0.097)	(0.968)
92.1	1.27***	-0.17	0.02	0.02	0.02***	-0.01	-0.05***	-0.01	0	0.03	-0.32	-0.3	-0.43*	-0.3	13.84***
	(0.386)	(0.152)	(0.205)	(0.039)	(0.005)	(0.020)	(0.015)	(0.018)	(0.007)	(0.142)	(0.197)	(0.212)	(0.225)	(0.208)	(1.605)
92.2	2***	0.01	-0.02	0.03	0.02***	0	-0.08***	0	0	0.03	0	-0.11	-0.28***	-0.19**	10.26***
	(0.261)	(0.099)	(0.091)	(0.036)	(0.003)	(0.009)	(0.015)	(0.011)	(0.004)	(0.052)	(0.068)	(0.079)	(0.086)	(0.085)	(0.921)
92.3+92.5	0.32	-0.15	-0.1	0.11*	0.01*	0	-0.01	-0.01	0.01	0.02	-0.07	-0.16	-0.29**	-0.28**	15.51***
	(0.504)	(0.161)	(0.141)	(0.063)	(0.005)	(0.014)	(0.022)	(0.018)	(0.006)	(0.095)	(0.113)	(0.130)	(0.143)	(0.140)	(1.602)
92.4	1.22*	-0.2	-0.29	0.05	0.01*	0.02	-0.02	0.01	0	0.09	-0.01	0.03	-0.08	-0.2	14.42***
	(0.633)	(0.185)	(0.181)	(0.076)	(0.007)	(0.019)	(0.031)	(0.026)	(0.009)	(0.109)	(0.147)	(0.165)	(0.176)	(0.195)	(1.925)
92.6	0.77	-0.12	-0.17	-0.07	0	0.03*	0.04**	0.01	-0.01	0.03	0.08	0.05	-0.12	-0.15	16.13***
	(0.487)	(0.130)	(0.153)	(0.064)	(0.004)	(0.016)	(0.019)	(0.014)	(0.005)	(0.063)	(0.080)	(0.091)	(0.100)	(0.103)	(1.411)
93.01	1.89**	0.57**	0.06	-0.1	-0.02*	0	0.03	-0.06**	0.01	-0.1	-0.31*	-0.38*	-0.53**	-0.57**	6.31**
	(0.874)	(0.273)	(0.227)	(0.091)	(0.011)	(0.020)	(0.049)	(0.025)	(0.010)	(0.114)	(0.170)	(0.200)	(0.220)	(0.236)	(2.650)
93.02	0.37	0.23	0.19	0.03	0	-0.05***	0	0.1**	-0.02*	-0.19*	-0.41**	-0.36*	-0.19	-0.06	12.06***
	(0.955)	(0.332)	(0.242)	(0.142)	(0.011)	(0.019)	(0.050)	(0.038)	(0.010)	(0.116)	(0.184)	(0.208)	(0.197)	(0.197)	(3.105)
93.03	-0.05	0.11	0.11	0.15***	0	-0.01	-0.02	0.03***	-0.01***	-0.02	-0.23**	-0.25**	-0.43***	-0.35***	13.56***
	(0.323)	(0.109)	(0.085)	(0.036)	(0.004)	(0.008)	(0.020)	(0.012)	(0.004)	(0.064)	(0.089)	(0.101)	(0.114)	(0.116)	(1.092)
93.04	-0.32	-0.48**	-0.33**	0.18***	0.02***	0.02	-0.02	0	0.01	0.11*	0.18**	0.11	0.14	0.15*	19.67***
	(0.466)	(0.223)	(0.134)	(0.063)	(0.007)	(0.013)	(0.027)	(0.016)	(0.006)	(0.058)	(0.074)	(0.083)	(0.085)	(0.092)	(2.023)

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Industry code	l	k	t	l^2	k^2	t^2	$l*k$	$l*t$	$k*t$	$year$ 2012	2013	2014	2015	2016	$const$
93.05	-1.73	0.67*	0.55	0.17	-0.04**	-0.05**	0.11*	0.02	-0.02	0.09	-0.07	-0.11	-0.17	0.07	13.03***
	(1.121)	(0.395)	(0.336)	(0.157)	(0.017)	(0.024)	(0.063)	(0.043)	(0.019)	(0.141)	(0.178)	(0.218)	(0.234)	(0.232)	(3.125)

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1