Firms' efficiency, exits and government procurement contracts[☆,☆☆]

Evguenia Bessonova [a,b,*]

[a] *The Bank of Russia, Russia*
[b] *HSE University, Russia*

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ABSTRACT

This study shows that productivity trends in Russia are similar to those in other countries where technology leaders enjoy productivity growth, with a gap increasing between them and other companies. The survival analysis suggests that the most efficient firms quit the market at a faster rate than other companies do. Survival functions of the least efficient firms do not always differ significantly from those of other enterprises. Additional financial support from government contracts helps firms in all efficiency groups survive but this effect is stronger for laggards. The shift of gains from the public procurement system towards low productive firms leads to the distorted allocation of resources in the economy and, in the long run, may undermine economic growth by allowing inefficient companies to stay in the market significantly longer than would be the case in a more competitive environment.

1. Introduction

In recent years, studies examining productivity trends have provided evidence that productivity growth has slowed at the aggregate level after the Global Financial Crisis (GFC). This was found to be true of various countries differing in the level of economic development. Research based on data for developed countries suggests that this trend emerged even before 2008. Estimations using aggregated data (see, for example, Voskoboynikov, 2017) show similar trends in the Russian economy. Since 2010, various industries have suffered a decline in both labour and total factor productivity growth rates.

Recent cross-country studies based on firm-level data attribute this slowdown in productivity growth to an increasing gap in productivity levels between the most and least efficient firms within the same industries rather than to a decline in the rate of technological progress. Research provides a number of explanations for this phenomenon, one of them being that the nature of technological progress has changed, innovation now involves higher costs, and inefficient firms do not have sufficient resources for innovation.

This explanation invites two questions. First, why has technological diffusion from leading companies to less efficient firms slowed down and why has it become more difficult for less efficient firms to replicate best practices? Second, why do inefficient firms not exit the market, continuing instead to use scarce production factors in their operations? This study focuses on the second question and deals with the analysis of firm dynamics in the Russian economy and the factors enabling inefficient firms to stay in the market. Recent

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research in productivity trends for developed countries quite often explains the presence of inefficient firms in the market by their access to cheap credit thanks to low interest rates after the GFC. This is not very relevant to Russia, where the levels of interest rates remained much higher than in developed countries over the period under study. The existence of a large share of inefficient firms in the market seems to arise from other factors.

In my research, I regard the public procurement system as a possible source of supporting inefficient companies in various industries. Recently, public procurement has been increasingly seen as one of the possible means of implementing industrial policy in a broad sense. In this case, public procurement, in addition to reducing the costs of acquiring goods and services for public needs, may also seek to address goals related to social issues, regional or sustainable development, etc. Government procurement contracts are widely used to support domestic firms via increasing demand. Studies based on data for the less developed countries quite often find that involvement in the public procurement system has a positive effect on growth, especially in lagging regions. In Russia, government purchasing contracts accounted for 27% of GDP in 2019,[1] with a significant share of firms (almost 37% in my sample) involved in public procurement. Thus, government financial support through public procurement is quite substantial and may have a considerable impact on the Russian economy.

Government (local or federal) purchases generally have a positive effect on economic development through an increase in demand, especially in less developed areas. But the impact could be different for different types of firms involved in the public procurement system. If the system of public procurement is not based on transparent and competitive practices, the positive effect on economic growth could fail to materialise, since the politically connected but not necessarily the most efficient companies can have access to financing through the public procurement contracts. In this case, the final allocation of resources could be distortional and have a generally negative effect on economic growth in the long-term, even though short-term effects could be positive, for example, due to supporting employment in a region.

The contribution of this study is to evaluate the effect of additional support via the public procurement system on the performance of firms with various efficiency levels, and to analyse the influence of government purchases on the creative destruction process.

For this purpose, I combine firm-level data from three sources: data from companies' balance sheets from the RUSLANA dataset; data on each firm's entry in and exit from the market from the Unified State Register of Legal Entities; and information on the participation of a firm in government procurement auctions from the SPARK Marketing database.

I estimate production functions for narrowly defined industries to evaluate TFP growth and the efficiency level for individual firms. Based on this estimation the companies in my sample are divided into three groups: the leaders, the baseline group and the laggards. I conduct the analysis by comparing exit hazards for each group, as well as by estimating the effect of winning government procurement contracts on the survival of firms of different efficiency levels.

I have found that the most efficient firms exit the market at a faster pace than firms from the other efficiency groups. At the same time, lagging companies quit the market less frequently than other firms. This suggests that the market mechanism of selecting the most efficient firms is not itself efficient enough in the Russian economy.

According to World Bank studies (see Cusolito et al., 2020), Russian markets are highly fragmented and if the high rates of exits of leaders are due to the limitations of local markets, one would expect that local governments can support leaders through the public procurement system to help them extend the market boundaries. My analysis shows that the opposite trends are observed. I show that the government procurement system indeed helps firms involved in it stay in the market longer but does not necessarily support the most efficient firms with growth potential. The comparison of exit hazards among firms with a government contract shows that inefficient firms with government contracts stay in the market longer than companies from the other efficiency groups.

Wide access of low-productivity firms to the public procurement system provides more incentives to distorted allocation of resources in the economy and in the long run undermines economic growth further by allowing inefficient companies to stay in the market significantly longer than would be the case in a more competitive environment.

The rest of the paper is structured as follows. The second section discusses the related literature. Section 3 dwells on the data used in the analysis. Section 4 is devoted to the empirical strategy. The results are described in section 5. Section 6 presents the robustness check of the main results. Section 7 concludes.

2. Related literature

This study is related to three strands of literature: that on divergence in productivity levels, on government support which can introduce additional rigidities to firm dynamics, and on the use of public procurement as an instrument of industrial policy in a broad sense. First, there is a bulk of empirical studies on the micro level that provide evidence of an increasing productivity gap among firms within industries, provoking a discussion about how this is related to firms' entry and exit rates and whether it slows aggregate GDP growth (Andrews et al., 2016; Berlingieri et al., 2017; Decker et al., 2017).

The second line of the recent literature which has a bearing on my research focuses on the effectiveness of support for various types of firms via industrial policy and its impact on firm dynamics. Federal or local governments quite often use industrial policies to promote economic growth in certain regions or specific industries. The effectiveness of such industrial policies remains questionable. On the one hand, they usually boost employment and prompt the recovery of economic activity in less developed geographic areas (Wade, 2010). On the other hand, an attempt of the state to mitigate shocks to the economy through support for certain market

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[1] In absolute terms, 8.3 trillion rubles under Federal Law No. 44 and 21.2 trillion rubles under Federal Law No. 223 in 2019.

participants or industries can lead to an increase in rigidities in the economic system and slow adaptation to shocks because of excessive support for inefficient market participants (Bergoeing et al., 2004; Gamberoni et al., 2016).

In addition to the main task of cost reduction, public procurement has in recent years started to address other goals (Sjafjell and Wiesbrock, 2017). In developed countries, an increasingly greater emphasis is placed on the possibility of achieving technological, social or sustainable development goals through public procurement. This approach has both supporters and opponents, but nowadays public procurement is included in a number of the EU, OECD, and UN's official documents as a means of implementing industrial policy in its broad definition (see Warwick and Nolan, 2014 for discussion). At the same time, this approach to the public procurement system requires much more expertise and finer tuning of the system. Therefore, its use in emerging markets raises more questions. If the system of public procurement is not based on transparent and competitive practices, the final allocation of resources could be distortional and result in support for less efficient firms which, however, have political connections at the local or federal level.

Thus, state intervention in the market mechanism of creative destruction could have long-term (negative) effects on economic growth, especially in transition economies featuring poorly developed market mechanisms and institutional barriers to an efficiently functioning public procurement system, such as cronyism and corruption.

2.1. Productivity trends on the micro level

Increasing availability of firm-level data has made it possible to analyse in detail the heterogeneity in the pattern of firms' productivity growth. Research suggests that productivity dispersion has been increasing in various countries. This became evident even before the 2008 financial crisis and has persisted beyond that point. A number of recent studies find that only a small share of the most productive firms enjoy productivity growth, while other companies fail to catch up with technological leaders (Andrews et al., 2016 and Berlingieri et al., 2017 for OECD countries, Decker et al., 2017 for the US). The authors argue that the nature of technological diffusion has changed, prompting a slowdown in average TFP growth in developed European countries after the 2008 crisis. Even in advanced countries, less efficient firms are unable to adopt new technologies or new ways of organizing their business from the leaders promptly enough. At the same time, the competition mechanism does not force inefficient firms to exit the market. Various explanations have been offered, but the there is no predominant hypothesis to account for the persisting productivity gap between more advanced firms and other market players and for this change in firm dynamics.

Studies in the Russian economy which focus on aggregate trends at the national or industry level suggest dynamics similar to global productivity trends. Voskoboynikov (2017) using industry-level data (KLEMS) shows that growth in both labour and total factor productivity has been slowing since 2010. In an earlier paper, Timmer and Voskoboynikov (2014) find that negative trends in aggregate productivity indicators are gaining strength owing to the allocation of resources towards industries with low total factorial productivity (i.e., the extractive sector). They also show that industries with high growth potential do not increase their share in Russia's GDP. Studies in the Russian economy's productivity trends on the micro level are few and far between. One of the papers based on micro data (Golikova et al., 2007) finds a huge productivity gap between the best and worst 20% of Russian firms (10–20 times depending on the sector) in 2007. The authors argue that this gap is significantly larger than what is seen in developed countries.

Recent research using firm-level data for other countries reveals a change in firm dynamics which has brought about a slowdown in aggregate productivity growth over the last decade. Decker et al. (2016) find that the reallocation has declined in the US economy and within-industry TFP dispersion has in recent years kept increasing in all sectors. They also find that the relationship between productivity and exit among young firms becomes less pronounced, especially in the high-tech sector. Thus, the process of creative destruction has slowed, with the current distribution of labour productivity reflecting a less efficient resource allocation in the economy.

In another empirical paper on divergence in productivity levels in OECD countries (Berlingieri et al., 2017), authors show that the gap in productivity increases mainly because of increasing dispersion in productivity at the lower bound of distribution (below the median). It means that low-efficiency firms in developed economies now exit markets at a slower pace than in previous years. Andrews et al. (2016) find that an increase in MFP divergence in developed countries was more pronounced in sectors where pro-competitive regulation was less strict, which means that the presence of the adjustment frictions in an economy may weigh down on firm dynamics.

The low rate of entrance of new firms has been discussed in many studies examining obstacles to economic growth in Russia (Aidis and Adachi, 2007; Bruno et al., 2013; Estrin and Prevezer, 2010; Iwasaki et al., 2016). In this research, I focus on the low rate of exits of inefficient firms which could have an even stronger long-term (negative) effect on economic development. This study checks whether global trends showing a slowdown in firm dynamics are also observed for the Russian economy, which is known for high entry costs and a rather monopolised industrial structure, especially on the regional level. These features were inherited from the Soviet economy and have not been completely overcome after the twenty-odd years of market reforms.

2.2. Government support and creative destruction

Many countries seek to promote economic growth through industrial policies. After the GFC, most governments, especially in the US and EU, provide significant subsidies to mitigate its consequences. Such policies usually have a positive effect on investment and employment, but a number of studies do not find a positive impact of industrial policy on firms' productivity growth.

In their theoretical paper, Hopenhayn and Rogerson (1993) demonstrate that an outcome of industrial policy may crucially depend on the environment in which companies operate. For example, strict regulation in certain markets could ex-post diminish firms' reaction to productivity shocks. In their model, an increase in the adjustment cost due to regulation reduces both exit and entry rates. Gamberoni et al. (2016) argue that regulations that reduce competitive pressure on the markets may result in a poor allocation of

resources because low-productivity firms do not exit, continuing their operations in an inefficient way.

Criscuolo et al. (2019) conclude that higher subsidies only have a positive effect on small firms, whereas large firms do not increase either employment or productivity in response to scaled up support. Bernini et al. (2017) show that the effect of subsidies on productivity is not straightforward: it is usually negative in the short run because firms overuse inputs for obtaining government support but could become positive in several years. Moffat (2014) finds that grants provided to companies from low-tech industries reduce their productivity. Thus, in a certain environment, an industrial policy may lead to a misallocation of recourses (Gamberoni et al., 2016) and affect the process of creative destruction by supporting less efficient firms which would otherwise exit the market.

In recent years, both theoretical and empirical literature has focused on the influence of industrial policy and the issue of its efficiency in supporting firms with growth potential. In the theoretical general equilibrium model, Acemoglu et al. (2018) show that an optimal industrial policy should be designed in such a way as to allow resources from the low-type firms move freely to the innovation activity of high-type firms, and this can be brought about by motivating low-productivity firms to exit the market. In an empirical paper on China, Aghion et al. (2015) demonstrate that sectoral government support promotes productivity growth more effectively where it focuses on more competitive sectors, and especially when it is not confined to just one or a handful of firms within the sector. Andrews et al. (2016), in their research on OECD countries, arrive at a conclusion that the increase in productivity gap was larger in sectors where market reforms fostering competition were less comprehensive. Thus, current research in this area shows that industrial policy should be targeted in such a way as to support the most efficient players.

2.3. Public procurement and firm dynamics

The goals of industrial policy have been changing in recent years. Nowadays, they include such tasks as promoting technological progress, dealing with social issues, regional development, and so on (Aiginger and Rodrik, 2020). At the same time, the role of public procurement is also changing. It is beginning to be included in the instruments of industrial policy in its new and broader sense. The mechanism that underlies the use of public procurement as an instrument of industrial policy is demand from the state in cases where private demand cannot create sufficient incentives to the development of industries or regions (Sjafjell and Wiesbrock, 2017). Public procurement is beginning to address multiple objectives, which may include support for innovation, technology adoption and transmission, support for SMEs, employment in the regions and other social challenges (Warwick, 2013; Uyarra and Flanagan, 2010; Rolfstam, 2012; Raiteri, 2018). In developing countries, there is a special emphasis on demand-side policies which can compensate for the lack of private demand in underdeveloped regions (Hoekman and Sanfilippo, 2020; Ferraz et al., 2015; Fadic, 2020). In fact, there is still no consensus on the inclusion in public procurement of more goals than cost reduction. Nevertheless, the EU Commission has referred to public procurement as part of a strategic policy seeking to achieve sustainability. Public procurement is also regarded as instrumental in meeting UN Sustainable Development Goals (Sjafjell and Wiesbrock, 2017).

Thus, one generally recognized goal of the public procurement system is to support various types of firms through boosting demand. However, the use of public procurement as an instrument of industrial policy may have an impact on the reallocation of resources in the economy, especially in cases where public demand accounts for a significant share of total demand (Albano and Sparro, 2010). Quite a few studies have been devoted to assessing the direct impact of public procurement on firm performance through an increase in demand.

Empirical studies dealing with government procurement and firm growth often find that government purchases help firms expand sales, introduce new products to markets and enter new markets. Recent papers on developing economies suggest that public procurement in general improves growth rates of firms which obtain government contracts. Ferraz et al. (2015), analysing government purchasing auctions in Brazil, show that government purchases via auctions could alleviate constraints on growth owed to lack of access to markets, letting firms know of potential markets or lowering barriers to sell in larger markets.

At the same time, the effect of government purchases could be different for different types of firms. Hoekman and Sanfilippo (2020) found a robust direct relationship between government demand (by public agencies) and the performance of firms in the low-income Sub-Saharan Africa countries. They show that there exists a substantial heterogeneity across firms, and the relationship between sales to government entities and performance is more pronounced for firms at the lower bound of the productivity distribution. Fadic (2020) using data on Equador's public procurement auctions demonstrates that positive demand shocks associated with government contracts are seen as short-term ones.

However, the analysis of an indirect impact through the reallocation of resources and firm dynamics is much less common (di Giovanni et al., 2022). At the same time, as discussed in section 2.1, reallocation of resources, which is associated with changes in firm dynamics, can have a significant impact on aggregate growth performance. On the micro level, there is also very little research on the impact of public procurement on firm survival, which largely defines the process of creative destruction in the economy (one of the few examples is Cappelletti and Giuffrida, 2021). My study contributes to the analysis of the indirect impact of public procurement on the process of creative destruction through an example of the Russian economy, considering the impact on firms belonging to different efficiency groups.

The system of the allocation of government contracts is not necessarily efficient. If government contracts are not awarded through a competitive procedure and informal connections play an important role in choosing the winner, then this will result in an inefficient allocation of resources toward firms with political connections in local or federal government bodies. These effects could be amplified in the economies with underdeveloped institutes, where the environment creates additional incentives for the opportunistic behaviour of the parties involved in public procurement.

The growing literature on cronyism shows that political connections have a strong association with a better access of connected firms to financing, including through capital markets (Khwaja and Mian, 2005; Claessens et al., 2008), bailouts for firms (Faccio et al.,

2006), and emergency loans for banks (Blau, 2017) or procurement contracts (Goldman et al., 2013). Also, Diwan et al. (2019), analysing Middle East countries, show that the presence of politically connected firms in a sector result in lower aggregate job creation, as well as lower sales and labour productivity for such firms. Thus, cronyism may result in slow productivity growth of firms which have access to public financing. Zhang et al. (2019) find that connections with corrupt local officials have a positive impact on the survival of private enterprises in China. Akcigit et al. (2018) show in their theoretical model that in industries where incumbent firms have political connections the processes of creative destruction are less pronounced. Also based on micro level data from Italy, they find that less efficient but politically connected firms survive better. Baltrunaite et al. (2018), also using Italian data, find that labour productivity of a firm that was awarded a public procurement contract declines if there is a local politician among its shareholders.

In the case of Russia, procedures for allocating government procurement contracts are not always transparent. For example, a recent research by Yakovlev et al. (2020) based on survey data shows that 53% of public procurement contract customers choose a strategy to award a contract to a predetermined supplier and 38% of contract customers describe the problem of informal relations as frequent. A study devoted to the Russian procurement system (Mironov and Zhuravskaya, 2016) shows that in areas known for a higher level of corruption contracts are more often awarded to less efficient companies.

In addition, local authorities' objectives (supporting employment in incumbent companies or implementing corruption schemes in the public procurement system) may run counter to mechanisms fostering economic growth. In low-income regions, the local government could act as a monopolist in the market, and then its willingness to award contracts to local companies could have a discouraging effect on the creative destruction process. For example, Demidova and Yakovlev (2012), using survey data on Russian manufacturing enterprises, find that old, partially government-owned companies and firms that address the goal of keeping jobs receive government support more often.

3. Data

To conduct this study, three databases were combined: firm-level data from balance sheets, data on each firm's entry in and exit from the market, and information on the participation of a firm in government procurement auctions.

3.1. Firm level data

To estimate productivity growth at a firm level, I use data from the RUSLANA database. In this study, the estimations are conducted using data from Russian firms' balance sheets for eight years from 2008 to 2015. The RUSLANA dataset contains information on firms' sales, fixed assets, the number of employees, and the cost of goods sold. For the purposes of my research, I limit the sample to the non-farm non-financial sectors so as to be able to estimate production functions using a standard set of output (value added) and inputs (labour and capital).

The RUSLANA database does not include data on the payroll fund for the entire period of observation. At the same time, Rosstat collects data on average wages separately for each of the Russian Federation regions, providing a fairly detailed breakdown by industry. This allows proxying the labour costs by multiplying the number of the firm's employees by average wages in the region's relevant industry. Therefore, value added for a firm is calculated as the difference between total sales and the cost of goods sold plus labour costs.

To estimate the parameters of the production functions, this study uses data on value added, capital and labour. For capital and labour inputs, the real fixed assets and the number of employees are used.

The value added numbers are deflated by industrial PPIs for mining and quarrying, manufacturing, and electricity, gas and water supply, and by the SNA deflators for the other sectors. The deflators for capital are obtained from the data on nominal capital stocks and volume indices of capital stocks which are published by Rosstat at the sectoral level. For estimating production functions, I exclude from the sample 0.5% of firms with the largest total sales and 0.5% of those with the lowest sales each year.

The final sample ranges from 127,570 firms in 2008 to 187,960 in 2015 and fairly accurately represents the industrial structure as shown by Rosstat data, with a slight bias towards manufacturing at the expense of business and personal services.

3.2. Data on exits and entries

The panel based on the RUSLANA database is unbalanced, and data for a certain part of firms is not available for the entire period of observation. If a firm stops reporting in a certain year it does not necessarily mean that it has exited the market. For this reason, in the next step, I combine my estimations of firms' efficiency levels with information on the dates of individual firms' incorporation and their removal from the Unified State Register of Legal Entities. A company is excluded from the register if it was officially liquidated or was not economically active according to Rosstat definition.[2] At the end of 2015, Federal Law No. 209 "On developing small and medium-sized enterprises in the Russian Federation" was amended to include a new article, 4.1., "The Unified Register of Small and Medium-Sized Enterprises". The Federal Tax Service was required to maintain the Unified Register of Small and Medium-Sized Enterprises as of that date. In 2016, the Federal Tax Service started revising the SME register, and in 2017 a sharp increase in exits was

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[2] The Rosstat methodology is in line with the international methodology described in "Eurostat-OECD Manual on Business Demography Statistics. - Luxembourg: office for official publications of the European Communities" (2007). To roughly sum up, it implies the absence of information on sales and employment for two consecutive years.

observed in the Unified State Register of Legal Entities.

To incorporate the revision results into my analysis, I use the following strategy to define the year of a firm's exit from the market. First, I use the information from the Unified State Register of Legal Entities to identify the fact of exit as of 2017. Then, as the exit could have emerged earlier and only recorded in 2017, I assign the exit year according to the fact of disappearance of balance sheet data from the RUSLANA dataset. To comply with the Rosstat methodology, I assign the exit year if a firm fails to provide information for two consecutive years and does not reappear in the sample by the end of the period under analysis.[3]

Most firms established in the Soviet period went through mass privatizations in 1992–1994 and were supposed to reregister as part of the privatization process. For these firms, the date of incorporation will reflect the date of privatization rather than that of establishment. The share of such firms in the sample is 9.5%. Another 11% of firms enters the market during 1995–1999. A large part of firms in the Russian economy (41%) were established in the 2000–2007 period of economic growth, and a 38.5% of firms were established after the 2008 crisis.

Since the productivity and efficiency indicators are estimated for the 2008–2015 period, the companies liquidated before the year 2008 are excluded from the analysis. As of 2017, 11.5% of the firms in the sample exited the market (see Table 1). The average age of firms is 12.4 years. The maximum age at exit for the firms in the sample is 26 years.

3.3. Government procurement contracts

Legislation governing public procurement has been changing over recent years. Since 2006, public procurement was governed by Federal Law No. 94 (FS94); in 2012, additional Federal Law No. 223 (FS223) was introduced, and in 2014 Federal Law No. 94 was replaced by Federal Law No. 44 (FS44). Thus, since 2014, public procurement has been governed by two laws in the Russian Federation: Federal Law No. 44 (FS44) and Federal Law No. 223 (FS223).[4] The former details the entire procurement process, from planning to the performance of contracts. The latter only addresses certain types of suppliers and contracts and is less strict in the sense that it only governs the general principles of the procurement process.

FS44 regulates the procurement activities of government and public sector institutions. FS223 deals with the procurement purchases of state corporations, state-owned companies, natural monopolies, state and municipal unitary enterprises, autonomous institutions and business entities with the state participation more than 50 per cent. FS44 can also be used by the above organizations for procurement where they use budgetary funds. In other words, the same institution can conduct procurement under both laws.

FS44 governs the use of budgetary funds and therefore is largely aimed at cost reduction for public procurement contracts. FS223 does not strictly regulate the choice of procurement methods. Therefore, under FS223, customers often deliberately introduce additional restrictions into the procurement documentation. Thus, creating attractive conditions for a supplier with a record of successful performance of work, provision of services or supplying of goods in a particular area. It entails the risk of creating a non-competitive environment and also increases the risks of providing contracts to companies which are in some way or other affiliated with the managers of state corporations or public sector organizations.

On the other hand, under FS223, state corporations award large contracts for various supplies, channelling state funds or subsidies to other marker players through public procurement. Indeed, the sums of contracts under FS223 significantly exceed funds that are distributed under FS44. In this case, FS223 can to a greater extent be used to meet the goals of industrial policy through the public procurement system, which may include innovation policy, social issues, regional development, depending on what state corporations or public sector organizations initiate these purchases.

Survey data and anecdotal evidence suggest that despite the clearer conditions for bidding under FS44, the likelihood of unfair competition or cronyism is quite high in this case as well. For example, in a survey conducted by Yakovlev et al. (2020), 61% of public procurement suppliers under FS44 attribute the awarding of contracts to predetermined suppliers to informal connections with the customer.

In purchases under FS223, state corporations or public sector organizations spend their own (rather than budgetary) funds and face lesser limitations in choosing a counterparty than under FS44, they may prove to be more inclined to sign contracts with more reliable suppliers and maintain long-term relationships. This may have an impact on the survival of supplier firms, especially if a practice of renewable contracts is used. Also, the existence of an affiliation between the owners of supplier firms and managers of state corporations or public sector organizations can help firms stay in the market longer.

Thus, it can be assumed that the awarding of contracts under FS223 and FS44 may affect the survival of suppliers in some way or other. For this reason, in a number of specifications, firms which receive contracts under different laws are analysed separately. However, the period under review saw several significant changes in legislation, in some cases allowing the same enterprises to be awarded contracts under both laws because regulation changed during this period (although customers' needs remained unchanged), therefore, it is not always possible to distinguish effects from a particular law.

Prior to 2011, information on public procurement contracts was collected separately for each region, while 2011 saw the

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[3] For robustness check I also tried two alternative definitions of the exit year: a) the year of removal from the Unified State Register of Legal Entities, regardless of the 2017 revision, as a year of exit and b) the fact of disappearance of balance sheet data from the RUSLANA dataset, regardless of the information about the exit in the Unified State Register of Legal Entities. The main results of my research hold for these two alternative approaches to defining the year of a firm's exit from the market. The regression results are not reported but are available on request.

[4] Federal Law No. 44-FZ "A Contract System for the Procurement of Goods, Works, and Services to Meet Government and Municipal Needs" of April 5, 2013; Federal Law No. 223-FZ "Purchasing Goods, Works, and Services by Certain Types of Legal Entities" of July 18, 2011.

Table 1
Survival statistics: number of firms, exits and age at exit.

	obs.	mean	min	max
Number of firms	297,759			
Exits	34,223	0.115	0	1
Age at exit		12.4	1	26

Note: Exits by 2017.
Source: author's estimates based on the RUSLANA dataset and the Unified State Register of Legal Entities.

introduction of a unified platform for all government purchases. Detailed information on all public procurement contracts, with the exception of contracts for defense purposes, is currently available on an official website.[5] Data on the winners of government procurement contracts is taken from the SPARK Marketing dataset.[6] This dataset contains information on public procurement purchases with very detailed data for each contract since 2011. The statistics on the number of contracts for each federal law are presented in Table 2. In my analysis, I use information on auction winners, the date of the contracts, the type of the contract, and the contract customers' regions for the 2011–2015 period.

During the period under consideration, a number of amendments were introduced to legislation. For this reason, in many cases a firm which took part in public procurement received contracts under different procedures. I do not make a distinction between different procedures in my analysis. This choice is predetermined by the purpose of this study. Here I do not investigate the efficiency of the methods of implementing public procurement procedures. Rather, I am interested in the effect of winning a public procurement contract of any type on the survival of a firm.

The dataset on government procurement contracts was linked to firm-level data on productivity growth using information on the winner identification code (INN). One firm could be awarded one or several government procurement contracts during the period under analysis or within one year. Also, if a firm becomes a supplier for several contracts, these contracts could be provided under different federal laws. One third of the firms from my sample participated in government procurement (see Table 3) in 2011–2015. Among firms which were awarded government contracts in 2011–2015, 22.6% obtained contracts under FS223, 37.2% won contracts under FS94 (in 2011–2013) or FS44 (in 2014–2015), and a large share of firms (40.3%) were awarded contracts under both FS223 and FS94 or FS44.

The SPARK Marketing dataset also contains basic information on contract customers, and in some specifications, I distinguish supplier firms located in the same region as contract customers from companies which receive contracts in other regions than those where they are registered. Almost half of companies were awarded government procurement contracts only in their home regions, while 13.2% of firms only received contracts in their non-home regions. And a very significant share of companies (38.3%) were involved in public procurement in both their home and non-home regions (see Table 3). Although Russian public procurement legislation does not allow for any restrictions on the regional affiliation of suppliers, it appears that the vast majority of firms (86.8%) receive contracts in the regions where they are registered.

4. Theoretical explanation and empirical methods

4.1. Theoretical explanation

One of the directions of the analysis of economic growth examines the contribution of firm dynamics, since dynamics at the microlevel can help explain the performance of macro indicators more accurately. Research in this direction uses the decomposition of aggregate productivity growth into individual components which reflect firm dynamics. This analysis highlights the contribution of existing firms' growth and market entries and exits to aggregate measures of productivity growth.

In the economic studies, several decomposition options are used. In general, the contribution of each enterprise to a change in the aggregate productivity index over time depends on a productivity change at an individual enterprise and on a change in the market share of this enterprise (reallocation effect, which also includes exits and entries). In the framework proposed in Foster et al. (2001), the aggregate productivity growth is decomposed into the following components: productivity growth of existing firms, change in the market share of existing firms, contribution of the covariance component, contribution of new firms, contribution of firms which have exited the market. Formally, it is expressed by the following equation (see Foster et al., 2001).

$$\Delta P_t = \sum_{i \in E} s_{it-1} \Delta p_{it} + \sum_{i \in E} (p_{it-1} - P_{t-1}) \Delta s_{it} + \sum_{i \in E} \Delta p_{it} \Delta s_{it} +$$
$$+ \sum_{i \in N} s_{it} (p_{it} - P_{t-1}) + \sum_{i \in X} s_{it-1} (p_{it-1} - P_{t-1}) \tag{1}$$

where P_t is the aggregate productivity index, p_{it} is the productivity of firm i, s_{it} is a share of firm i. E denotes existing firms, N denotes entering firms, X denotes exiting firms.

Table 2

Government procurement contracts by federal law.

Federal Law		2011	2012	2013	2014	2015
FS 223	number of contracts	n/a	5658	132,353	254,786	1,082,407
FS 94	number of contracts	2,048,918	2,449,038	2,656,452	n/a	n/a
FS 44	number of contracts	n/a	n/a	n/a	2,461,933	2,960,185

Source: author's estimates based on the SPARK Marketing dataset.

Table 3

Firms with government procurement contracts by federal law and region of contract.

	percentage
Government procurement contracts	
share of firms without government procurement contract	63.1%
share of firms with government procurement contract	36.9%
Federal Laws	
firms with government procurement contract of which	100%
share or firms with contracts under FS223 only	22.6%
share or firms with contracts under FS94 or FS44 only	37.2%
share or firms with contracts under both FS233 and FS94 (in 2011–2013) or FS44 (in 2014–2015)	40.3%
Region of contract	
firms with government procurement contract of which	100%
share of firms with contracts in a home region only	48.5%
share of firms with contracts in a non-home regions only	13.2%
share of firms with contracts in both home and non-home regions	38.3%

Source: author's estimates based on the SPARK Marketing dataset.

In equation (1), the three components which reflect the reallocation effect (a change in the market share of existing firms, the contribution of exits and entries) include the difference between a given firm's productivity level and the aggregate productivity index. I.e., the contribution of each of these components will be positive or negative depending on the relative level of productivity of individual enterprises. The impact of firms' exits on growth aggregates depends on which firms exit the market. If creative destruction processes are at work and inefficient firms exit the market, then the contribution of exits to aggregate growth will be positive. If, on the contrary, high-productivity firms exit, then the contribution of this component will be negative.

In addition, this decomposition shows that the effect of transferring resources from exiting enterprises to newly formed enterprises or to incumbent firms strongly depends on the existing productivity distribution of firms.

For example, in their study, Hsieh and Klenow (2009) show, using the example of India and China, that if, due to institutional factors which may be specific to each country, the distribution of enterprises in the economy is biased towards smaller and less efficient firms, then it is reflected in a significant loss in aggregate indicators of productivity growth compared with countries where resources are allocated more efficiently.

Studies on the Russian economy usually show that the distribution of firms by productivity within narrowly defined industries is skewed towards low-performing firms, and only a small proportion of firms operate at levels close to the production frontier (see, for example, Golikova et al., 2007). Moreover, the productivity gap between low-performing enterprises and leaders in an industry is significantly larger than in developed economies (see Bessonova and Tsvetkova, 2022). If low-performing firms maintain their positions in the market, staying in it for a long time, then this can have a negative impact on economic growth, since resources from firms which leave the market will with high probability be transferred to inefficient players. Therefore, in my study, I first consider exits from the market depending on the level of productivity of enterprises, since the analysis of firm dynamics can explain the trends of productivity at the aggregate level. In addition, Bessonova and Tsvetkova (2022) show that inefficient enterprises in each of the industries are largely concentrated in underdeveloped regions. Therefore, this paper also examines the dynamics of exits depending on the level of regions' development.

Hypothesis 1. Firms' exit rates vary with their efficiency levels, but laggard firms do not necessarily exit the market at a faster pace than more efficient players do.

Hypothesis 2. In underdeveloped regions, inefficient companies tend to stay in the market longer.

Bergoeing et al. (2004) in their study, using a stochastic general equilibrium model, show that the economy's adjustment after a shock, which requires reallocation of resources is a costly process. The costs which arise during the reallocation of resources in response to a shock, consist of two components: on the one hand, they result from a natural process associated with creative destruction, on the other hand, they can come from the government which pursues economic policy aimed at smoothing shocks. Such a policy reduces the negative impact of shocks on the economy, albeit in the short term. On the other hand, it introduces additional rigidities to the economy, slowing firm dynamics, lengthening inefficient firms' presence in the market and slowing the reallocation of resources from low-productivity firms to efficient players. Government policy intervention can take various forms: excessive protection in the labour market, additional loans to inefficient sectors, barriers to entry in certain markets, and so on. But according to the

above model, the overall effect of government policy intervention in the long run is to slow the process of adjustment and delay the recovery after the shock, as resource reallocation from less efficient players to more efficient ones takes longer.

By using public procurement to support demand, the government intervenes in the natural process of reallocation of resources from less efficient market participants to enterprises with growth potential (see Cappelletti and Giuffrida, 2021). Thus, a decision to use a public procurement system for other objectives than cost reduction implies a trade-off between short-term effects and a long-term impact on business dynamism, because an increase in public demand has a positive effect on the likelihood of enterprises remaining in the market, while the public procurement system does not always select the most efficient players.

In the Russian economy, government purchases make up a significant share of GDP and can have a significant impact on the economy not only directly, through boosting demand, but also indirectly. If the public procurement system influences firm dynamics and creates additional opportunities for inefficient enterprises to stay in the market longer, then in the long run this introduces additional rigidities to the economic system, slowing creative destruction processes and thus reducing the rate of productivity growth at the aggregate level.

Hypothesis 3. Involvement in public procurement helps all types of firms stay in the market longer, though this effect could be more pronounced for less efficient players.

In less developed regions, the influence of the state on the economy through the public procurement system may be stronger, since demand from government agencies can constitute a significant part of demand in such regions. In addition, regional authorities may try to interfere in the labour market through supporting employment at large enterprises by providing orders to such enterprises via the public procurement system. Such intervention can further increase the rigidities in regional markets and thus slow the process of ousting inefficient companies from the market in underdeveloped regions.

Hypothesis 4. Addressing social problems (such as supporting employment) in the region through an increase in public demand could keep up the already existing negative trends in firm dynamics.

4.2. Empirical methods

This study is comprised of two steps. In the first step, I estimate productivity growth and efficiency at the firm level. In the second step, I estimate survival functions for firms belonging to different efficiency groups and analyse the effect of involvement in the public procurement system on firm dynamics taking into consideration the firms' efficiency level.

4.2.1. Estimation of TFP growth and the efficiency level

I estimate production functions to evaluate TFP levels and growth rates for each firm. The production function is modelled as a translog function of three parameters – labour (L), capital (K), and time (t).

$$\ln Y_{it} = \alpha_0 + \alpha_L \ln L_{it} + \alpha_K \ln K_{it} + \alpha_t t + \alpha_{LL}(\ln L_{it})^2 + \alpha_{KK}(\ln K_{it})^2 + \alpha_{tt}t^2 + \alpha_{LK} \ln L_{it} \ln K_{it} + \alpha_{Lt} \ln L_{it}t + \alpha_{Kt} \ln K_{it}t + \varepsilon_{it} \tag{2}$$

The main problem with estimating TFP at a firm level is that the use of input factors can be correlated with the residual TFP. In this study, the Ackerberg-Caves-Frazer (ACF) methodology is employed to tackle the endogeneity problem of OLS estimation of production functions (Ackerberg et al., 2015). The ACF methodology suggests the control function approach under which the productivity shock is proxied by flexible inputs different from the initial sets of inputs. In this study, intermediate materials are used as such a proxy. Production functions are estimated separately for 282 industries,[7] mainly for three- or four-digit industries under the NACE 1.1 classification. I use the *prodest* command in the Stata software package developed by Mollisi and Rovigatti (2017) for production function estimations.

Using the estimated parameters of the production function, the TFP growth rates for each firm are computed in a standard way as the residual of value added growth unexplained by growth of production factors.

$$TFP\ Growth_{i,t+1} = \ln(Y_{i,t+1} / Y_{it}) - \overline{\eta}_L \ln(L_{i,t+1} / L_{it}) - \overline{\eta}_K \ln(K_{i,t+1} / K_{it}) \tag{3}$$

where

$$\overline{\eta}_L = (\eta_{L,t+1} + \eta_{L,t}) / 2$$

$$\overline{\eta}_K = (\eta_{K,t+1} + \eta_{K,t}) / 2$$

$$\eta_{K,t} = \frac{\partial \ln Y_{it}}{\partial \ln K_{it}} = \widehat{\alpha}_K + 2\widehat{\alpha}_{KK} \ln K_{it} + \widehat{\alpha}_{LK} \ln L_{it} + \widehat{\alpha}_{Kt}t$$

$$\eta_{L,t} = \frac{\partial \ln Y_{it}}{\partial \ln L_{it}} = \widehat{\alpha}_K + 2\widehat{\alpha}_{LL} \ln L_{it} + \widehat{\alpha}_{LK} \ln K_{it} + \widehat{\alpha}_{Lt}t$$

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[7] The estimation results for each industry are not reported in the paper for space considerations but are available on request.

In addition, all firms within each industry were ranged according to their TFP levels to divide companies into three efficiency level groups (leaders, the baseline group and laggards, see section 5.1 for details).

4.2.2. Exits and government procurement contracts

The second part of the paper uses the survival analysis to look at whether a firm's exit from the market depends on its efficiency level. Thus, under the survival analysis framework, I estimate the effects of belonging to a certain efficiency group on the conditional probability of exit at age t after having survived until that age (the hazard rate at age t). The survival rate at age t is defined as the probability of surviving until age t. In this study, the age of a firm is measured in years and calculated as the year of observation minus the year of a firm's incorporation.

Firm survival may depend on unobservable characteristics of a firm or the markets in which it operates. For example, I have no information about a firm's political ties which can affect both survival and obtaining of public procurement contracts. Also, information about shareholders is not fully disclosed if they are individuals. In addition, while I control for competition on the industry level and an individual company's share in regional employment I lack details of labour market specifics and competition at the local level, which can also affect firm survival.

To account for the effect of unobservable firm characteristics in the survival analysis, this study uses a survival model with unobservable heterogeneity, or frailty (see Vaupel et al., 1979; Hougaard, 1986; and Gutierrez, 2002, for application in Stata). Although I include a set of control variables in the regression, it is natural to assume that not all covariates influencing the exit solution of a firm are included in the model and a set of unobserved factors may affect the distribution of survival outcomes. Of course, in my setup it is hardly possible to include all risk factors in the analysis. At the same time, the frailty models give a tool to account, to a certain extent, for unobserved heterogeneity through the introduction of random effects into the model. See Balan and Putter (2020) for a recent overview of frailty models and, also, Duchateau and Janssen (2007) and Wienke (2010) for detailed analysis of survival models with frailty and their use for accounting for unobserved heterogeneity or omitted variables.

The treatment of unobserved heterogeneity requires a certain assumption about the underlying unobserved distributions. There exist non-parametric approaches, but in my case, I had to use parametric model specifications, since with semi-parametric approaches I run into a software limitation due to the number of observations that I work with.

I use a specification with multiplicative frailty. At the firm level, individual frailty is introduced as an unobservable random effect, θ, and in this case the hazard at time t for a firm is

$$\gamma(t, x, \theta) = \theta \gamma_0(t) e^{x'\beta} \tag{4}$$

where $\gamma_0(t)$ is a baseline hazard, x is the vector of explanatory variables, and β is estimated coefficients. The model in this specification can be estimated if the assumptions on the parametric form of baseline hazard and the distribution of random effects are made. Here I use the Weibull survival distribution and gamma distribution for frailty.

The baseline model estimates the effect of a firm's efficiency level on the hazard ratios. For the base specification, I also present estimations based on the proportional hazard model with Weibull survival distribution without unobserved heterogeneity and on the Cox proportional hazard model (Cox, 1972). Cox proportional hazard model is a semi-parametric approach under which the parametric form of the base hazard function is left unspecified. This is done to show that the results of the parametric estimation of proportional hazard model do not differ significantly from the semi-parametric (i.e., more flexible) model. And the difference in the results comes from accounting for unobserved heterogeneity in the analysis. The direction of change is in line with theoretical predictions.

Then I analyse how access to additional financing from government procurement contracts affects hazard ratios. To test this hypothesis, a dummy for obtaining a government contract and a cross-term of this variable with a firm's efficiency level are added to the regression.

Involvement in public procurement may have a prolonged effect, i.e., winning a government contract helps a firm survive for several years following this event or for the entire period of observation. In analysing such effects, the dummy for a government contract is defined in the following way. It equals 1 if a firm obtained a government procurement contract at least once in the 2011–2015 period and 0 otherwise. The failure event is an exit by the end of the period (i.e., 2016). In this case, the estimations of the firm's efficiency level for the last observable year are used.

In this study, I conduct the survival analysis to investigate the long-term effects of public procurement on firms exiting the market, i. e., exit at the end of the period under study rather than in the year following the year of receipt of the government contract is considered. In this setup, the covariates are supposed to be fixed over time. Therefore, data on the efficiency group for the last observed period for a given enterprise is included in the survival regressions. The distribution by the TFP level is quite stable and the efficiency groups in my study are defined broadly enough (see section 5.1), hence there are no frequent transitions from one group to another. About 87% of firms in my sample remain in their original efficiency group. In order to test the results for robustness with respect to changes in position in the efficiency group, a breakdown into efficiency groups based on estimates of the distance to the stochastic production possibility frontier is included in section 6. Under this approach, performance groups are exceptionally stable, with about 98% of enterprises remaining in their original performance group during the period under study. The main results persist under stochastic frontier approach to defining efficiency groups.

In addition, several specifications with a breakdown of contracts by federal law and by region where the contract was awarded, are examined.

In all the estimations, I control for the sector in which a firm operates and the size of a firm by including sector and size dummies.

Additional controls include the level of competition in the industry measured as Herfindahl-Hirschman index for 2-digit industries; the level of economic development of a region measured as real gross regional product per capita and the share of a firm in the local labour market. The last parameter is proxied by the dummy variable identifying if a firm is below or above the 90th percentile of a distribution of the shares of a firm in the region's employment headcount. The summary statistics on the combined dataset are presented in Table 4.

5. Results

5.1. Productivity trends based on micro level estimations

The distribution of firm level TFP growth rates obtained from production function estimations shows a large variation. At the same time, the average TFP growth rates remained negative over the entire period of observation. After the GFC, a productivity decline was significant at about 20–15% in the 2009–2010 period. In 2011, the decrease stood at 8.6%. In 2012 and 2013, the TFP decline was slower at around 3.5%. But in the following years, the decline deepened, reaching −15% by 2015.

Thus, after the 2008 crisis and up to 2014, productivity growth trends for Russia are similar to the results obtained for other countries (see Andrews et al. (2016) and Berlingieri et al. (2017) for OECD countries, Decker et al. (2017) for the US, Gamberoni et al. (2016) for EU countries). The Russian specific is that the average productivity growth rates are lower (staying in negative territory over the entire period of observation) than in developed countries, where very low but positive productivity growth rates are posted. It could reflect the fact that the gap between more and less efficient firms is larger in the Russian economy and the slowdown due to the negative impact of laggards is more significant. Also, Russia's negative trends have been amplified by the challenging geopolitical situation since 2014.

Using the estimations of the TFP levels for each firm, the sample was divided into three categories to compare productivity trends in three different efficiency groups:

- Leaders. The top 10% of firms with the highest TFP levels within the industry.
- The baseline group. Firms with TFP levels ranging from 20% to 90% of distribution within the industry.
- Laggards. The bottom 20% of firms with the lowest TFP levels in the industry.

Table 4
Definition of variables and summary statistics.

Variable	Description		percentage of firms
Efficiency groups	Efficiency level groups based on the author's estimation of TFP levels. Efficiency groups were defined within each industry for which production functions were estimated separately for each year.	Leaders (top 10%)	10.7
		Baseline group (middle 20–90%)	67.3
		Laggards (bottom 20%)	22.0
Size dummies	Based on employment size groups in SPARK database: less than 100 employees - small firms, 101–250 employees - medium firms, more than 250 employees - large firms	Small	94.4
		Medium	3.5
		Large	2.1
Sector dummies	Sectors according NACE Rev. 1.1		
	Section C. Mining and quarrying	Sector C	1.0
	Section D. Manufacturing	Sector D	18.7
	Section E. Electricity, gas and water supply	Sector E	1.9
	Section G. Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods	Sector G	48.4
	Section H. Hotels and restaurants	Sector H	4.5
	Section I. Transport, storage and communications	Sector I	7.2
	Section K. Real estate, renting and business activities	Sector K	16.3
	Section O. Other community, social and personal service activities (in subsections 92 "Recreational, cultural and sporting activities" and 93 "Other service activities")	Sector O	2.1
Dummy for share in regional employment headcount	0 if a firm's share in regional employment headcount is below the 90th percentile, 1 – above the 90th percentile of the distribution	Below the 90th percentile of the distribution	90.1
		Above the 90th percentile	9.9
			statistics
Herfindal-Hirshman Index (HHI)	Herfindal-Hirshman Iindex (HHI) at the level of 2-digit industry according NACE Rev. 1.1	Mean	0.014
		St.Dev.	0.013
		Min	0.003
		Max	0.105
Gross regional product per capita	Logarithm of real gross regional product per capita deflated by GDP deflator	Mean	12.7
		St.Dev.	0.6
		Min	11.1
		Max	14.0

Source: author's estimates.

These groups are defined within each industry for which the production functions were estimated. In the economic literature, industry leaders are typically defined as the top 5–10 percent of firms. Regarding lagging firms, there is no generally established approach to the definition of this group. Where lagging enterprises need to be defined, various studies include firms that belong to the bottom 20–50 percent of the distribution. I look at the bottom quintile of the distribution to show that even the most inefficient firms manage to stay in the market for a fairly long time.

The accumulated TFP growth rates for each efficiency group are presented in Fig. 1.

Trends presented in Fig. 1 reveal that the gap between leaders and laggards kept widening in 2009–2015. Comparison between trends based on simple averages and weighted by value added average TFP growth rates provides evidence that more efficient firms not only grow faster but also increase their market shares. At the same time, the market share of laggards is shrinking but they do not exit the market.

5.2. Efficiency and exit rates

In the next step, I analyse firm dynamics, comparing survival functions for different efficiency groups. The nonparametric Kaplan-Meier survival estimates are presented in Fig. 2. The unrestricted survival estimates for leaders are lower than those for the baseline group and laggards.

Table 5 presents the results of the survival analysis for three models: the semi-parametric Cox proportional hazard model, the proportional hazard model without unobserved heterogeneity, and hazard model with multiplicative frailty.

The results show that the coefficient estimates which do not account for unobserved heterogeneity are biased towards zero, which is in line with theoretical predictions. In accounting for unobserved heterogeneity, the values of the coefficients for the variables of interest increase, and some of them become significant. The model with frailty shows that laggards are less likely to exit markets than firms in the baseline group. In models without unobserved heterogeneity, this coefficient is statistically insignificant. Estimates of coefficients in all models indicate that the probability of exit from the market of leaders is higher than that of firms from the base group.

In the Russian economy, the creative destruction mechanism seems to work in the way opposite to what is conventionally expected. The relationship between a firm's efficiency level and the conditional probability of its exit is counterintuitive. The most efficient companies quit markets at a faster pace than average companies in the economy. At the same time, the conditional probability of the exit of laggards is comparable with the exit rates of firms from the baseline group and is significantly lower than that of the leader. Similar results are found in OECD and World Bank reports on the Russian economy. Wildnerova and Blöchliger (2019) show that the longest survivors normally have a very low productivity towards the time of exit, suggesting that many old unproductive firms outstay their welcome in the market. Cusolito et al. (2020) find that poorly managed firms stay in the market longer compared with other economies, both developed and developing. It indicates that market selection mechanism does not lead to the reallocation of resources to more efficient players.

There may be different interpretations of higher exit rates for leaders. Leaders may operate in markets with a stronger competitive pressure and more intense firm dynamics. A fast growing but not big enough leader could attract attention of large companies or firms affiliated with regional authorities and go through a friendly or hostile acquisition, which means that it does not exit the market but changes the tax identification code and is not any longer seen as a separate entity in the sample.

In addition, markets are highly fragmented in the Russian Federation. For example, Cusolito et al. (2020) show that 69% of firms regarded their own localities rather than country-wide or international markets in 2019 as their main sales targets. In the case of limited demand, the system of public procurement could serve as a demand-boosting instrument for efficient companies in less developed regions and also help them enter markets in other regions by applying for contracts in non-home regions. For example, Ferraz et al. (2015) find such an impact for the Brazilian companies.

To analyse the effect of economic development of the region on the exit rate of firms in different efficiency groups, I include the cross-term of real GRP per capita and the efficiency group dummies (the regression results are presented in Appendix A). The estimated survival functions for regions with low, mean, and high levels of GRP per capita are presented in Fig. 3.

The estimates support Hypothesis 2, but not to the full extent. Indeed, inefficient firms do remain in the market longer than other firms, and this gap is greater in less developed regions. However, exits from the market of efficient companies show a greater difference in regions with different levels of development. In low-developed regions, the conditional probability of exit for leaders is lower than for the other efficiency groups. The same picture can be seen in the regions with the mean level of GRP per capita, though the gap between leaders and the other efficiency groups seems to be smaller. Only regions with a very high level of economic development show "normal" trends: the laggards exit the market more often than firms from the baseline group, with the leaders staying in the market longer than other firms. However, differences in estimated survival functions are not considerable in the last case.

A higher monopolisation level of an industry leads to a lower conditional probability of exit, therefore, stronger competition stimulates the process of creative destruction. At the same time, if a company's share in the regional employment headcount belongs to the top 10% of the distribution, then the probability of this firm's exit declines significantly (see the relevant coefficients and hazard ratios in Table 5 and Appendix A).

5.3. Exits and involvement in public procurement

In this section, I analyse in more detail how involvement in the public procurement system helps firms from different efficiency groups survive in the market. The previous section came up with an unexpected finding that the most efficient companies exit the market at a faster rate. Also, I have found that laggards and companies that are large by regional standards stay in the market longer.
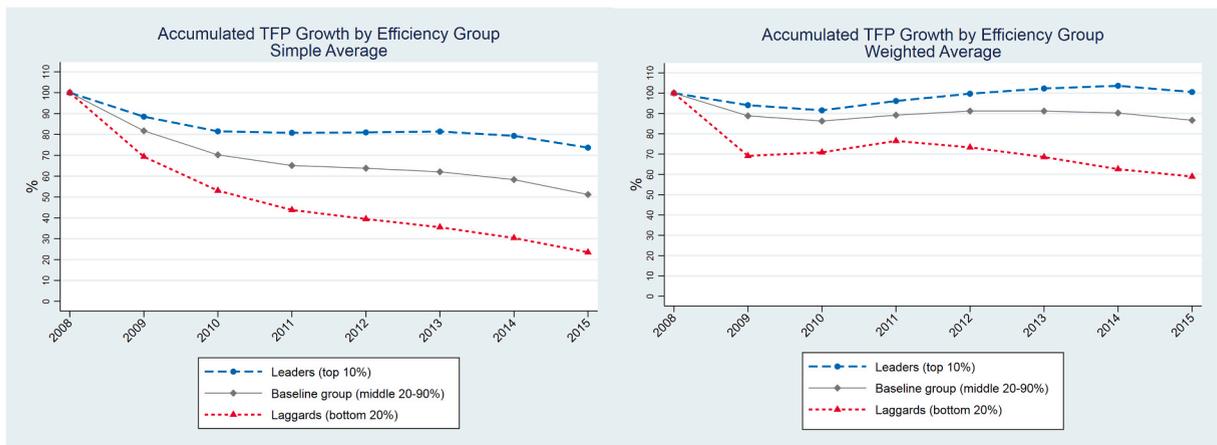
Fig. 1. Accumulated TFP growth by efficiency group. Source: author's estimates based on production functions estimations. Source: *author's estimates*.
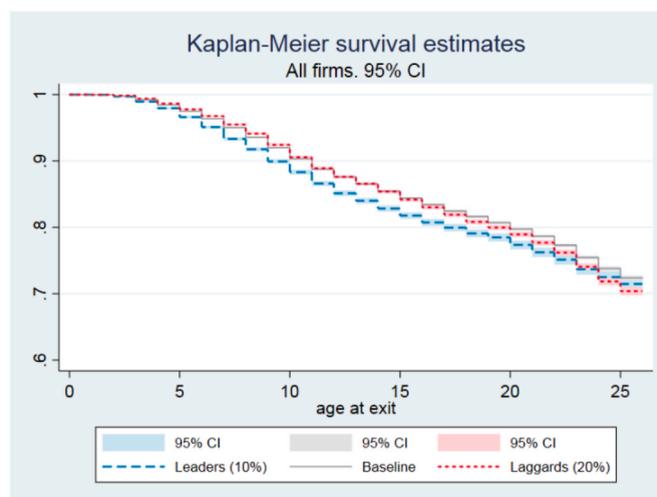

Fig. 2. Survival functions by efficiency group. Kaplan-Meier survival estimates with 95% confidence intervals. Source: *author's estimates*.

These findings could signal that large (in terms of employment) but inefficient firms have better access to financing through various government contracts than more efficient companies which are smaller in size.

In Russia, the public procurement system accounts for a significant part of GDP, with a large number of firms involved in it. In my sample, 36.9% percent of firms were involved in public procurement in 2011–2015 (see Table 6). On the one hand, the public procurement contract could help firms with growth potential overcome the boundaries of local markets. The non-transparence of the public procurement system and its lack of competitiveness, may, however, result in an inefficient allocation of resources. Instead of supporting more productive firms, involvement in government purchases could protect non-efficient market players from competition, providing them with additional financing. The effectiveness of this public procurement system may be questionable if it affects firm dynamics through changing the market mechanism of selection of more productive firms. Indeed, the share of the most efficient companies with government contracts is not significantly higher than that in the baseline group of firms (40.3% and 38.7% respectively). Laggards received public procurement contracts less often than other companies, still one third of them were awarded by government contracts in 2012–2015. It is less than in the more efficient groups, but this suggests that a very large part of enterprises from the lowest part of the efficiency distribution participate in public procurement.

Here I move on to the analysis of how involvement in the government procurement system affects the survival functions of firms with different efficiency levels. In this section, the conditional probability of exit at a certain age is explained by both the level of efficiency and winning government contracts. The non-parametric estimations of hazard ratios show that the probability of exit is lower for firms with government purchasing contracts in all efficiency groups (see Fig. 4). It can also be seen that for laggards the gap in hazard ratios between firms with and without government contracts increases with the age at exit. Inefficient firms without government contracts exit the market more often than firms from the baseline group, but differences in hazard ratios between different

Table 5

Exits by efficiency group.

Dependent variable: firm age at exit	Cox proportional hazard model		Proportional hazard model with Weibull survival distribution		Model with Weibull survival distribution and frailty	
	Coef.	Hazard ratios	Coef.	Hazard ratios	Coef.	Hazard ratios
Efficiency level[i], Leaders - top 10%	0.171***	1.187***	0.202***	1.224***	0.427***	1.533***
	(0.018)	(0.021)	(0.018)	(0.022)	(0.035)	(0.053)
Efficiency level, Laggards - bottom 20%	0.000	1.000	−0.011	0.989	−0.079***	0.924***
	(0.013)	(0.013)	(0.013)	(0.013)	(0.026)	(0.024)
Firm size[ii], Medium	0.030	1.030	−0.022	0.978	0.052	1.053
	(0.034)	(0.035)	(0.034)	(0.033)	(0.065)	(0.068)
Firm size, Large	−0.206***	0.814***	−0.264***	0.768***	−0.530***	0.588***
	(0.054)	(0.044)	(0.054)	(0.042)	(0.094)	(0.055)
Sector dummies	yes	yes	yes	yes	yes	yes
HHI	−1.910***	0.148***	−1.747***	0.174***	−6.244***	0.002***
	(0.622)	(0.092)	(0.621)	(0.108)	(1.181)	(0.002)
Real GRP per capita	0.005	1.005	0.018*	1.018*	−0.001	0.999
	(0.009)	(0.009)	(0.009)	(0.010)	(0.018)	(0.018)
Dummy for the employment share in a region	−0.651***	0.521***	−0.704***	0.495***	−1.316***	0.268***
	(0.022)	(0.012)	(0.022)	(0.011)	(0.041)	(0.011)
p (Weibull distribution parameter)					3.172	
					(0.332)	
θ (Gamma distribution parameter)					13.008	
					(0.292)	
LR test for H$_0$ $\theta = 0$					4570.95	
					(0.000)	
Number of observations	297,759	297,759	297,759	297,759	297,759	297,759

Notes: Standard errors are in parentheses.

[i]Omitted category: Baseline group (efficiency level 20–90%). [ii]Omitted category: Small firms.

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

For the model with frailty hazard ratios are for t = 0. The degree of decay depends on θ.
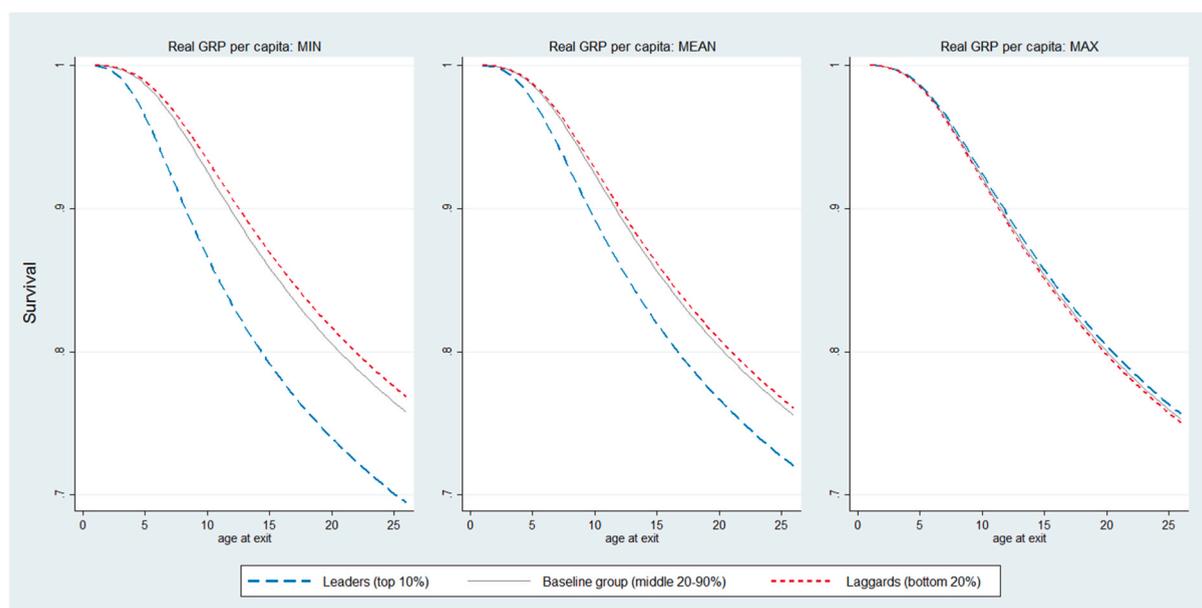

Fig. 3. Survival functions for the model with frailty by GRP per capita levels. Source: *author's estimates*.

efficiency groups diminish for firms with government contracts. Fig. 4 also show that if leaders are not involved in the government procurement system, hazard ratios for them are higher than in the baseline group.

The results of the estimates of the model with unobserved heterogeneity are presented in Table 7. As expected, winning a government contract reduces the exit hazards by 68.1 percentage points. The coefficient of the cross-term for the leaders dummy and the government contract dummy is negative and significant. Thus, involvement in the government procurement system helps leaders stay

Table 6
Involvement in public procurement by firms' efficiency group.

	Government contract	
	No	Yes
All firms	63.1	36.9
Leaders (top 10%)	59.7	40.3
Baseline group (middle 20–90%)	61.3	38.7
Laggards (bottom 20%)	68.5	31.5

Source: author's estimates based on the SPARK Marketing dataset and RUSLANA dataset.
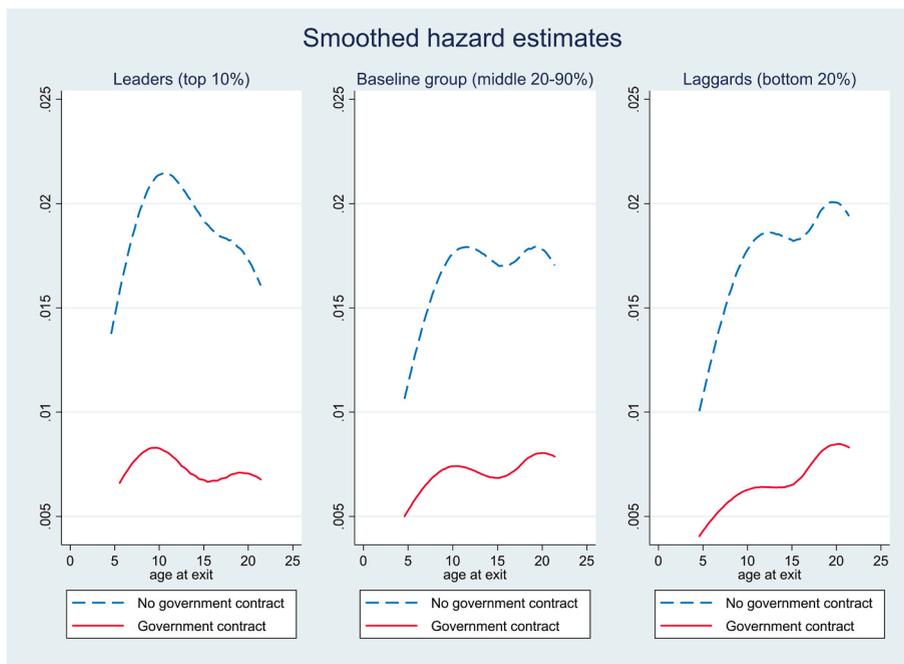

Fig. 4. Smoothed hazard estimates by efficiency group. Source: *author's estimates.*

in the market longer, reducing exit hazards for this group to the level of the other efficiency groups. For laggards, winning a government contract also reduces the conditional probability of exit. The exit ratios are already lower for the least efficient enterprises in comparison with the other efficiency groups, and winning a government purchasing contract further reduces the conditional probability of exit for laggards and results in the highest survival rates among all efficiency groups.

These results are illustrated in Fig. 5, showing the survival functions by efficiency group for the model with unobserved heterogeneity. The survival functions for laggards and the baseline group are similar, and leaders quit the market at a faster pace than firms from the other efficiency groups. If firms which win a government contract at least once during the period under study are considered, then the least efficient firms stay in the market longer than companies from the baseline group. One could conclude from these trends that survival rates for the leaders in the long run remain lower than for the other efficiency groups even if they manage to obtain government contracts. Also, involvement in public procurement has a stronger effect on the least efficient firms, helping them survive longer. The regression estimates show that the effect of obtaining a state contract is somewhat lower for the laggards than for the leaders, but as a result, the survival rates of inefficient firms obtaining public procurement contracts is higher than in other groups, since inefficient firms, even those without government contracts, show the highest survival rates in the market.

Thus, the public procurement system does not help the leaders fully overcome the limitations of local markets by increasing

Table 7

Exits and involvement in public procurement. The model with Weibull survival distribution and frailty.

Dependent variable: firm age at exit	Coef.	Hazard ratios
Efficiency level[i], Leaders - top 10%	0.457***	1.579***
	(0.038)	(0.060)
Efficiency level, Laggards - bottom 20%	−0.115***	0.891***
	(0.027)	(0.024)
Government contract dummy	−1.143***	0.319***
	(0.026)	(0.008)
Leaders X Government contract	−0.214***	0.808***
	(0.067)	(0.054)
Laggards X Government contract	−0.102*	0.903*
	(0.054)	(0.049)
Firm size[ii], Medium	0.215***	1.239***
	(0.058)	(0.072)
Firm size, Large	−0.232***	0.793***
	(0.084)	(0.067)
HHI	−4.733***	0.009***
	(1.061)	(0.009)
Real GRP per capita	0.003	1.003
	(0.016)	(0.016)
Dummy for share in regional employment headcount	−1.086***	0.338***
	(0.037)	(0.013)
Sector dummies	yes	yes
p (Weibull distribution parameter)	2.881	
	(0.028)	
θ (Gamma distribution parameter)	9.563	
	(0.235)	
LR test for H_0 $\theta = 0$	3766.51	
Probability	(0.000)	
Observations	297,759	297,759

Notes: Standard errors are in parentheses.

[i]Omitted category: Baseline group (efficiency level 20–90%). [ii]Omitted category: Small firms.

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

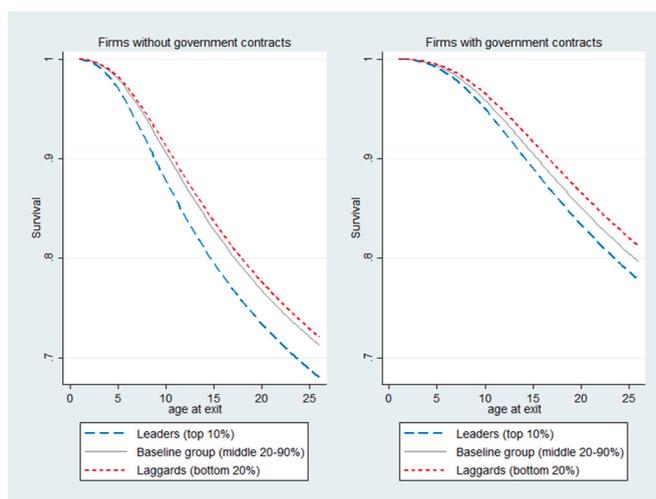For the model with frailty hazard ratios are for t = 0. The degree of decay depends on θ.

Fig. 5. Survival functions for the model with frailty by efficiency group. Source: *author's estimates*.

demand for their products. Therefore, the standard approach of using procurement contracts for supporting firms in certain industries or less developed regions through boosting demand does not appear to be effective, since financial support is not provided to firms with growth potential. Also, in Russia, the public procurement system does not seem to be competitive, which results in an inefficient reallocation of resources towards less productive players.

To analyse a possible distortion arising from the inefficient allocation of resources through the public procurement system, I consider differences in awarding government contracts within different regions and under different federal laws.[8]

Since the legislation does not provide for any restrictions on the participation of enterprises in public procurement, depending on their place of registration, I consider the following cases. Firms could be awarded contracts only in their home regions, only outside their home region or in both their home and non-home regions. I estimate the model with unobserved heterogeneity including interaction of dummies for efficiency groups and regions where contracts are awarded (see Table 8). A reduction in the conditional probabilities of exit is larger if a firm is awarded contracts in both its home and non-home regions. Winning a contract only in a company's home region has the lowest effect on the probability of exit in the long run. For leaders, exit hazards are significant only if contracts are awarded both in home and non-home regions. At the same time, for laggards, receiving contracts only in their home regions or in both home and non-home regions reduces the probability of exit.

The Russian economy is characterized by a strong fragmentation of local markets (Cusolito et al., 2020). If an enterprise manages to go beyond the boundaries of the regional market and operate in several markets, at least in the public procurement system, this can have an additional positive effect on its survival.

The estimated survival functions (see Fig. 6) show that the positive effect of being awarded a procurement contract for low productive firms is observed if such a company gets a contract in its home or both home and non-home regions. In the non-home region, the survival patterns for different efficiency groups are similar to those observed for firms without public procurement contracts, i.e., in non-home regions, the effect of obtaining a government contract for laggards is not as pronounced as in the case when at least one contract was received in the home region. These tendencies can be explicable if the public procurement system suffers from cronyism and politically connected companies have better access to financing through government contracts in their home regions or if local or regional authorities are trying to support local enterprises through the public procurement system, pursuing other goals (for example, supporting employment) than just reducing procurement costs. In this case, funds are not necessarily directed to the most efficient market players.

I also compare exit hazards for firms from different efficiency groups in relation to federal laws under which government contracts were awarded. The estimated survival functions are presented in Fig. 7.[9]

Winning a contract under Federal Law No. 94 (in 2011–2013) or Federal Law No. 44 (in 2014–2015) only slightly decreases the conditional probabilities of exits. At the same time, being awarded government contracts only under Federal Law No. 223 or more than one federal law within the period under analysis dramatically reduces exit hazards in all efficiency groups. Meanwhile, regardless of which law governs awarding contracts, survival functions for laggards with government contracts appear to be higher than for other efficiency groups. Also, the leaders' survival rates improve, especially if they are awarded public procurement contracts under Federal Law No. 223, but they never reach the levels of other efficiency groups. Thus, the probability of inefficient companies' survival appears to be higher than for the other groups regardless of which law the contract was awarded under. These trends can stem from both the desire of customers making purchases under Federal Law No. 223 to maintain long-term relationships with suppliers, and from the presence of cronyism or even corruption in public procurement carried out under all laws when contracts are awarded to enterprises which have connections with the customer. However, I do not have enough information in the public procurement dataset to separate these two effects. But the impact on firm dynamics will remain the same: firms from the low end of the efficiency distribution stay in the market longer.

In all specifications, the positive effect on a company's survival holds good if a firm's share in the regional labour market is high enough. To investigate this effect in more detail, the specification with the interaction of three variables – a government contract dummy, a dummy for the share in the region's employment, and gross regional product per capita – was estimated.[10] The graphical presentation of the regression results is provided in Fig. 8. In less developed regions, the positive effect of receiving government contract is observed only for very large (by regional standards) companies. It could reflect the fact that local authorities in under-developed regions are more often inclined to support large companies in order to avoid social problems related to unemployment. At the same time, government contracts received by efficient but smaller firms do not help them survive substantially longer or at least reach the survival rate of the less efficient companies. These contracts are probably not large enough to compensate for low demand in poor regions and do not provide additional opportunities for finding new customers. Thus, in the less developed regions, the public procurement system does not help improve resource allocation for the benefit of more efficient market players, with the least efficient

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[8] The investigation of the effects of different procedures of awarding a contract on firm dynamics could also be a promising direction of research, especially with regard to the competitiveness of different procedures. At the same time, it is extremely difficult to define which procedures are more competitive based on the kind of a heterogeneous dataset I worked with. Anecdotal evidence suggests that the procedures which are formally supposed to ensure competitiveness do not in fact appear to be competitive. For example, a supplier could be predetermined even at an electronic auction. However, I have tried to carry out an estimation for different procedures (sole supplier vs electronic auctions). The results are the same for various procedures: survival rates for inefficient companies are higher than in other efficiency groups. As the results do not differ for competitive and non-competitive procedures, they are not included in the paper, but are available on request.

[9] The relevant regression results for the model with unobserved heterogeneity are reported in Appendix B.

[10] The estimation results are not reported because they are difficult to interpret without graphical representation but are available on request.

Table 8

Exits and involvement in public procurement by region of receiving contract. The model with Weibull survival distribution and frailty.

Dependent variable: firm age at exit	Coef.	Hazard ratios
Efficiency level[i], Leaders - top 10%	0.454***	1.575***
	(0.038)	(0.060)
Efficiency level, Laggards - bottom 20%	−0.112***	0.894***
	(0.027)	(0.024)
Region of government contract[ii]		
Contracts in home region	−0.801***	0.449***
	(0.033)	(0.015)
Contracts in non-home region	−1.030***	0.357***
	(0.058)	(0.021)
Contracts in both home and non-home regions	−1.702***	0.182***
	(0.040)	(0.007)
Leaders X Contract in home region	−0.096	0.909
	(0.093)	(0.084)
Leaders X Contract in non-home region	−0.104	0.901
	(0.142)	(0.128)
Leaders X Contract in both home and non-home region	−0.211**	0.809**
	(0.096)	(0.078)
Laggards X Contract in home region	−0.219***	0.804***
	(0.067)	(0.054)
Laggards X Contract in non-home region	0.098	1.103
	(0.131)	(0.144)
Laggards X Contract in both home and non-home region	−0.189**	0.828**
	(0.093)	(0.077)
Firm size[iii], Medium	0.266***	1.304***
	(0.058)	(0.075)
Firm size, Large	−0.114	0.892
	(0.085)	(0.075)
HHI	−4.340***	0.013***
	(1.062)	(0.014)
Real GRP per capita	0.022	1.022
	(0.016)	(0.017)
Dummy for share in regional employment headcount	−1.066***	0.344***
	(0.037)	(0.013)
Sector dummies	yes	yes
p (Weibull distribution parameter)	2.885	
	(0.028)	
θ (Gamma distribution parameter)	9.506	
	(0.230)	
LR test for H_0 $\theta = 0$	3809.91	
Probability	(0.000)	
Observations	297,759	297,759

Notes: Standard errors are in parentheses.
[i]Omitted category: Baseline group (efficiency level between 20 and 90%). [ii]Omitted category: No contract. [iii]Omitted category: Small firms.***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.
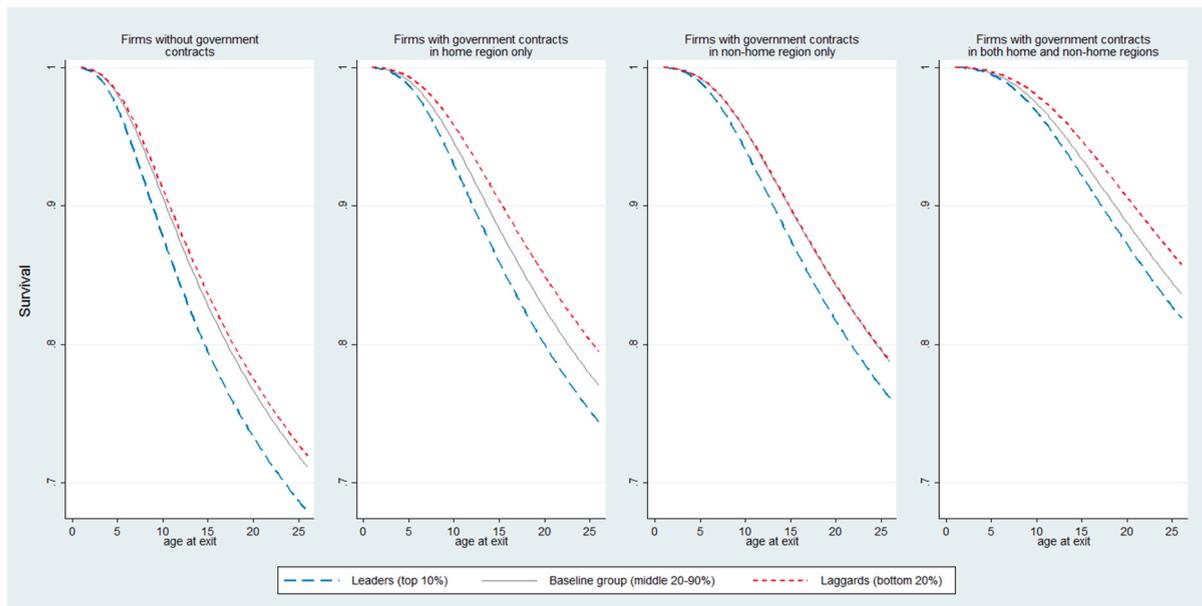For the model with frailty hazard ratios are for t = 0. The degree of decay depends on θ.

Fig. 6. Survival functions for the model with frailty regression by region. Source: *author's estimates*.
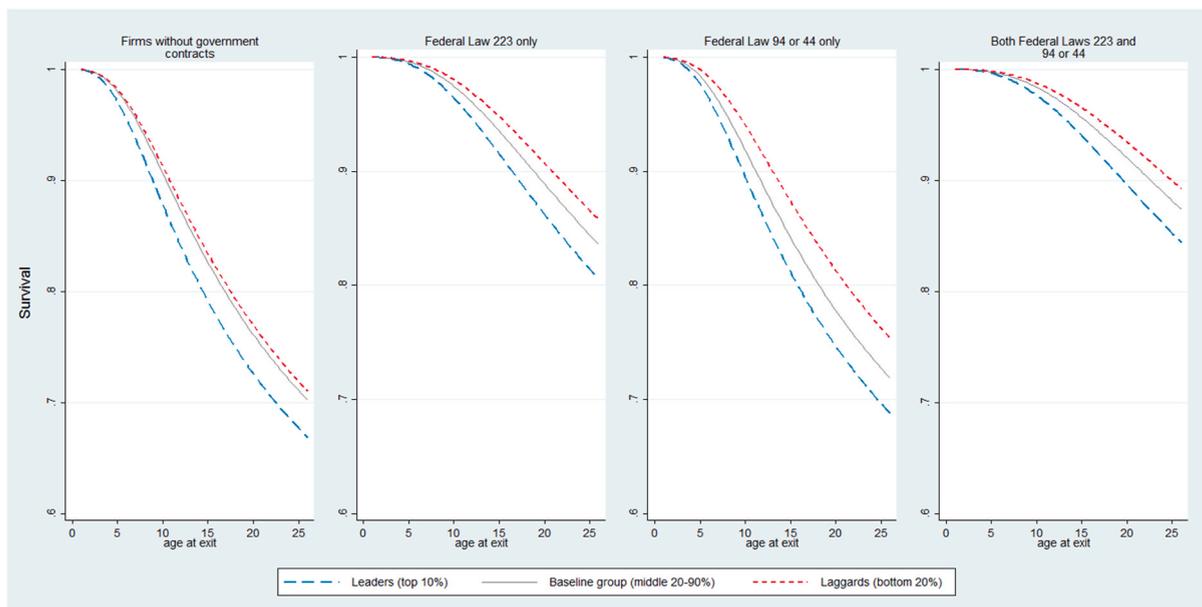

Fig. 7. Survival functions for the model with frailty by federal law. Source: *author's estimates*.
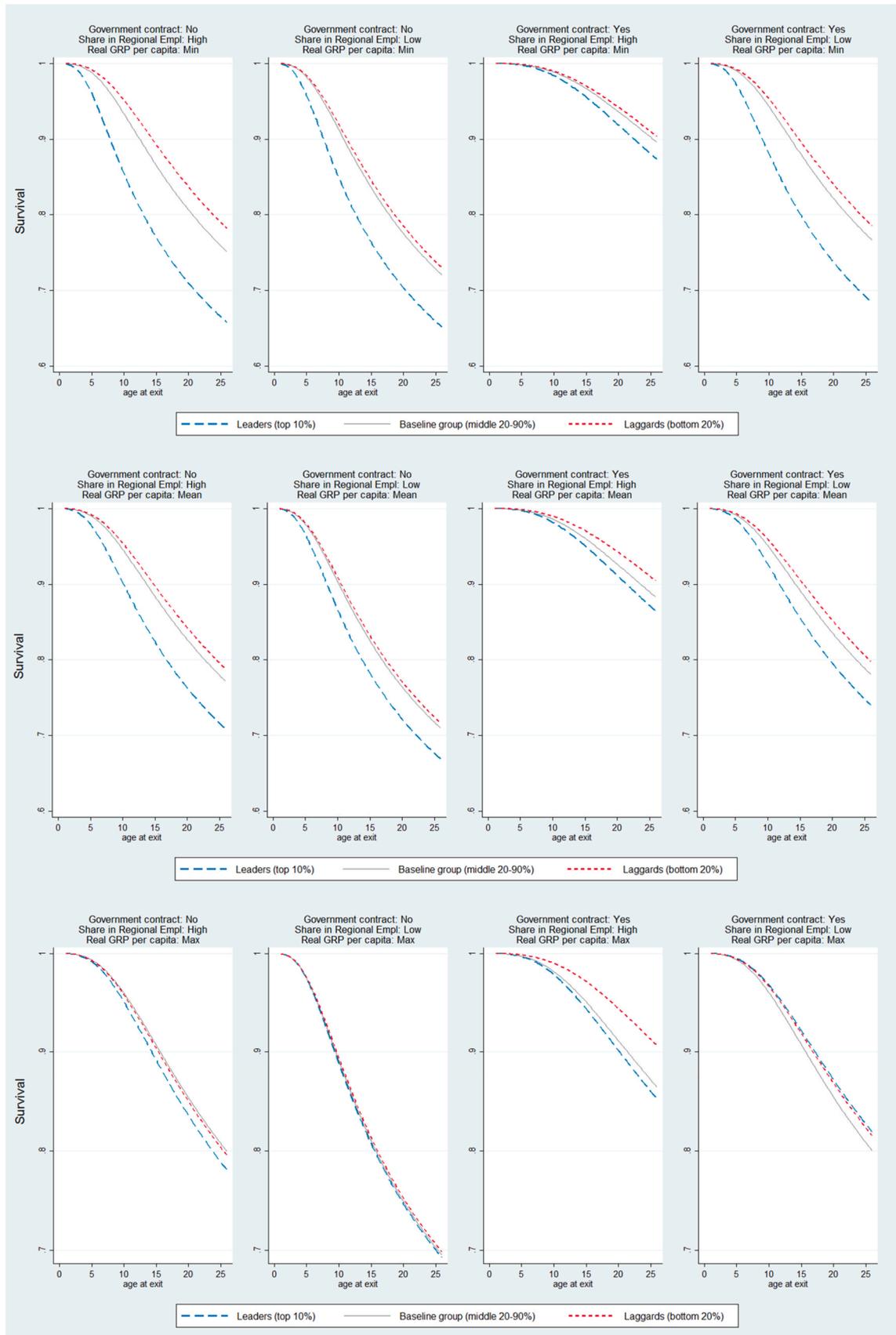
(caption on next page)

Fig. 8. Survival functions for the model with frailty by the level of regional development and share of a firms on the regional labour market. Source: *author's estimates.*

companies benefitting more from winning a government contract in terms of survival in the market than other types of firms.

In the most developed regions, winning a government contract significantly improves the survival rates of firms from all efficiency groups. Leaders with government contracts manage to stay in the market longer than firms in the baseline group even if they are small in size. In the most developed regions, a gap between the survival rates of leaders is not as wide as between firms from other efficiency groups. Among small enterprises, there are almost no differences in survival rates of companies from all groups of firms. At the same time, the least efficient companies which succeed in winning a government contract show lower exit rates than firms from the baseline group, just as was the case in less developed regions. Thus, the higher level of a region's economic development improves the efficiency of the creative destruction mechanism. However even in the best developed regions the system of public procurement seems to support less efficient companies, especially large ones, thus deteriorating market selection forces.

Support for inefficient enterprises may not necessarily be linked to local corruption. For example, in their study, Tkachenko and Esaulov (2020) showed that the propensity of governors to corruption in public procurement may depend on their assessment of the likelihood of being removed from office in the next election. Those governors who expect to stay for another term are less inclined to extract rent in public procurement and are more concerned with the development of the region. Even if cronyism plays a limited role in some regions and local governments have a noble purpose of supporting employment in the region by financing large but not the most efficient companies, such a policy would have a negative effect by undermining the creative destruction process and eventually a strong negative impact on economic growth, since new and potentially efficient players would then have no incentives to enter the markets occupied by large inefficient companies relying on government support.

Comparison of the regression results from all specifications suggests that exit hazards are higher for the most efficient firms than for companies from the other efficiency groups. This effect is the most pronounced in less developed regions. This study also shows that the conditional probability of exits for inefficient firms often lower than for those from the baseline group almost in all regions with the exception of the most economically developed ones.

If the high rates of exits of leaders are due to the limitations of local markets, one would expect that local governments can support leaders through the system of public procurement to help them extend the market boundaries. In reality, the opposite trends are observed. The comparison of exit hazards among firms with a government contract shows that inefficient firms with government contracts stay in the market longer than companies from the other efficiency groups. It implies that the system of public procurement is not transparent, helping firms with political connections drive more efficient companies out of the public procurement system.

The shift of gains from the public procurement system towards low productive firms leads to the distorted allocation of resources in the economy and in the long run undermines economic growth by allowing inefficient companies to stay in the market significantly longer than it could be in a more competitive environment.

6. Robustness check

In this section, I consider an alternative definition of efficiency groups for the robustness check of the rather unexpected result that leaders exit the market at a faster rate. I implement the stochastic frontier analysis for a range the firms according to their distance to the stochastic frontier.

I use the stochastic frontier approach (SFA) to evaluate the efficiency level for each firm. The deterministic part of the production function is modelled as a translog function of three parameters – labour (L), capital (K), and time (t). The inefficiency term is modelled as a function of firm-specific variables and time following Battese and Coelli (1995).[11] Using the estimated parameters of the stochastic frontier, technical efficiency (defined as the distance to the industry-specific frontier) is computed for each firm. Based on the estimated technical efficiency parameters, the leaders, baseline groups, and laggards are defined in the same way as in the main part of the study: the leaders account for 10% of the most efficient firms; the laggards represent 20% of the least efficient companies.

Under this approach, the group of leaders which define the stochastic frontier is determined taking into account a firm's position over the entire period of observation, which makes this group quite stable. Firms enter this group but rather rarely exit it. This contrasts with the method I use in the previous sections, under which entries in and exits from this group occur more often and firms which have only temporary efficiency gains can be assigned to the group of leaders.

I re-estimate the survival regression for the specification with the cross-term of efficiency group dummies and a dummy for winning a government contract using the efficiency groups based on the stochastic frontier approach and the exits rate measure which was used in the main part of the study. The estimated survival functions are presented in Fig. 9, and the regression results are reported in Appendix C. One could observe that the survival function for leaders is lower than for the other efficiency groups. The laggards do not exit the market faster than firms from the baseline group.

In this set of results, winning a government contract helps the most efficient companies stay in the market longer than a firm from the baseline group. However, the inefficient companies with a government contrast seem to exit less often than other companies.

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[11] Stochastic production functions are estimated separately for 282 industries, mainly for three- or four-digit industries under NACE 1.1 classification. The list of the industries is the same as in the main part of the study. The estimation results for each industry are not reported in the paper for space considerations but are available on request.
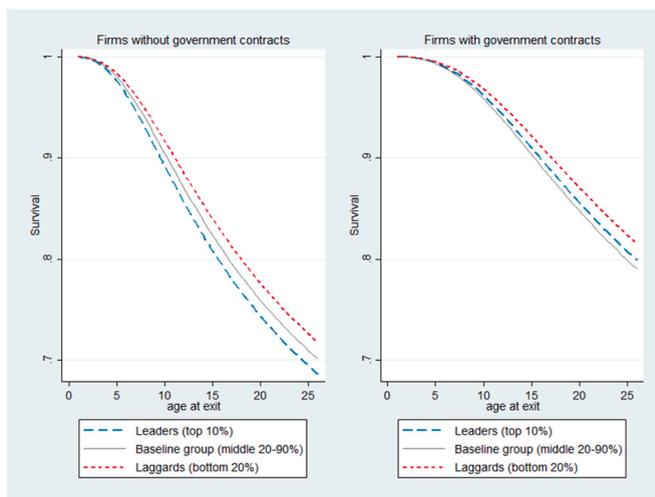
Fig. 9. Survival functions for the model with frailty. Alternative definition of efficiency groups based on stochastic functions estimations. Source: *author's estimates*.

Thus, the main findings that more efficient companies exit the market at a faster pace and low productive firms awarded government contracts stay there longer hold for the alternative definition of firms' efficiency groups.

7. Conclusion

The results obtained confirm that productivity growth trends in Russia are similar to those in other countries with technological growth among leaders and an increasing productivity gap between leaders and other companies. The analysis of TFP growth dynamics provides indirect evidence that a significant share of inefficient enterprises in the Russian economy do not exit the market, continuing to use production factors inefficiently.

The survival analysis shows that the most efficient firms quit the market at a faster pace than firms from the other efficiency groups in the Russian economy. At the same time, inefficient enterprises do not face higher exit hazards in all the specifications, and it often appears that survival functions of the least efficient firms do not differ significantly from those of the baseline group companies. This trend is the most pronounced in less developed regions where the leaders quit the market much more often than other firms.

In this situation, one would expect that providing additional financing through the public procurement system could help firms with growth potential stay in the market longer because it expands market boundaries, especially for firms operating in lagging regions. I show that in Russia involvement in the public procurement system indeed significantly reduces exit hazards in all efficiency groups. Also, more efficient companies seem to be more active in applying for procurement contracts.

However, I have found that winning a government contract does not result in better survival rates for leaders in comparison with laggards. This seems to suggest that the public procurement system does not support all types of firms with growth potential but only those affiliated with local authorities. It could reflect the fact that the system of public procurement contracts is non-transparent and dominated by the practices of awarding contracts to predetermined suppliers.

The non-transparency of the public procurement system eventually results in an inefficient resource allocation, undermining economic growth. This effect comes from the persistent support of non-efficient firms, which drives more efficient companies out of the market. Even if corruption plays a limited role in some regions and local governments seek to support employment in a region by financing large but not always the most efficient companies, the efficiency of such an economic policy is questionable if it affects firm dynamics through changing the market mechanism of selection of more productive firms.

Firms at the bottom of the efficiency distribution that show a decline in growth and market share stay in the market for a long time. However, these firms are quite likely to participate in public procurement (a third of such firms are awarded public procurement contracts). At the same time, the most productive firms, which are among the top 10 percent of efficiency distribution, are much more likely to fail to stay in the market than the low-performing firms, especially in underdeveloped regions. And even the leaders' receipt of contracts in the public procurement system does not improve negative trends in creative destruction process effectively enough. Thus, the public procurement system keeps up the negative trends that already exist in the economy, which can lead to a further increase in the productivity gap between firms in the same industry and, as a result, to a productivity growth slowdown at the aggregate level.

Declaration of competing interest

None.

Data availability

Data will be made available on request.

Appendix A

Table A
Exits by efficiency group and level of real GRP per capita. The model with Weibull survival distribution and frailty

Dependent variable: firm age at exit	Coef.	Hazard ratios
Efficiency level[i], Leaders - top 10%	304.769***	5.720***
	(218.412)	(0.717)
Efficiency level, Laggards - bottom 20%	0.345*	−1.064*
	(0.196)	(0.569)
Real GRP per capita	1.031	0.030
	(0.022)	(0.022)
Leaders X Real GRP per capita	0.662***	−0.413***
	(0.037)	(0.056)
Laggards X Real GRP per capita	1.082*	0.079*
	(0.049)	(0.045)
Firm size[ii], Medium	1.050	0.049
	(0.068)	(0.065)
Firm size, Large	0.590***	−0.528***
	(0.055)	(0.094)
Sector dummies	yes	yes
HHI	0.002***	−6.254***
	(0.002)	(1.181)
Dummy for share in regional employment headcount	0.266***	−1.324***
	(0.011)	(0.041)
p (Weibull distribution parameter)	3.173	
	(0.033)	
θ (Gamma distribution parameter)	13.003	
	(0.292)	
LR test for H_0 $\theta = 0$	4568.32	
Probability	(0.000)	
Observations	297,759	297,759

Notes: Standard errors are in parentheses.
[i]Omitted category: Baseline group (efficiency level between 20 and 90%). [ii]Omitted category: No contract.
[iii]Omitted category: Small firms. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.
For the model with frailty hazard ratios are for t = 0. The degree of decay depends on θ.

Appendix B

Table B
Exits and involvement in public procurement by federal law. The model with Weibull survival distribution and frailty

Dependent variable: firm age at exit	Coef.	Hazard ratios
Efficiency level[i], Leaders - top 10%	0.436***	1.547***
	(0.037)	(0.057)
Efficiency level, Laggards - bottom 20%	−0.101***	0.904***
	(0.026)	(0.024)
Federal Law[ii]		
Contracts under FS223 only	−1.669***	0.188***
	(0.051)	(0.010)
Contracts under FS94 or FS44 only	−0.209***	0.812***
	(0.032)	(0.026)
Contracts under both FS233 and FS94 or FS44	−2.185***	0.113***
	(0.043)	(0.005)

Table B (*continued*)

Dependent variable: firm age at exit	Coef.	Hazard ratios
Leaders X Contracts under FS223 only	−0.052	0.949
	(0.124)	(0.118)
Leaders X Contracts under FS94 or FS44 only	−0.047	0.955
	(0.094)	(0.089)
Leaders X Contracts under both FS233 and FS94 or FS44	−0.029	0.972
	(0.098)	(0.095)
Laggards X Contracts under FS223 only	−0.187	0.830
	(0.115)	(0.096)
Laggards X Contracts under FS94 or FS44 only	−0.332***	0.717***
	(0.066)	(0.047)
Laggards X Contracts under both FS233 and FS94 or FS44	−0.175*	0.840*
	(0.097)	(0.081)
Firm size[iii], Medium	0.373***	1.452***
	(0.056)	(0.082)
Firm size, Large	0.118	1.126
	(0.083)	(0.093)
HHI	−3.590***	0.028***
	(1.034)	(0.029)
Real GRP per capita	0.048***	1.049***
	(0.016)	(0.017)
Dummy for share in regional employment headcount	−0.994***	0.370***
	(0.036)	(0.013)
Sector dummies	yes	yes
p (Weibull distribution parameter)	2.804	
	(0.026)	
θ (Gamma distribution parameter)	8.462	
	(0.202)	
LR test for H_0 $\theta = 0$	3623.79	
Probability	(0.000)	
Observations	297,759	297,759

Notes: Standard errors are in parentheses.

For the model with frailty hazard ratios are for t = 0. The degree of decay depends on θ.

[i]Omitted category: Baseline group (efficiency level between 20 and 90%). [ii]Omitted category: No contract.

[iii]Omitted category: Small firms. ***p < 0.01, **p < 0.05, *p < 0.1.

Appendix C

Table C

Alternative definition of efficiency groups based on stochastic functions estimations. The model with Weibull survival distribution and frailty

Dependent variable: firm age at exit	Alternative definition of efficiency groups based on SFA	
	Coef.	Hazard ratios
Efficiency level[i], Leaders - top 10%	0.198***	1.219***
	(0.031)	(0.037)
Efficiency level, Laggards - bottom 20%	−0.213***	0.809***
	(0.025)	(0.020)
Government contract dummy	−1.137***	0.321***
	(0.025)	(0.008)
Leaders X Government contract	−0.308***	0.735***
	(0.052)	(0.038)
Laggards X Government contract	−0.106**	0.899**
	(0.050)	(0.045)
Firm size[ii], Medium	0.107**	1.113**
	(0.049)	(0.055)
Firm size, Large	−0.459***	0.632***
	(0.065)	(0.041)
HHI	−3.286***	0.037***
	(0.956)	(0.036)
Real GRP per capita	−0.018	0.983
	(0.015)	(0.015)

Table C (*continued*)

Dependent variable: firm age at exit	Alternative definition of efficiency groups based on SFA	
	Coef.	Hazard ratios
Dummy for share in regional employment headcount	−0.988***	0.372***
	(0.034)	(0.013)
Sector dummies	yes	yes
p (Weibull distribution parameter)	2.847	
	(0.025)	
θ (Gamma distribution parameter)	8.766	
	(0.203)	
LR test for H_0 $\theta = 0$	4058.03	
Probability	(0.000)	
Observations	336,500	336,500

Notes: Standard errors are in parentheses.
[i]Omitted category: Baseline group (efficiency level between 20 and 90%). [ii]Omitted category: No contract. [iii]Omitted category: Small firms.***p < 0.01, **p < 0.05, *p < 0.1.
For the model with frailty hazard ratios are for t = 0. The degree of decay depends on θ.

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