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Productivity divergence and the role of digitalisation

En delstudie i ramprojektet *"Hur kan staten främja produktivitet i svenska företag?"*

Tillväxtanalys
Myndigheten för tillväxtpolitiska utvärderingar och analyser

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Förord

Tillväxtanalys uppdrag är att utvärdera och analysera effekterna av statens insatser för en hållbar nationell och regional tillväxt. Vi ska också ge underlag och rekommendationer för utveckling, omprövning och effektivisering av politiken.

Syftet med den här rapporten är att studera produktivitetsutvecklingen för olika delar av fördelningen, vad som karaktäriserar de olika delarna och dynamiken mellan grupperna. Rapporten är skriven av Pontus Mattsson och Abdulaziz Reshid, båda analytiker vid Tillväxtanalys.

Pontus Mattsson har varit projektledare. Vi vill tacka projektets referensgrupp för fått synpunkter samt deltagarna vid produktivitetsseminariet i Karlskrona den 16 juni 2022 som anordnandes av Blekinge tekniska högskola (BTH) samt löpande inspel från medarbetare på Tillväxtanalys.

Östersund september 2022

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Sammanfattning

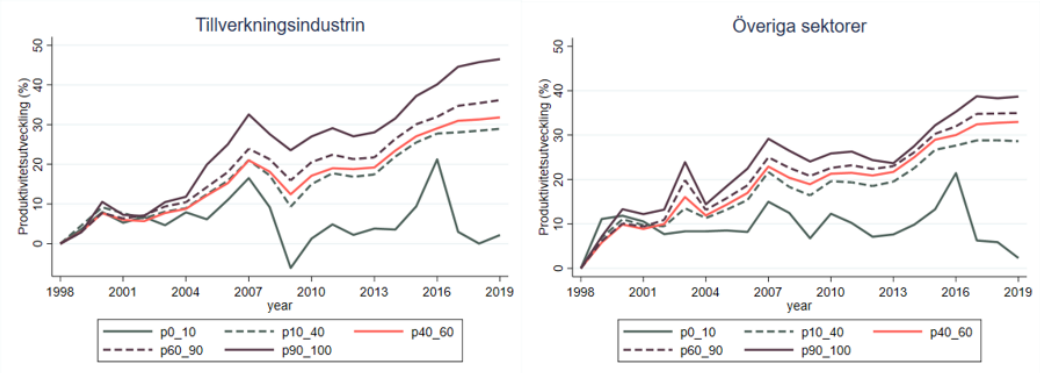
Produktivitetstillväxten är viktigt eftersom den lägger grunden för utvecklingen i länders levnadsstandard, exempelvis löner och välfärd. Länders produktivitetsutveckling byggs upp av de enskilda företagen och att studera dessa är därför betydelsefullt för helhetsbilden. Produktivitetsfördelningen, det vill säga skillnader i produktivitet mellan företag, har i princip inte studerats på svenska data. I syfte att öka förståelsen för produktivitetsfördelningen och få en bättre bild av företagens utveckling studerar vi i den här rapporten:

- produktivitetsutvecklingen för olika delar av produktivitetsfördelningen, det vill säga högproduktiva (frontföretag, eng. *frontiers*) och lågproduktiva (eftersläntrare, eng. *laggards*) med särskilt fokus på de senare och till vilken grad de närmar sig fronten (eng. *catch-up* effekten),
- vad som karaktäriserar produktivitetsgrupperna frontföretag och eftersläntrare
- dynamiken i produktivitetfördelningen, det vill säga hur företagen rör sig mellan de olika produktivitetsgrupperna och,
- om det finns skillnader i resultat baserat på om sektorn är digitalt intensiv eller präglas av mycket immateriella tillgångar.

Sammantaget bidrar studien med att förbättra förståelsen för Sveriges produktivitetsutveckling i allmänhet och de enskilda företagens utveckling i synnerhet, exempelvis huruvida de minst produktiva företagens utveckling kan vara en förklaring till lägre produktivitetstillväxt. Den här studien är den andra i ramprojektet ”*Hur kan staten främja produktivitet i svenska företag*?”.

Produktivitetsskillnaderna mellan företag har ökat över tid

Vi har i denna studie utgått från produktivitet mätt som förädlingsvärde per anställd, det vill säga värdet företaget tillför ekonomin i förhållande till dess arbetskraft. I figuren nedan visar vi produktivitetsutvecklingen för olika produktivitetsgrupper uppdelat på företag inom tillverkningsindustrin och övriga sektorer. Exempelvis representerar p0-10 den minst produktiva tiondelen av företag inom respektive sektor för det enskilda året och på motsvarande sätt visar p90-100 de mest produktiva företagen.



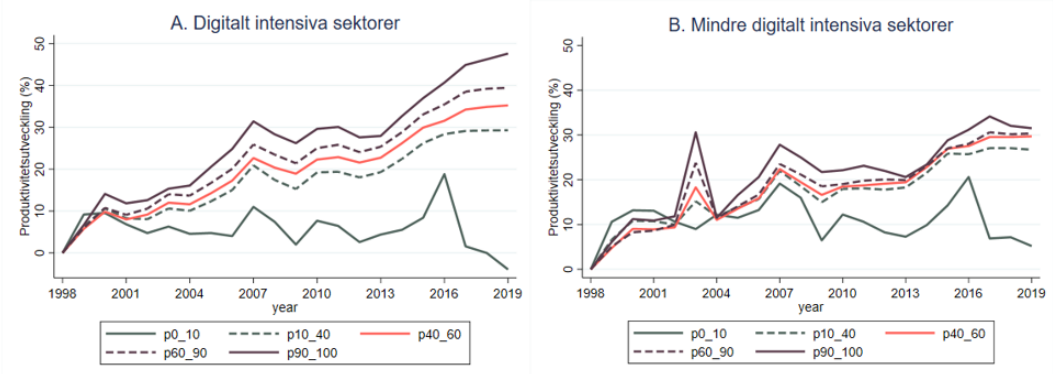
Utveckling av arbetsproduktivitet för olika delar av produktivitetsfördelningen, uppdelat på sektorer

Figuren visar att skillnaderna i produktivitet mellan de mest produktiva och de minst produktiva företagen har ökat inom såväl tillverkningsindustrin som övriga sektorer. Skillnaderna är något större inom tillverkningsindustrin där den mest produktiva gruppen (p90_100) haft högst produktivitetsutveckling i förhållande till de som var mest produktiva i början av perioden, det vill säga, när de mest produktiva jämförs som grupp över tid (utan att det behöver vara samma företag). Vidare kan vi konstatera att grupperna i mitten (p10-40, p40-60 och p60-90) har en likartad och positiv utveckling under hela tidsperioden. Den minst produktiva gruppen, p0-10, har däremot en likartad produktivitetsnivå i början och slutet av tidsperioden.

I en jämförelse med internationell litteratur, när globala frontföretag används som referens, har skillnaderna i produktivitet mellan företag med högst respektive lägst produktivitet i genomsnitt ökat mindre i Sverige. Om nationella frontföretag är jämförelse har Sverige, i genomsnitt, visuellt sett haft större ökning av produktivitetsspridningen i tillverkningsindustri och mindre i övriga sektorer. Denna internationella jämförelse kan endast göras fram till 2012. Jämförs spridningen av produktivitet i olika delar av fördelningen ser vi, i likhet med internationell litteratur, att den ökat mer bland lågproduktiva företag än högproduktiva, det vill säga skillnaden är större mellan p10 till p50 än mellan p50 och p90.

Ökning i produktivitetsspridning drivs av digitalt intensiva sektorer

Att bli bäst i världen på att tillvarata digitaliseringens möjligheter är enligt Digitaliseringsstrategin regeringens övergripande digitaliseringspolitiska mål. Att digitala teknologier har möjlighet att bidra positivt till produktivitetsutvecklingen råder det konsensus kring i litteraturen. Men digitaliseringen kan även bidra till ökade skillnader i produktivitet mellan företag då en hög grad av digitalisering kräver investeringar. Stora företag och företag som redan presterar bra har här en fördel gentemot andra företag. I figuren nedan visas utvecklingen i produktivitet för de olika delarna av fördelningen uppdelat på mer eller mindre digitalt intensiva sektorer. Vi kategoriserar digitalt intensiva sektorer på samma sätt som i internationell litteratur där intensiteten exempelvis mäts som robotar per anställd, andel IT-specialister och andel av försäljningen som sker digitalt.



Utveckling i arbetsproduktivitet uppdelat på digital intensitet

Figuren visar att produktivitetsskillnaderna har ökat mer i digitalt intensiva sektorer än i övriga sektorer. Skillnaderna syns både i toppen och botten av fördelningen, det vill säga spridningen mellan de mer produktiva grupperna av företag är större i digitalt intensiva

sektorer men avståndet till de minst produktiva företagen har också ökat. Vi delar också upp sektorerna på andel immateriella tillgångar. Då ser vi att ju högre andel immateriella tillgångar, desto mer ökar skillnaderna i produktivitet. Det här innebär dock varken att digitalisering (eller immateriella tillgångar) är negativt för produktivitetstillväxt eller att det är just dessa faktorer som driver skillnaderna.

Lågproduktiva företag präglas av hög förändring

Företagen i den lägst produktiva gruppen är mindre, yngre och försvinner oftare från ekonomin än andra företag. Tidigare litteratur har visat att låga räntor kan göra att lågproduktiva företag till en högre grad överlever. Våra resultat visar att det är få företag som förblir lågproduktiva över tid. Exempelvis är det endast 17 procent av företagen i gruppen p0-10 som är kvar i den produktivitetsgruppen efter tre år. Orsakerna till att få företag är kvar i denna grupp är att de:

- har högre produktivitetsutveckling än genomsnittet och hamnar därför i en annan produktivitetsgrupp
- försvinner från ekonomin

Båda dessa orsaker är positiva för produktiviteten som helhet. Vidare är det inte särskilt vanligt att de mest produktiva företagen förblir i den mest produktiva gruppen över tid. Exempelvis har 68 procent lämnat gruppen frontföretag inom tre år. Tittar vi på utvecklingen av företagsstorlek i de olika produktivitetsgrupperna över tid ser vi att de minst produktiva företagen har minskat antalet anställda, förädlingsvärde och försäljning. Det är positivt för den aggregerade produktiviteten eftersom de minst produktiva företagen då representerar en mindre andel av ekonomin.

De minst produktiva företagen, det vill säga eftersläntrarna, ska inte likställas med de i litteraturen benämnda zombieföretagen. Begreppen är dock relaterade till varandra då eftersläntrare är de minst produktiva företagen, medan zombieföretag är de olönsamma. Definitionen vi använder klassificerar företag som ett zombieföretag om de är minst tio år gamla och inte kunnat täcka sina räntekostnader under de tre senaste åren. Våra resultat visar att det är en betydligt högre andel zombieföretag bland de minst produktiva och en låg andel bland de mest produktiva. Vi konstaterar samtidigt att den absoluta majoriteten av de lägst produktiva företagen inte klassificeras som zombieföretag.

Utifrån produktivitetsfördelningen i allmänhet och förekomsten av zombieföretag kan vi konstatera att det inte är enkelt att tydligt definiera en representativ eftersläntrare eftersom företagen inte förblir en eftersläntrare över tid. Vi kan dock konstatera att förekomsten av mindre produktiva företag i en ekonomi inte behöver vara ett tecken på att ekonomin presterar dåligt. Orsaken är att det endast är en liten andel som presterar dåligt under lång tid. Det stora flertalet kommer öka sin produktivitet över tid, alternativt försvinna från marknaden. Givet att lågproduktiva företag till en hög grad är nya företag som ökar produktiviteten kan det tvärtom vara positivt för produktivitetsutvecklingen att dessa existerar under kort tid.

Lågproduktiva företag närmar sig fronten i en långsammare takt

Vi undersöker till vilken grad lågproduktiva företag närmar sig fronten. Vi använder de 40 procent minst produktiva företagen inom respektive sektor och studerar huruvida de närmar sig fronten. Uppdelat på digital intensitet visar resultaten att lågproduktiva

företag i de digitalt intensiva sektorerna inte kommer ifatt de mest produktiva företagen i samma grad som i övriga sektorer. Detsamma gäller för sektorer med hög andel immateriella tillgångar. Vidare gör vi motsvarande uppdelning och studerar huruvida *catch-up* effekten förändrats över tid. I figuren nedan ser vi dessa resultat. Resultaten visar att *catch-up* effekten är ungefär lika stor i båda grupperna i början av tidsperioden (1999–2001). Därefter minskar den i princip under hela tidsperioden för företagen i digitalt intensiva branscher samtidigt som nivån är konstant över tid i mindre digitalt intensiva sektorer. Samma mönster ser vi när vi delar upp företagen på mer eller mindre intensiva sektorer avseende immateriella tillgångar. Vi kontrollerar även för, exempelvis, storlek så det är inte företagsstorlekar som driver resultaten. Resultaten indikerar, men inte kausalt, att det är ökade barriärer för eftersläntrare att anamma nya teknologier då teknologispridningen ser ut att ha minskat i vissa sektorer. Om de lågproduktiva kommit ifatt i lika hög grad som tidigare så hade den aggregerade produktivitetsutvecklingen varit högre.

Catch-up effekten för lågproduktiva företag uppdelat på digital intensitet (heldragen linje är medelvärde och streckad är konfidensintervall)

Studerar vi i stället enskilda kohorter och följer dessa över tid bekräftar det bilden av att lågproduktiva företag har en högre produktivitetstillväxt än andra. Däremot ser vi också att de, i genomsnitt, inte kommer i kapp utan förblir på en lägre produktivitetsnivå.

Spridning av kunskap och teknologi är viktigt

Resultaten i den här rapporten visar att skillnaderna i produktivitet mellan företag i Sverige har ökat över tid och att *catch-up* effekten har minskat i digitalt intensiva sektorer. Det här är relevant ur många policyaspekter även om vi inte på ett djupgående sätt har undersökt drivkrafter bakom. Exempelvis innebär en minskad *catch-up* effekt, allt annat lika, minskad aggregerad produktivitet.

Enligt internationell litteratur kan för stora skillnader i produktivitet mellan företag som beror på barriärer orsaka minskad konkurrens när högproduktiva företag dominerar marknaden. Det är i sin tur negativt för produktivitetsutvecklingen på lång sikt. Barriärer kan exempelvis uppstå när större aktörer köper upp patent. Men ökad spridning kan också hänga ihop med att de mest produktiva företagen växer så att mer produktionsfaktorer allokeras dit, vilket är positivt för aggregerad produktivitetstillväxt.

Vi har inte specifikt studerat drivkrafterna bakom den ökade spridningen i produktivitet mellan företag i Sverige. Men utifrån tidigare litteratur vet vi att spridning av kunskap och teknologi är viktigt för att skillnaderna i produktivitet mellan företag inte ska öka

alltför mycket. Med tanke på att vi främst ser ökade skillnader i digitalt intensiva sektorer, vilka ofta präglas av en hög teknisk utveckling, borde kunskapsspridning vara särskilt viktigt där. Bristen på digital kompetens har i tidigare studier lyfts som ett allmänt problem för företagen, vilket inte är specifikt för Sverige. Faktorer som är viktiga för en hög grad av produktivitetsspridning är utbildningsnivån i ekonomin (exempelvis inom digital kompetens), en hög rörlighet på arbetsmarknaden och tillgång till riskkapital. Dessa kan i sin tur vara positivt för konkurrens och produktivitetsutveckling. Vid eventuella riktade stöd är det i de flesta ekonomiska situationer dock viktigt att dessa inte bidrar till att hålla lågproduktiva företag vid liv i stället för att dess produktionsfaktorer via strukturomvandling kan allokeras till mer produktiva verksamheter.

Abstract

Productivity development in general has been extensively studied. Behind the aggregates, there are a variety of firms which potentially show substantial productivity differences. The productivity distribution is, to a large extent, unexploited in a Swedish context. This paper investigates productivity development in different parts of the productivity distribution, dynamics between the productivity groups, and whether differences can be observed depending on the digital intensity and the intangible asset intensity of the sector. We find increases in productivity differences over time, with greater increases in digital-intensive sectors and sectors characterised by a large share of intangible assets. Similarly, the catch-up effect is found to decline over time, driven by these sectors. Additionally, there are large dynamics between groups, so the least productive firms do not remain low-productive for a long time. From a policy perspective, it is important to promote the spread of new technologies and knowledge, where education level of the employees in general is important, especially concerning digital competence. Moreover, labour market mobility and different collaboration activities (e.g., between firms or universities) can also be positive for spreading technologies.

1. Introduction

Productivity is the main driver of economic growth. Many countries have experienced a lower aggregate productivity growth from around 2005 onwards compared to previous periods (Inklaar et al., 2020). There are various possible explanations for this, such as new technologies having less potential to spur aggregate productivity growth compared to previous innovations (Gordon, 2012); new technologies having adoption lags due to complementary investments (Brynjolfsson et al., 2019); and measurement issues due to new goods related to the IT revolution (e.g. Brynjolfsson et al., 2020; Byrne and Corrado, 2020). Regardless, aggregate productivity does not tell us anything about the micro-dynamism among individual firms. It is the dynamism and structural change among firms that build up aggregate productivity, meaning that it becomes interesting to analyse the heterogeneity in productivity across firms. Apart from being one potential source of the productivity slowdown, as argued for example by Andrews et al. (2016) and Gouveia and Osterhold (2018), an increase in productivity differences can also be a source of inequalities, i.e., wage differences among individuals. Moreover, with low labour mobility, a low-productive firm can keep individuals with low productivity to a low wage and these firms will not be able to attract the best human capital (Criscuolo et al., 2021). Such inequalities are likely to have been exacerbated during the Covid-19 crisis (OECD, 2020).

Internationally, there is a growing consensus that within-industry productivity gaps, i.e., the difference between high- and low-productivity firms, has increased during the last few decades. This is not, in itself, negative depending on the reasons for which it appears (Corrado et al., 2021). Different arguments have been put forward regarding the causes of increased dispersion globally. Andrews et al. (2016) claim that the slowdown is due to slower productivity growth among the laggard firms, while the global frontier has shown strong growth. This indicates that the laggards (and frontiers) are considered as separate groups and that the result of increased dispersion contradicts Neo-Schumpeterian growth theory, i.e., laggards do not catch-up to the frontiers. However, it is not necessarily the case that the frontiers will stay frontiers and the laggards stay laggards for several consecutive years.

Similarly, superstar firms with a high degree of markups and barriers to outperform their competitors (Autor et al., 2020). Low-productive firms also linked to the bordering concept of zombie firms, which are increasing in number according to Banerjee and Hofmann (2018). These are firms that are expected to exit the market given their low profitability but, it is argued, are kept alive due to the low real interest rates (Gouveia and Osterhold, 2018).[1] Additionally, firms can be kept alive by public support in general and particularly in economic downturns (Adalet McGowan et al., 2018) – such as the global financial crisis and the Covid-19 pandemic – generating a loss in potential output. The productivity distribution is, to a large extent, unexploited in a Swedish context. In addition, less is known about the characteristics of the different parts of the productivity distribution.

[1] There are different definitions of zombie firms; one is firms that can pay their interests but not the amortisations.

The aim of this report is to investigate productivity development for different parts of the productivity distribution and dynamics between the groups. The question of dynamism between groups is particularly important to address, as different public policies might be appropriate depending on whether it is the same laggards over time that remain far behind, whether their distance to the frontier increases, or whether there are different firms at the bottom. We also examine characteristics of firms in different parts of the distribution and heterogeneity is analysed depending on the digital and intangible asset intensity.

The outline of this study is as follows: section 2 presents the previous literature related to productivity differences and to some extent zombie firms; section 3 presents the data and descriptive statistics; section 4 examines the evolution of the productivity dispersion graphically as well as looking at firm dynamics; section 5 analyses convergence of the laggard firms econometrically; and finally, section 6 concludes the study.

2. Previous literature

Historically, there has been a lot of research into both productivity and productivity growth in general, but less on the topic of productivity differences between firms within sectors. During the last decade, this has changed, and a growing number of studies have examined productivity differences between firms from various angles. This overview focuses on; 1) productivity differences and 2) zombie firms.

2.1 Productivity differences

To begin with, when looking at previous studies, it is important to highlight that there are varying definitions of frontier and laggard firms. For example, Andrews et al. (2016) compare global frontier firms, defined as the top five percent of the productivity distribution in each two-digit industry and year, with all other firms over the period 2001 to 2013. The top five percent is included as a fixed number of firms over time as the number of firms in the data tends to increase, i.e., the top five percent of the median number of firms across years is included. Berlingieri et al. (2020) focus on the laggard firms separated into five groups of the labour productivity and total factor productivity (TFP) distribution.[2] The groups are: the bottom 10th percentile, 10th to 40th, 40th to 60th, 60th to 90th and 90th to 100th with a focus on the two groups at the bottom. The results of a study on productivity differences could also depend on which benchmark is used. For example, Bartelsman et al. (2008) show that productivity growth among the least productive firms within a country is more comparable to the most productive firms within that country than those at the global frontier.

The results reported in Andrews et al. (2016) indicate that the decrease in productivity growth is mainly due to a growing labour productivity gap between global frontier companies and laggard companies. They show that the gap is not due to slowdown in productivity of the frontier companies, but rather that the laggard companies have stagnated in their development and have to a lesser extent the ability to adapt to best-practice experiences from the frontier companies. In contrast, for the Netherlands, Van Heuvelen et al. (2018) found that both frontiers and laggards developed fairly similarly over the period under study, i.e., 2006 to 2015. Additionally, they showed that in sectors with fast-growing frontiers, the laggards also have faster productivity growth. In a comparison of labour productivity dispersion across several countries in 2011, Berlingieri et al. (2017) show that Sweden has a dispersion that is smaller than the average of the countries included in the study (e.g., Norway and the Netherlands) but larger or similar to that of Denmark and Finland.

Andrews et al. (2016) also show that the market share has risen for frontier firms, especially in sectors like computer programming and telecommunication. Further, Berlingieri et al. (2020) point out that laggards are smaller and have higher productivity growth than others, i.e., they converge to frontiers. However, this group appears to be heterogeneous and characterised by high dynamism. Akcigit and Ates (2021) review the literature on the trend of declining business dynamics and its implications. They highlight that a decline in technological diffusion from frontier to laggard firms could be a driver of slowdown in productivity growth in the US. For example, market

[2] Berlingieri et al. (2020) define MFP according to the Wooldridge (2009) definition.

concentration has increased, mark-ups have increased, profit share of GDP has increased, firm entry rate and the share of young firms have declined, and productivity growth has declined. In relation to these potential drivers, Andrews et al. (2016) claim that lack of pro-competitive product market reforms increased the productivity dispersion. Additionally, Diez et al. (2018) draw particular attention to the superstar firms as a driver of divergence in so-called "winner-takes-all" industries, i.e., the ICT intensive. For example, Calligaris et al. (2018) find larger differences in mark-ups between frontiers and laggards in digital-intensive industries compared to other sectors.

Other studies point to a decline in knowledge diffusion as an argument for increased productivity difference (Akcigit and Ates, 2021). Theoretical papers have discussed the connection mechanism between productivity dispersion and intangibles (Aghion et al., 2019; De Ridder, 2019), but empirical evidence is scarce. An exception is Corrado et al. (2021), who show that the increased productivity dispersion is especially large in intangible-intensive sectors. The divergence is at least in part explained by scalability, as the gap between the top and median is stronger in industries where differences in sales are larger. Specifically, their heterogeneity analysis indicates that dispersion on the top of the distribution is associated with scalability, while the dispersion at the bottom is linked with digital intensity, trade openness and venture capital. Moreover, Akcigit and Ates (2019) conclude that patents are more heavily used for strategic reasons which is likely to lead to a decline in business dynamism. Additionally, Calvino and Criscuolo (2019) show a sharper decline in entry rates for intangible-intensive sectors, and (Criscuolo et al., 2022) show that the divergence is larger at the bottom of the productivity distribution compared to the top.

For the lowest-performing firms, Bartelsman et al. (2008) indicates that there might be effects of monetary policy, i.e., lower interest rates keep low-productive firms alive. However, Berlingieri et al. (2020) point out that one should be cautious about associating laggard firms with zombies, i.e., unhealthy firms. Regardless, the literature on productivity gaps is linked the literature regarding zombie firms. In the next section, we provide a summary of the literature from a productivity perspective.

2.2 Zombie firms

There are several different definitions of zombie firms used in the literature. Caballero et al. (2008) define zombies as firms that receive subsidised credits. Adalet McGowan et al. (2018) define zombie firms as old firms that continuously have problems covering their interest payments, i.e., their operating income is smaller than their interest payments. The latter is a more common definition in more recent research on the topic.

On the aggregated level for 14 countries, Banerjee and Hofmann (2018) show that a higher number of zombie firms lowers the aggregate economic growth, as these firms use labour and capital inputs that could have been used by more productive firms. The connection between zombie firms and weak banks and its consequences on productivity in Europe has been analysed by Andrews and Petroulakis (2017). The analysis shows that the zombie firms are related to weak banks and aggregate productivity growth.

Caballero et al. (2008) analysed the impacts of credit flows to insolvent borrowers, i.e., zombies. They show, for example, that an increased number of zombie firms reduces entry of and investment in healthy firms. In addition, industries with a large share of

zombie firms are characterised by lower job creation and productivity. A larger share of zombie firms is also connected to a larger productivity gap.

Adalet McGowan et al. (2018) show that the number of zombie firms in the OECD has risen since the mid-2000s, which means that more resources are in low-productive firms, constraining growth for the more productive ones. In the case of Sweden, Adalet McGowan et al. (2018) show that the prevalence of zombie firms increased from 2007 to 2010. These years were exceptional due to the global financial crisis. Banerjee and Hofmann (2018) indicate that one reason for an increased share of zombie firms is low interest rates. In contrast, Cella (2020), using the Serrano database by Bisnode, found that for Sweden, the share of zombie firms has declined from 2010 onwards, a period characterised by lower interest rates. The share of zombie firms in Sweden was approximately six percent in 2010 and three percent during 2016. Moreover, Cella (2020) does not find any correlation between the presence of zombie firms and the growth of non-zombie firms for most sectors.[3]

As can be seen above, there is some knowledge of the frontier firms as well as the laggard firms and zombie firms. However, less is known about the dynamics between these groups in general and in a Swedish context in particular.

[3] Cella (2020) follows Adalet McGowan et al. (2018) in identifying zombie firms as firms with interest coverage ratio below one for at least three consecutive years, and as being 10 years old or more.

3. Data

3.1 Data and definitions

The analysis in this study uses firm-level data from Statistics Sweden (SCB). The data comes from various firm-level registered sources and includes all non-financial private-sector firms in Sweden during the period 1998-2019. We exclude non-market services, financial services, and agriculture from the analysis. Moreover, firms with an average number of employees below two are excluded.[4] The final sample consists of an unbalanced panel of 288,362 unique firms with a total of 2,491,170 firm-year observations for the entire period. The financial statistics contain various firm-level information such as value added, number of employees measured as full-time equivalent, capital stock, industry, sales, and total wages paid.

As discussed in Tillväxtanalys (2021), there are many possible ways of measuring productivity. The easiest method that does not require a measure of capital assets is labour productivity. Total factor productivity (TFP), on the other hand, requires a capital measure and often an econometric estimation. We choose to use labour productivity, defined as log (real value added per employee), as our main variable of interest, and we report results based on a TFP measure as a robustness check.[5] The main motivations for the above choices are: 1) a comparison to several related studies on the topic becomes possible as they also use labour productivity (Andrews et al., 2016; Berlingieri et al., 2020), and 2) our robustness tests with a TFP measure gave similar results, indicating that the choice between these productivity measures does not matter.

In this study, we follow Berlingieri et al. (2020) and classify firms into five productivity groups, defined by firms' position in the productivity distribution within each two-digit industry and year.[6] These groups are p0-10 (1st to 10th percentile), p10-40 (10th to 40th percentile), p40-60 (40th to 60th percentile), p60-90 (60th to 90th percentile), and p90-100 (90th and 100th percentile). To exemplify, p0-10 represents the firms in the bottom decile of the productivity distribution within each two-digit industry and year. In line with Berlingieri et al. (2020), laggard firms are defined as firms in the bottom 40 percent of the productivity distribution, i.e., p0-10 and p10-40.

Firms might be within the lowest productive group for different reasons (Berlingieri et al., 2020). One type of firm is zombie firms that are expected to leave the market (Adalet McGowan et al., 2018). It may be that the nature of the firm is different (e.g., family businesses), the firm has suffered a temporary productivity shock, or the firm might simply be young and therefore not yet efficient. All these reasons have different policy implications and are therefore necessary to examine. Section 3.2 presents the characteristics of the five productivity groups.

[4] Firms with productivity growth in the top and bottom 0.5 percent are considered as outliers and are excluded from the baseline sample.

[5] The TFP measure we have applied is the one developed by Levinsohn and Petrin (2003).

[6] This is in contrast to Andrews et al. (2016), who include the top five percent as a fixed number of firms over time because the number of firms in the data tends to increase, i.e., the top five percent of the median number of firms across years is included.

3.2 Characteristics of laggards and frontiers

To give an understanding of the differences between the productivity groups, we start by describing the mean characteristics of the firms in the five productivity groups. Table 1 presents several interesting features of the firms at the top and bottom of the productivity distribution.

Table 1 Summary statistics of the productivity groups based on labour productivity classification.

	Productivity groups				
Variables	p0_10	p10_40	p40_60	p60_90	p90_100
Labour productivity (log)	11.68	12.61	12.94	13.25	13.89
Employment	7.73	10.88	16.48	23.02	24.76
Age	11.65	12.28	13.05	13.73	13.66
Share of employment	0.05	0.20	0.20	0.41	0.15
Value added (log)	12.82	14.19	14.78	15.20	15.53
Share of value added	0.01	0.10	0.14	0.42	0.32
Capital-labour ratio (log)	11.82	11.78	11.98	12.34	12.94
Net sales (log)	14.15	15.16	15.73	16.15	16.44
Wage rate (log)	11.49	12.16	12.40	12.54	12.73
Stay *t*+1*	0.46	0.56	0.38	0.59	0.58
Stay *t*+1, *t*+2 & *t*+3	0.17	0.26	0.09	0.29	0.32
Change LP group at *t*+1	0.47	0.40	0.58	0.38	0.40
Change LP group at *t*+1, *t*+2 & *t*+3	0.72	0.67	0.85	0.66	0.64
Exit the economy at *t*+1	0.07	0.04	0.04	0.03	0.02
Exit the economy at *t*+1, *t*+2 & *t*+3	0.10	0.07	0.06	0.05	0.04
Share of zombie firms (baseline sample) **	0.05	0.03	0.02	0.01	0.01
Share of zombie firms (Sub-sample of firms aged>=10)	0.10	0.06	0.03	0.02	0.01
Observations	250,079	747,733	498,353	746,648	248,357

Note: Each cell reports the average values of the variables listed in the left column during the period 1998-2019.
* The variables Stay *t*+1, Change LP group at *t*+1 and exit the economy at *t*+1, respectively, indicate the fraction of firms that stay, change productivity group and leave the economy after one year. Similarly, the variables Stay *t*+3, Change LP group at *t*+3 and exit the economy at *t*+3, respectively, indicate the fraction of firms that stay, change productivity group and leave the economy after three years.
** The share of zombie firms appears smaller in the baseline sample because the reference group includes all firms (i.e., also age<10), a group that is normally excluded from the analysis when zombie firms are studied.
Source: Own calculations based on data from SCB.

In the first row of Table 1, we observe the productivity dispersion between the least, the median and the most productive firms. The firms in the top 10 percent (p90_100) are 3.5

and 9.1 times[7] more productive than the firms in the median (p40_60) and bottom (p0_10) part of the productivity distribution, respectively.

On average, the firms in the bottom of the productivity distribution are smaller and younger than other firms. Firm size and age increase as we move to the top of the productivity distribution. In terms of the firms' contribution to employment and value added, the firms in the bottom 40 percent of the productivity distribution (p0_10 and p10_40), which represents 40 percent of the firms, account for about 25 percent of the total employment and 11 percent of the value added in the economy. In contrast, frontier firms (p90_100) are larger in size and account for about 15 percent of the employment and 32 percent of the value added. It is also apparent from Table 1 that the least productive firms have lower capital intensity, sales and wages compared to the frontier firms.

Another interesting aspect of the productivity groups is that there is a high firm dynamic between groups. For example, only 17 percent of the firms in the lowest productivity group remain in the same group after three years. Most firms in this group move to a higher productivity group (about 72 percent), while 11 percent leave the economy. Looking at the frontier firms, i.e., p90-100, the share of the firms that remain in the same group after three years is 32 percent, indicating that the frontiers to a larger extent remain in the same group in comparison to the laggards. However, even though there is a lower share of firms that leave the frontier group compared to the share that leave the least productive laggards, it can still be argued that the frontier group is not static as 68 percent do not remain frontiers after three years.

Regarding low-productive firms, it is interesting to examine the link between low-productive firms and zombies, i.e., whether they overlap. The last two rows of Table 1 present the share of zombie firms within each productivity group. We follow McGowan et al. (2018) and define "zombies" as old firms that have financial difficulties paying the interest on their loans over several years. Specifically, firms are classified as zombies if: i) interest coverage ratio is less than one for three consecutive years (calculated as the ratio of operating profit and interest payment) and ii) the firm is 10 years old or above. Firms that do not satisfy the above two criteria are classified as non-zombies. This means that the group of non-zombie firms includes not only financially viable old firms but also young firms irrespective of their financial viability. This explains why we observe a relatively smaller share of zombie firms compared to what is reported in the literature, which generally excludes young firms from the analysis. For this reason, we report the share of zombie firms calculated using our baseline sample as well as for a sub-sample that only includes firms aged 10 or over.

In general, it is evident that the share of zombie firms decreases as we move from the lowest productivity group to a higher productivity group. The share of zombie firms among the least productive firms, p0_10, is about 5 to 10 percent (depending on the baseline sample), followed by the second-lowest productive group, p10_40, constituting about 3 to 6 percent zombie firms. Compared with the share of zombie firms in a previous Swedish study, i.e., Cella (2020), we find a slightly lower share during most years but a similar share for the end of their study period, i.e., 2014-2016.[8] An international comparison indicates that the share we find here is smaller than

[7] These figures are obtained by taking the exponential of the log difference for the productivity groups. For instance, the gap between p0_10 and p90_100 is obtained by taking exp(13.89-11.68)=9.1.

[8] One difference compared to Cella (2020) is that we exclude firms with an average number of employees below two. The annual average share of zombie firms in our data is reported in Figure A5 in the Appendix.

what Banerjee and Hofmann (2018) find on average in several developed countries. Results from McGowan et al. (2018) indicate that Sweden is approximately at an average level regarding zombie firms.[9] Moreover, it is interesting to note that irrespective of the definition of a zombie, more than 90 percent of the firms among the bottom 10 percent can be classified as non-zombies. However, the presence of laggard firms should not be considered a sign of a poorly performing economy with unhealthy firms because most of the laggards are not performing poorly according to the zombie definition. A maximum of 1 percent of the zombie firms remain zombies after three years according to

Table A2 in the Appendix. Instead, the zombies and laggards are characterised by high dynamism, as many firms do not remain in that group over time. Moreover, the laggard firms are smaller and younger than others. Perhaps, as outlined by Berlingieri et al. (2020), the laggards may also include other types of firms such as small family businesses with no ambition for growth, as well as firms undergoing temporary negative productivity shocks. From this, we conclude that a representative laggard firm is not easily defined.

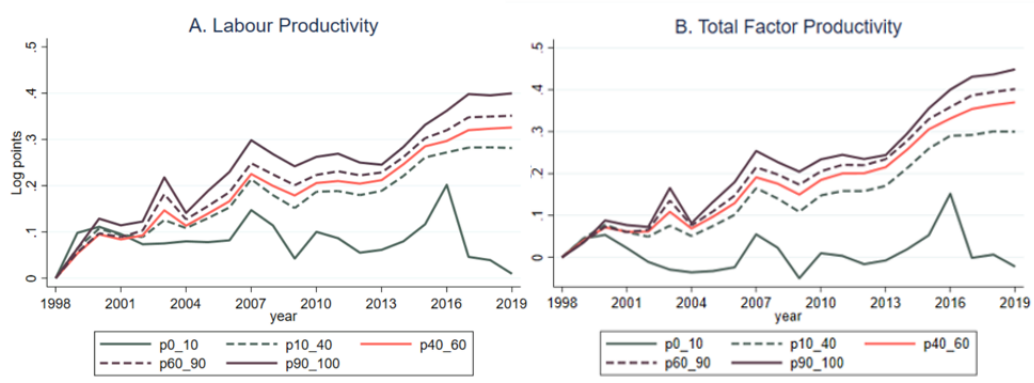
[9] One problem with our and other definitions of a zombie firm is that firms can optimise taxes by creating groups of firms to move the income to more favourable jurisdictions, which is also noted by, for example, Cella (2020). Therefore, one firm can appear to be a zombie if revenues are reported for another entity.

4. The evolution of productivity dispersion

4.1 Productivity development for frontier and non-frontier firms

In Figure 1, we present the development of productivity for frontier and non-frontier firms, which are classified into five productivity groups, during 1998-2019. Panel A shows the development of labour productivity of the five productivity groups, where the initial year 1998 is used as the reference year and indexed to zero. Similarly, we show this for Total Factor Productivity (TFP) in Panel B.

Figure 1 Development of labour productivity and TFP of laggard and frontier firms



Note: In the above figure, p0_10 shows the average development in labour productivity (Panel A) and development in TFP (Panel B) of firms in the bottom decile of the productivity distribution within two-digit industry and year. Similarly, p10_40 to p90_100 represent their different parts of the productivity distribution.

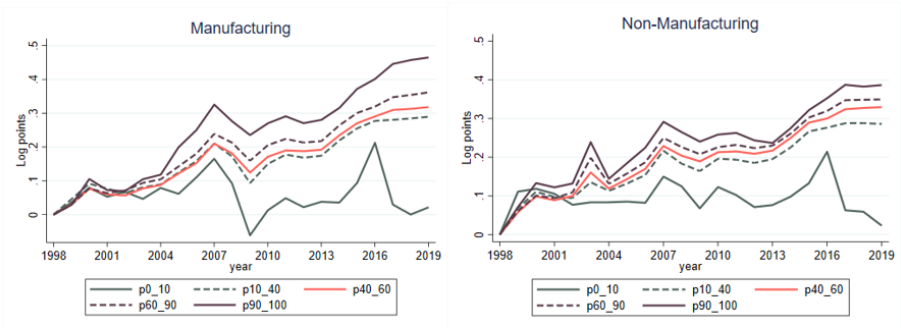
From Figure 1, we observe that the least productive firms, i.e., the lowest decile labelled as p0_10, also have the lowest development. Their productivity development is in fact zero during this period of approximately 20 years, regardless of productivity measure. This may seem surprising according to neo-Schumpeterian growth theory, as firms lagging behind are supposed to grow faster by learning from the best (Acemoglu et al., 2006).[10] However, this result does not amount to claiming that the theory does not hold. There may be several possible explanations for this pattern, e.g., that there is a large dynamic within this group so there are to a large extent different firms within this group, as indicated by the descriptive statistics in section 3.2. For the remaining productivity groups, we find that there is a positive productivity development. It is also evident from the graph that the firms in the upper part of the productivity distribution have a relatively stronger productivity growth, contributing to a widening productivity gap between the groups. Hereafter, we focus on labour productivity as the different

[10] We see a jump in 2016 for the least productive group. We have investigated causes for this but have not found any errors in the data.

productivity measures give similar results. Differences in productivity divergence as well as productivity growth are, however, likely to depend on the industry.[11]

Figure 2 shows the results as separated into the manufacturing and non-manufacturing sectors.[12] From the figure, we can see two quite similar patterns, except that a slightly higher productivity divergence is observed in manufacturing than non-manufacturing. A distinguishing feature in the manufacturing sectors is that the frontier firms exhibit stronger productivity growth than their closest productivity group, p60-90. Meanwhile, in the non-manufacturing sectors, we see that most of the non-frontier groups (p10-40, p40-60, p60-90) are relatively close to the frontier. Looking at the bottom part of the productivity distribution, we find a widening productivity gap between the bottom 10 percent (p0_10) and the rest in both manufacturing and non-manufacturing sectors. Tillväxtanalys (2021) studies labour productivity and TFP on the sector level for Sweden compared to a few other countries. They observe that the development of TFP in the Swedish manufacturing sector was relatively strong compared to other countries from 1995 to 2016. The exception is the period of the global financial crisis, 2007-2009. During this period, we also see in Figure 2 that all productivity groups have a decline in productivity simultaneously. Another sector studied in Tillväxtanalys (2021) is information and communication technology (ICT), which had a strong TFP growth compared to other sectors in Sweden but weak relative to other countries. However, labour productivity growth performed slightly better overall, especially during the period 2010-2016. ICT is included under non-manufacturing in Figure 2, which displays a smaller productivity divergence than manufacturing. Given that manufacturing has a larger productivity divergence than non-manufacturing, and in an international comparison performs relatively well according to Tillväxtanalys (2021), it is not necessarily bad for aggregate productivity to have a larger divergence. Instead, it is an empirical question of whether it is good or bad (Criscuolo et al., 2022).

Figure 2 Development of labour productivity of laggard and frontier firms, by industry



Note: Panel A shows the cumulative change in average labour productivity of firms in the manufacturing sector within each productivity group and year, where the initial year 1998 is used a reference year and indexed to zero. Panel B shows a similar graph for the non-manufacturing sector.

[11] We show this using confidence intervals created by dummy variable regressions in Figure A3 in the Appendix.

[12] The five productivity groups are, however, still constructed on the two-digit sector level.

Our findings, on the micro level, can be compared with results from a few studies from OECD countries, in particular Andrews et al. (2016). For ease of comparison in this case, we follow Andrews et al. (2016) and define frontiers as the firms in the top five percent of the productivity distribution within two-digit sector and year (using 2001 as the index year). According to Figure A1and Figure A2 in the Appendix, it is evident that the increase in productivity dispersion is more substantial in Andrews et al. (2016), measured globally in OECD countries, than it is in Sweden. Within each country, Berlingieri et al. (2017) study productivity differences as an average for several countries, where visually it looks like Sweden has a larger increase in productivity differences in manufacturing and a smaller increase in non-manufacturing. This comparison can be made until 2012, where their results end.[13] Previous studies argue that productivity differences began to increase during the last two decades (Andrews et al., 2016) and that a higher productivity gap can be observed in the bottom half of the productivity distribution (10^{th} vs 50^{th} percentile) than in the upper half (50^{th} percentile vs 100^{th} percentile) (Berlingieri et al., 2020).[14] However, it is not surprising that some divergence occurs over time, and, to the best of our knowledge, it is not known whether a similar pattern has been taking place for a longer period. The reason for this is that previous studies start when micro data becomes generally available, and an increased divergence has occurred since then. It can, however, be noted that the increased divergence is very small to begin with in the Swedish case.

4.2 Digital intensity and heterogeneity in productivity divergence

Digital technologies have great potential to enhance aggregate productivity growth. In light of this potential, the Swedish government has set in place a digitalisation strategy with the aim of becoming the best in the world at utilising the opportunities created by digitalisation.[15] However, the gains from digitalisation may benefit frontier firms to a larger extent than laggards, according to Andrews et al. (2016). The main reason is that the adoption and diffusion of digital technologies require complementary investment in intangible assets that are often costly and time-consuming to acquire. Examples are investments in ICT equipment and skilled labour (Andrews et al., 2016; Pisu et al., 2021). Laggard firms that lack the necessary absorptive capacity and complementary assets may find it difficult to adopt new technologies and therefore have difficulties in catching up to frontier firms.

Figure 3 presents the evolution of the frontier and laggard firms for digital-intensive sectors (Panel A) and less digital-intensive sectors (Panel B). The classification of two-digit sectors into digital-intensive and less digital-intensive sectors is made according to the methodology developed in Calvino et al. (2018).[16]

[13] A difference is that we exclude firms with less than two employees on average over the period.

[14] One reason could be that the size distribution of firms has changed over time. In Figure A3 in the Appendix, we report firm size by year which indicates a similar size distribution over time.

[15] This strategy consists of different parts, e.g., digital competence, digital innovation and digital infrastructure.

[16] The indicators used by Calvino et al. (2018) to classify the digital intensity of a sector are: share of ICT tangible and intangible investment; share of purchases of intermediate ICT goods and services; stock of robots per hundred employees; share of ICT specialists in total employment; and share of turnover from online sales.

Figure 3 Development of labour productivity, separated by digital intensity of sectors

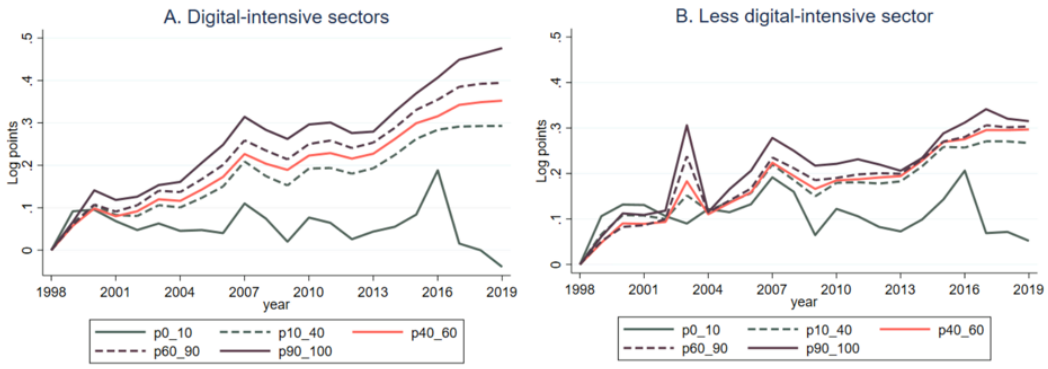
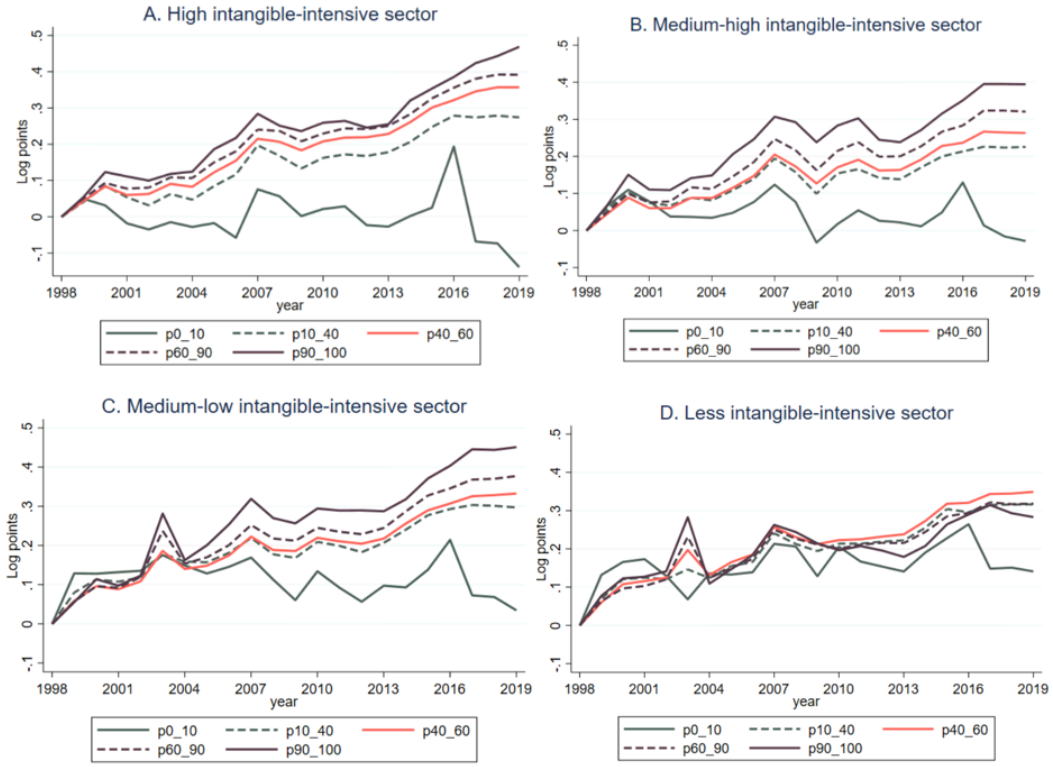


Figure 3 shows that the productivity gap between the frontier and laggard firms has increased more in digital-intensive sectors compared to less digital-intensive sectors. This finding is in line with Andrews et al. (2016) who document a larger productivity gap in digital-intensive sectors. The larger dispersion is, according to Berlingieri et al. (2020), not driven by ICT-producing industries. Instead, it reflects barriers to diffusion of ICT in all sectors where those technologies are important. Moreover, the digital intensity at the sector level is also shown by Calligaris et al. (2018) to be linked to increased mark-ups, i.e., mark-ups increase more in digital-intensive sectors driven by firms at the top of the mark-up distribution.

Figure 4 presents the evolution of labour productivity for the five productivity groups by intensity of intangible assets on the sector level. To classify sectors, we use information from Statistics Sweden on the share of intangible investments relative to total investment within two-digit sectors averaged over the period 1998-2019. Then the sectors are grouped into high (4th quartile), medium-high (3rd quartile), medium-low (2nd quartile) and low (1st quartile) intangible-intensive sectors. Table A1 in the Appendix presents a list showing which two-digit sectors belong to each of the four quartiles according to the share of investment in intangible assets.

According to Figure 4, the productivity gap between frontier and laggard firms has increased in sectors characterised by a high or medium share of intangible assets. In contrast, we find no evidence of productivity divergence in sectors with a low ratio of intangible assets (See Panel D). In Panel D, we even observe that the median firms by the end of the period have the highest productivity increase compared to the rest of the productivity groups.

Figure 4 Development of labour productivity, separated by intangible asset intensity of sectors



To summarise, the above descriptive analysis is to a large extent in line with what has been found in previous studies, i.e., increases in productivity divergence. Moreover, we find that the productivity divergence is higher in digital- and intangible-intensive sectors.[17] In addition, we find that laggard firms, except the bottom 10 percent, show a positive productivity growth over the period of investigation. The productivity gap among Swedish firms has increased less than what has been observed for a global sample by Andrews et al. (2016). However, comparing our results to Berlingieri et al. (2017), Sweden's productivity dispersion is visually larger in manufacturing and smaller in non-manufacturing compared to an average of the OECD countries included in Berlingieri et al. (2017).

4.3 Laggards and firm dynamics

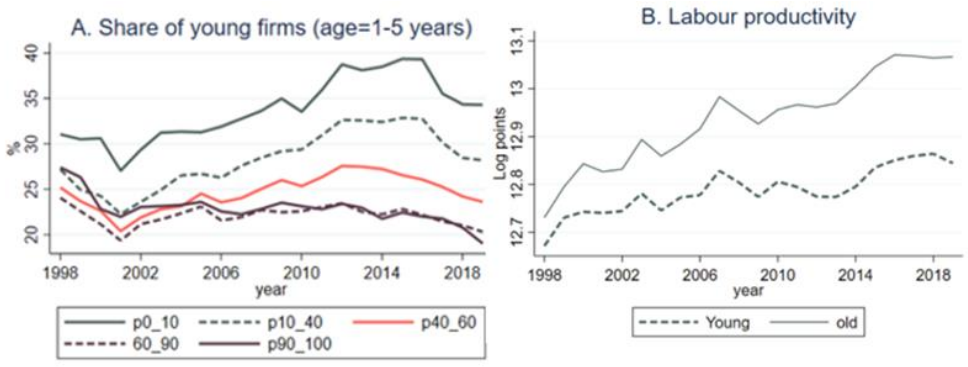
In the previous sections, we have documented a widening productivity gap between laggards and frontier firms. From our results, we can also see that the productivity divergence is more pronounced at the bottom of the productivity distribution, where the productivity gap between the bottom 10 percent and the rest has increased substantially. However, the analysis in the previous section is based on an unbalanced panel data set. In this case, firms can enter or exit the economy, and jumps between productivity groups are allowed. Thus, one potential explanation for the observed pattern could be linked to

[17] It is worth noting that firms in the groups with median productivity and above in more digital-intensive sectors are, on average, larger than their counterparts in less digital-intensive sectors. We show descriptive statistics separated into digital-intensive and less digital-intensive sectors in Table A3 and Table A4 in the Appendix. Given the result of increased dispersion in digital-intensive sectors, the larger dispersion may be an effect of larger size and therefore higher ability to adopt new technologies. In this section, we do not distinguish between these.

firm dynamics in the bottom part of the productivity distribution; that is, this part of the distribution may be overrepresented by low-productive incumbent firms that exit the economy, or young (new) firms that are expected to temporarily operate below their full productivity potential.[18] A rise in the share of young firms or a decline in the exit rate of the least productive firms could potentially explain the increasing productivity gap between the bottom 10 percent and the rest. Figure 5 and Figure 6 provide descriptive evidence of firm dynamics by productivity group.

Figure 5 presents the share of young firms within the productivity groups (Panel A) and average labour productivity by age[19] group (Panel B). Starting from Panel A, it is evident that more than a third of the firms in the bottom 10 percent constitute firms that are younger than six years old (depending on year). The share of young firms drops as we move to the upper group in the productivity distribution. When looking at the share of young firms over time, one can see an increasing trend in the share of young firms in both the laggard groups (p0_10 and p10_40). Meanwhile, the share of new firms within the median group increased for several years before starting to decline at around 2011. The sharp increase in the share of young firms in the two groups of laggard firms around 2010 coincides with a Swedish policy reform that reduced the minimum capital requirement to start a limited liability company. The share of firms in different size groups is, however, relatively constant over time according to Figure A4. Panel B confirms the evidence from prior studies (Berlingieri et al., 2018; Pagano and Schivardi, 2003) that younger firms on average have lower productivity than older firms. In addition, the divergence has increased over time, a finding which implies that the increase in productivity divergence observed over the past two decades can be explained in part by the increase in the share of young (new) firms in the bottom part of the productivity distribution.

Figure 5 The share of young firms and average productivity by age group



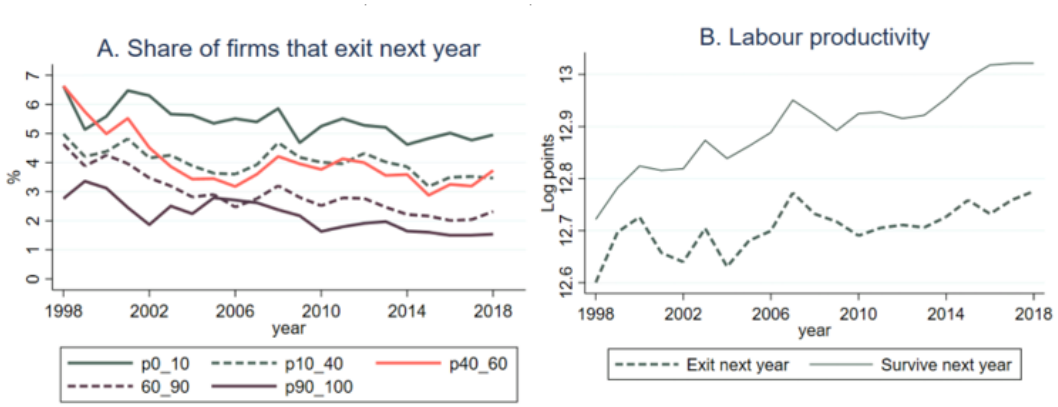
Note: Panel A presents the share of young firms (age=1-5 years) within each productivity group and year. It is obtained by taking the ratio of young firms in productivity group *j* and year *t* relative to total number of firms in their respective productivity group and year. Panel B shows the average labour productivity of young firms (solid line) and older firms (dashed line) over time.

[18] The reason behind this is that it takes time to make production efficient, build reputation, build a customer base, etc. (Foster et al., 2018, 2016; Jovanovic, 1982).

[19] The age of firms is calculated based on the year the firm is observed for the first time in the firm register database, which includes the entire population of firms starting from 1984.

Figure 6 shows the exit rate of firms within each productivity group (Panel A) and the development of labour productivity for firms that exit the economy the following year compared with firms that stay (Panel B). We rely on the population of firm registers to determine whether an incumbent firm exits or not.[20]

Figure 6 The share of firms that exit the following year



Note: Panel A shows the share of firms that exit the following year within each productivity group and year. Panel B shows the average labour productivity of firms that exit the following year (dashed line) and firms that continue to operate in the economy.

From Panel A in Figure 6, one can see that the least productive firms constitute the largest share of firms that exit the following year. This share drops as we move to the higher part of the productivity distribution. The exit rate, however, has been declining for all productivity groups. Panel B shows that firms exiting the following year have on average lower productivity than the firms that stay, and the difference has increased over time. This indicates that the lower part of the productivity distribution to some extent can be viewed as a transitory place where the less productive firms stay before leaving the economy, indicating a positive effect on structural change even though it is at a slower pace, i.e., the exit rate within this group has slowed down. Moreover, we have seen in that the share of new firms was higher by the end of the period of investigation compared to the beginning for most productivity groups, even though a consistent trend is not observed. The exception is the top two groups of firms (p60-90 and p90-100), where the share of young firms has decreased slightly. In Figure 6, we also observe a declining exit rate for all groups.

4.4 Productivity distribution and changing firm characteristics

As discussed in the previous section, the sets of laggard and frontier firms are not fixed groups over time. Thus, it is interesting to look at how firm characteristics in the different productivity groups have changed over time. We look at changes in average firm size and market size of the productivity groups measured by the number of employees, sales and value added. The choice of variables is motivated based on the growing body of literature that links firm size to high absorptive capacity for new technologies and thus

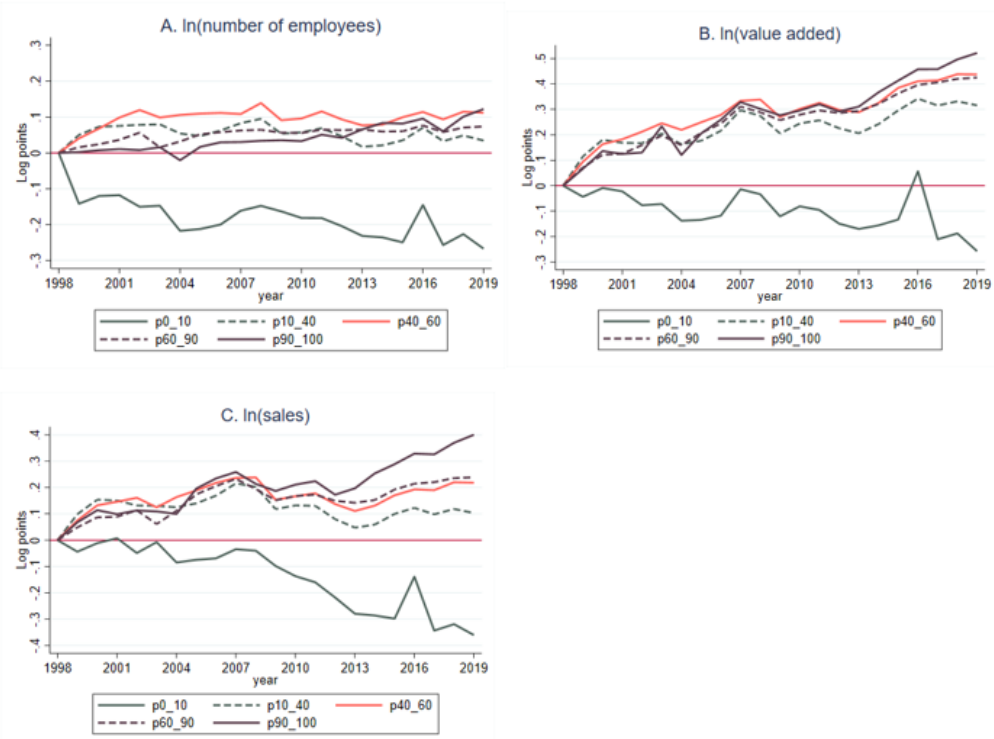
[20] A limitation of our definition is that an incumbent firm that changes its legal status due to merger or acquisitions, which corresponds to change of firm ID in the firms register, could be counted as exit from the economy. For this reason, the graph on exit rate should be interpreted with caution.

higher productivity growth (Berlingieri et al., 2018; Brynjolfsson et al., 2019). Moreover, productivity is a comparison of outputs and inputs, i.e., it can either increase by a reduction of inputs with the same output or an increase of outputs given the level of inputs. In addition, it refers to allocative efficiency, i.e., it is positive for aggregate productivity growth if more resources are allocated to the most productive firms (see (Criscuolo et al., 2022) that study this in detail).

Figure 7 presents the development of firm size measured by number of employees, value added and sales. Two interesting results emerge from the analysis. Firstly, the size of the firms within the least productive group, bottom 10 percent, has declined. During the past 20 years, the average number of employees in this group has declined by about 30 percent, while value added and sales have declined by approximately 40 and 30 percent, respectively. The shrinking size of firms among the bottom 10 percent may, in part, reflect the increased entry rate of newly founded firms, which tend be smaller and are overrepresented in this group. Regardless, the shrinking average size of the least productive firms is positive for aggregate productivity growth because a smaller part of the economy will be represented by this group.

Secondly, we find no visual evidence of an increased gap in terms of number of employees among the remaining four productivity groups, i.e., p10-40, p40-60, p60-90, and p90-100. However, we find divergence in terms of value added and sales. From Figure 7, we see that the productivity dispersion mainly relates to increases in output for all groups, except p0-10 where inputs and outputs decrease simultaneously.

Figure 7 The evolution of mean employment, value added and sales



In sum, the descriptive evidence shows that the bottom of part of the productivity distribution is overrepresented by firms that are relatively young or small and firms that exit the following year. This indicates that laggards can contribute to future aggregate

productivity growth either through exit of the least productive firms or through productivity growth of the surviving young and small firms. The bottom part of the distribution, i.e., the laggards, is studied in the next section. We focus on the bottom 40 percent and provide estimates of the convergence rate of the laggard firms compared to the technological frontiers, and how the rate of convergence changes over time.

5. Laggard firms and the rate of productivity convergence

According to neo-Schumpeterian growth theory, the firms at a greater distance from the frontier have opportunities to learn from the best, and are predicted to experience a relatively high productivity growth. However, it has been suggested that the rising importance of tacit knowledge in the production process and required complementary investments for digital technological adoption make it increasingly costly for laggard firms to adopt existing technology, thereby contributing to a slowdown in the productivity convergence rate of laggards over time (Akcigit and Ates, 2019; Andrews et al., 2016; Berlingieri et al., 2020). Thus, a slowdown in the convergence rate has been put forward as a potential explanation for the productivity divergence that has been observed globally over the past couple of decades. This section tests the above hypothesis by: i) estimating the productivity convergence rate of laggard firms; ii) examining whether the convergence rate has declined over time; and iii) investigating whether the rate of convergence is different depending on how digital and/or intangible asset intensive the sector is.

5.1 Empirical model

To empirically investigate the convergence rate of laggards, we follow the literature on convergence (Andrews et al., 2016; Berlingieri et al., 2020; Griffith et al., 2009). Equation 1 below estimates the baseline model for laggard firms, i.e., p0-40:

$$\Delta P_{ist} = \alpha + \beta_1 gap_{ist-1} + \delta \Delta P^F_{s,t} + \sum_k \theta_k X_{ist-1} + \delta_s + \gamma_t + \varepsilon_{ist}, \quad (1)$$

where ΔP_{ist} is the productivity growth of firm i in sector s and year t. P represents the logarithm of labour productivity. The above model describes the productivity growth of laggard firms as a function of the size of the productivity gap relative to the frontier firms (denoted by gap_{ist-1}, where $gap_{ist-1} = P_{ist-1} - P^F_{s,t-1}$) and of the productivity growth of frontier firms in the same sector and year (denoted $\Delta P^F_{s,t}$). X_{ist-1} represents model controls such as age and size of firms; δ_s represents sector fixed effect defined at two-digit industry classification; γ_t is year fixed effect; and ε_{ist} is the error term. The main parameter of interest is β_1, which represents the average rate of convergence of laggard firms.

5.2 Productivity convergence of laggard firms

The productivity convergence estimates for laggard firms are presented in Table 2. Column 1 shows the average productivity convergence, which corresponds to the β_1 in equation 1. We see here a positive productivity convergence of laggard firms, i.e., firms at a greater distance from the frontier in the same industry exhibit a relatively higher productivity growth. This is in line with Berlingieri et al. (2020); however, the coefficient is larger in Sweden than the OECD average in Berlingieri et al. (2020), meaning that the rate of catch-up is stronger.

Further, we explore whether the pace of convergence is different for sectors characterised by high intensity of digital technology compared to sectors with lower digital intensity. To investigate this, we estimate equation 1 by adding an interaction term between the

productivity gap (gap_{ist-1}) and a dummy variable that takes a value of 1 for digital-intensive sectors and 0 for less digital-intensive sectors in Column 2.

Table 2 Laggard firms and productivity convergence

Variables	Dependent variable: LP growth of laggards		
	(1)	(2)	(3)
Gap	0.352***	0.395***	0.412***
	(0.015)	(0.019)	(0.027)
Gap * Digital intensive		-0.069***	
		(0.025)	
Gap * Medium-low intangible intensive			-0.033
			(0.027)
Gap * Medium-high intangible intensive			-0.054*
			(0.029)
Gap * High intangible intensive			-0.135***
			(0.030)
Controls	Yes	Yes	Yes
Observations	828,591	828,591	828,591

Robust standard errors are in the parentheses
*** p0.01, ** p<0.05, * p<0.1

Column 2 reports the estimate for the productivity gap, which represents the convergence rate for less digital-intensive sectors, and the interaction effect captures the difference in convergence rate between these and the digital-intensive sectors. The results show a slower rate of convergence in digital-intensive sectors than less digital-intensive sectors. The difference is statistically significant at the 1 percent level. This is potentially due to the fact that it is more expensive with complementary investments in these sectors.

Finally, and similar to Column 2, we examine heterogeneity in the pace of convergence by interacting the gap variable with dummy variables for intangible asset intensity classified into low, medium-low, medium-high, and high intangible-intensive sectors in Column 3 (low intangible-intensive sectors are omitted). The results show a slower rate of convergence for laggard firms in sectors characterised by higher intensity of intangible assets. Additionally, the magnitude (speed) of convergence declines on average for each step.

5.3 Slowdown in convergence rate of laggard firms?

To empirically investigate whether convergence has slowed down over time, we estimate the following model:

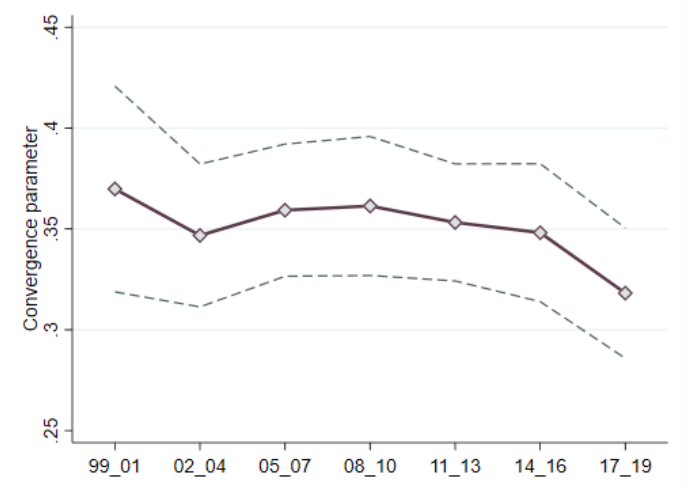
$$\Delta P_{ist} = \alpha + \delta \Delta P^{F}_{s,t} + \beta_1 gap_{ist-1} + \sum_j \beta_2^j gap_{ist-1} * D_t^j + \sum_k \theta_k X_{ist-1} + \delta_s + \gamma_t + \varepsilon_{ist} \qquad (2)$$

The above model is similar to equation 1 except that an interaction variable is added between the productivity gap (gap_{ist-1}) and time period dummies D_t^j, where j represents dummy variables for 1999-2001, 2002-2004, 2005-2007, etcetera. The main parameters of interest are β_1 and β_2^j. β_1 represents the average rate of convergence of laggard firms, while β_2^j represents the extent to which the rate of convergence differs over time. The

average convergence rate at a given period j can be obtained by adding the two parameters, i.e., $\beta_1 + \beta_2^j$.

Figure 8 presents the estimates of convergence rate of labour productivity for laggard firms over time. The figure shows a positive convergence parameter, implying convergence of laggard firms in terms of productivity. That is, firms that are further away from frontier firms in terms of productivity grow at a faster pace than firms that are relatively closer to the frontier, possibly taking advantage of the existing stock of technology. However, as can be seen in Figure 8 below, the rate of convergence shows a modest decline after the financial crisis. For instance, compared to the level in 2008-2010, the rate of convergence declined by approximately five percentage points at the end of the period.

Figure 8 Convergence rate of laggard firms over time



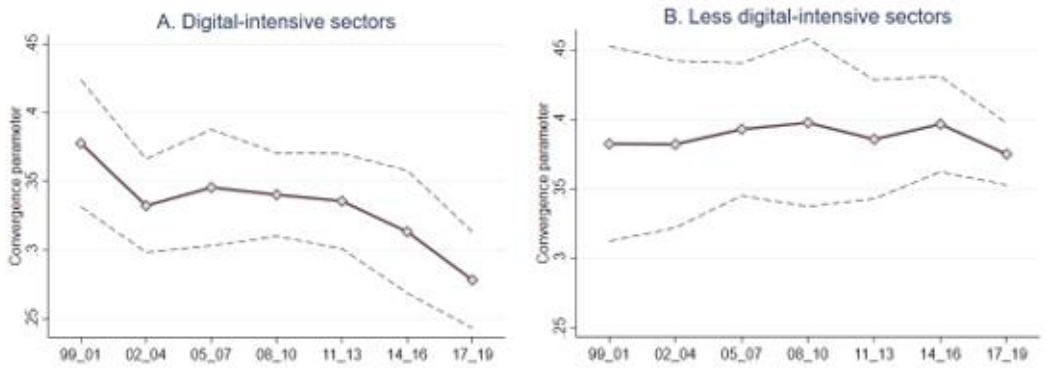
Note: The above figure shows the estimated convergence parameter over time; that is, the sum of the estimated parameters on gap (β_1) and its time dummy interaction (β_2^j), i.e., $\beta_1 + \beta_2^j$ from equation 2. The solid line corresponds to each point estimate and the 95 percent confidence interval is represented by the dashed lines.

The slowdown in the rate of convergence is often linked to increasing costs of technological adoption due to the rising importance of tacit knowledge and complementary investments in intangible assets (Akcigit and Ates, 2019; Corrado et al., 2021). This may serve as a competitive advantage for the firms at the frontier and a barrier to the adoption and diffusion of new technologies. In relation to the convergence rate of laggard firms, we see the tendency for a slowdown over time, and during this period we also see an increased importance of digital technologies. Moreover, Berlingieri et al. (2020) state that the slowdown can be linked to the increased importance of complementary investments due to structural transformation towards the use of more digital technologies. Thus, the slowdown over time might be driven by specific sectors.

In Figure 9, we show the heterogeneity in the convergence rate depending on the digital intensity at sector level. Each panel in Figure 9 is obtained from a separate regression of equation 2 depending on whether the sector is defined as digital intensive (Panel A) or less digital intensive (Panel B). As expected, the results show a decline in the rate of convergence in digital intensive sectors. From the period 1999-2001 to 2017-2019, the convergence parameter declined by approximately 10 percentage points in digital

intensive sectors. In addition, during the same period, the convergence parameter was less in digital-intensive sectors. This result does not imply that high digital intensity is bad for aggregate productivity growth in general, but it can be a problem at the bottom of the distribution. For example, the scarcity of digital competence is generally raised as a problem for firms. Tillväxtverket (2022) raises three areas of importance in relation to this: i) increased collaboration to enhance digital front edge competence, ii) education and research in digital areas, and iii) increased knowledge through statistics and forecasts.

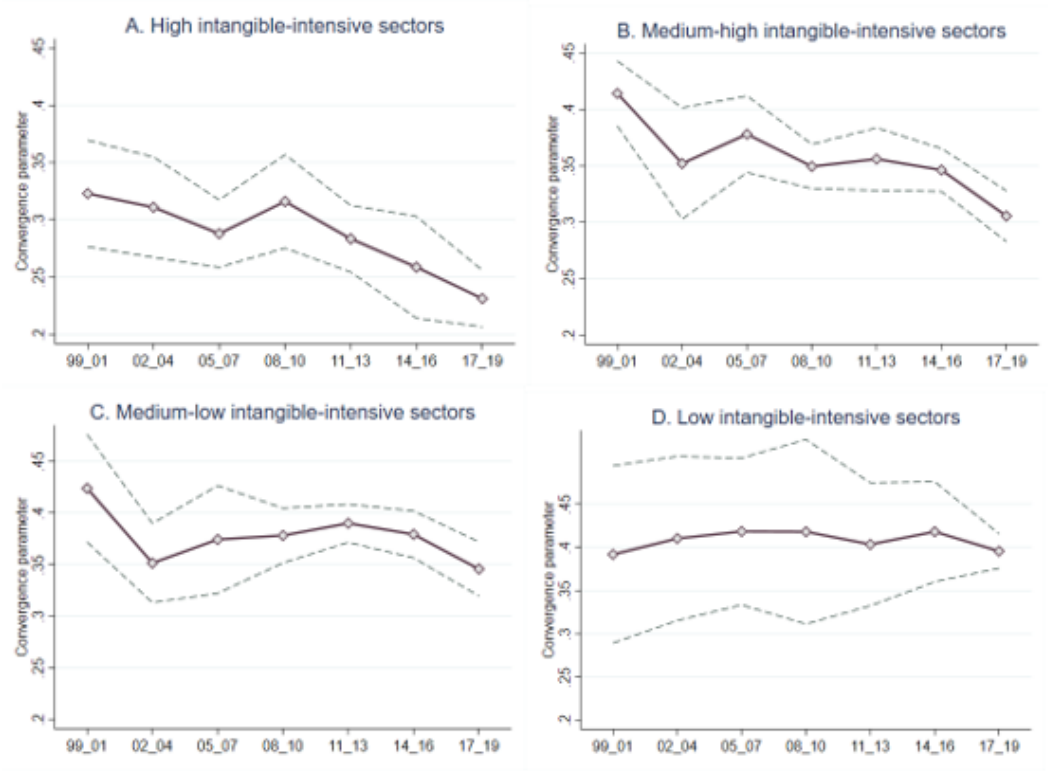
Figure 9 Convergence rate of laggard firms' labour productivity, by digital intensity



Note: Panels A and B show the convergence parameter ($\beta_1 + \beta_2^j$) from a separate regression of equation 2, respectively, for digital-intensive and less digital-intensive sectors. The point estimate is represented by the solid line and the dashed lines represent a 95 percent confidence interval. Approximately 56 of the industries in our data are classified as digital intensive.

Figure 9 shows estimates of convergence rate by intangible asset intensity of sectors. The results are separated as in Table 2 and Figure 4, i.e., four quartiles.

Figure 10 Convergence rate of laggard firms' labour productivity, by intangible asset intensity



Note: Panels A to D show the convergence parameter ($\beta_1 + \beta_2^j$) from a separate regression of equation 2, respectively, for high, medium-high, medium-low and low intangible-intensive sectors. The point estimate is represented by the solid line and the dashed lines represent a 95 percent confidence interval.

We see in Figure 10 that the decline in convergence over time is driven by the sectors with a high share of intangibles. These findings indicate, but not causally, the presence of increasing barriers to the adoption and diffusion of new technologies in sectors that are characterised by high digital and intangible asset intensity.

5.4 Trends in productivity of laggard and frontier firms defined at a given year

It may seem contradictory that the regression results in sections 5.2 and 5.3 indicate productivity convergence of laggard firms, while at the same time the development of productivity in sections 4.1 and 4.2 points to an increasing productivity gap between frontiers and laggards. One explanation, as discussed in beginning of section 5, is that the increased productivity gap can partly be attributed to the slowdown in the convergence rate over time. Another explanation relates to the way the productivity groups are defined. In section 4, a firm is allowed to move to a higher or lower productivity group depending on whether a firm has had a positive or negative productivity growth. In section 5, however, we define a firm's productivity group at time t-1 and calculate the productivity growth (catch-up rate) at time t, irrespective of the firm's productivity group at time t. This section builds on the analysis in section 5 and examines trends in labour productivity of firms grouped according to their productivity in 2005.[21] Firms that enter

[21] This is to show the pattern; the results are similar regardless of the chosen period.

the economy after 2005 are excluded from the sample. The results normalised in 2005 are presented in Panel A of Figure 11 and the development of the productivity level is shown in Panel B.

Figure 11 Development in labour productivity (in logs) of firms grouped according to their productivity level in 2005 (panel data)

Note: Panel A shows the development of labour productivity, where the initial year is normalised to zero. Panel B shows the same without normalising at the first year. The sample in the above figure is restricted to firms that were observed in 2005. This means that it does not include firms that entered the economy after 2005.

Panel A of Figure 11 shows a greater increase in labour productivity for the low-productive firms in line with the analysis in section 5. This might seem surprisingly strong, but it is important to bear in mind that it starts from a low level and the share that remains in the economy is expected to grow fast. Additionally, we see that firms with the highest productivity in the year 2005 on average have a decline in productivity over the period. However, this group remains the most productive, as we can see from Panel B, i.e., the laggards do no catch up fully to the frontiers. In fact, each group is, on average, placed at the same relative level during the whole period, e.g., p60-90 is always less productive than p90-100 and p10-40 is always behind p40-60. The main implication is that the convergence rate of laggards is not high enough to make the average productivity of the groups to become the same over time. We are unaware of whether a similar pattern has occurred in other countries, as previous studies on the topic allow the sample to change between years as we did in previous sections.

To summarise, the results are not contradictory, i.e., a catch-up is observed even though it is slowing down over time, at the same time as the productivity difference between high- and low-productive firms has increased.

6. Conclusions and discussions

This report investigates productivity development over time for different groups in the productivity distribution in Sweden. It shows that productivity dispersion has increased over time, i.e., there is a larger difference in productivity level between the most and least productive firms by the end of the period of investigation compared to the beginning. The increase in dispersion is visually larger in the manufacturing sector and smaller in non-manufacturing compared to the average in several OECD countries, which can be made until 2012.

We find a positive catch-up rate of laggard firms. However, there is a tendency for this catch-up effect to decline over time, i.e., laggard firms converge at a slower pace during the end of the period compared to the beginning. In general, the increased dispersion is relatively similar for manufacturing and non-manufacturing sectors. The difference is that the frontiers in the manufacturing sector have slightly stronger productivity growth at the top, contributing to a larger productivity dispersion in this sector. Further separating sectors by digital and intangible intensity, we find that the productivity gap increases more in digital-intensive and intangible-intensive sectors compared to sectors with lower digital and intangible intensity. Similar differences are observed between these groups of sectors when studying the catch-up effect, i.e., the decline in catch-up rate is driven by digital industries.

We see that most parts of the productivity distribution have a positive productivity growth over time. However, the bottom 10 percent stands out and is, in principle, at the same level compared to the base year during the whole period. Worth bearing in mind when making an interpretation of this is that the bottom group is characterised by a large share of new firms and a higher exit rate than the average firm, and it is common that firms change productivity group. For example, only 17 percent of the firms in this group remain there for three years. To further obtain a picture of these firms over time, we fixed a cohort of firms representing the different productivity groups in the year 2005 and followed them over time. We observe that the bottom 10 percent has a substantially higher productivity growth than the rest and that frontier firms, i.e., top 10 percent, have a negative development on average in relation to the reference year. However, looking at the different productivity levels, we see that the average for each group remains at the same relative productivity position.

There are many interesting policy questions to be raised in relation to the analysis of the increased productivity dispersion. We cannot isolate whether one or another should be focused on; however, we provide a brief discussion of potential policies that have been put forward in the literature.

Increased productivity dispersion can make aggregate productivity growth higher if it is driven by large increases at the top, which relates to the debate around superstar firms. In the short term, productivity dispersion at the top of the distribution is positive, given that it is driven by positive effects of innovation among the frontiers which will generate a higher aggregate productivity growth. Moreover, it is positive, at least in the short term, if the market share of the high-productive firms increases. In the long run, however, it can be negative if there are a few highly productive companies that drive the

development and if they are able to create barriers to knowledge diffusion via, for example, purchase of patents (Akcigit and Ates, 2019; De Ridder, 2019). This may make it more difficult for small firms to grow (Autor et al., 2020). For Sweden, we did not econometrically study the top of the distribution separately; however, we did not see a large increase in dispersion at the top of the distribution in the graphical analysis, i.e., between frontiers and median firms. However, we observe that the Swedish frontiers grew less than the global frontiers compared to Andrews et al. (2016). Our focus is mainly on the bottom 40 percent of the productivity distribution, where we saw convergence to the frontier, but the pace slows down over time, a result driven by sectors characterised by digital and intangible intensity. The slower convergence rate is, therefore, to some extent and explanatory factor of lower aggregate productivity growth. We did not investigate why dispersion occurs on different parts of the distribution, but Corrado et al. (2021) show that divergence at the top is at least partly driven by scalability, and they claim that factors of importance for the bottom part is likewise, but not causally, lack of digitalisation and venture capital.

Specific policy interventions are not studied explicitly here. However, previous research has discussed general policies of spurring aggregate productivity growth by promoting the spread of new technologies and knowledge (e.g. Andrews et al., 2016; Berlingieri et al., 2020; Corrado et al., 2021). High education level is normally seen as most important to spread knowledge. Further, enhancing labour market mobility and collaboration is particularly important for spreading knowledge. As Corrado et al. (2021) claim the importance of venture capital at the bottom of the distribution, different kinds of monetary support can be relevant in specific situations. Such policies would probably have the largest productivity effect if low-productive firms with the potential to become frontiers were identified in order to give them the monetary capacity to reach their full potential. However, the trickier question is how to identify these firms, which is not within the scope of this report. Also, it is important not to give support to firms that slow down structural change (e.g., zombie firms that have remained consistently in that group), as this would harm creative destruction.

All in all, it becomes of importance to both foster innovative activity for the most productive firms and strengthen the economy to manage diffusion of new technologies as widely as possible, which is also pointed out by Corrado et al. (2021). In particular, Corrado et al. (2021) state the importance of policies that encourage intangible investments.

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Appendix

Table A1 Classification of two-digit industries by digital and intangible asset intensity.

SNI 2007	Description	Digital intensity	Intangible asset intensity
05	Mining of coal and lignite	Less digital intensive	Medium-Low
06	Extraction of crude petroleum and natural gas	Less digital intensive	Medium-Low
07	Mining of metal ores	Less digital intensive	Medium-Low
08	Other mining and quarrying	Less digital intensive	Medium-Low
09	Mining support service activities	Less digital intensive	Medium-Low
10	Manufacture of food products	Less digital intensive	Medium-Low
11	Manufacture of beverages	Less digital intensive	Medium-Low
12	Manufacture of tobacco products	Less digital intensive	Medium-Low
13	Manufacture of textiles	Less digital intensive	Medium-Low
14	Manufacture of wearing apparel	Less digital intensive	Medium-Low
15	Manufacture of leather and related products	Less digital intensive	Medium-Low
16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	Digital intensive	Medium-Low
17	Manufacture of paper and paper products	Digital intensive	Medium-High
18	Printing and reproduction of recorded media	Digital intensive	Medium-High
19	Manufacture of coke and refined petroleum products	Less digital intensive	Medium-Low
20	Manufacture of chemicals and chemical products	Less digital intensive	High
21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	Less digital intensive	High
22	Manufacture of rubber and plastic products	Less digital intensive	Medium-High
23	Manufacture of other non-metallic mineral products	Less digital intensive	Medium-Low
24	Manufacture of basic metals	Less digital intensive	Medium-High
25	Manufacture of fabricated metal products, except machinery and equipment	Less digital intensive	Medium-High
26	Manufacture of computer, electronic and optical products	Digital intensive	High
27	Manufacture of electrical equipment	Digital intensive	High
28	Manufacture of machinery and equipment n.e.c.	Digital intensive	High

SNI 2007	Description	Digital intensity	Intangible asset intensity
29	Manufacture of motor vehicles, trailers and semi-trailers	Digital intensive	High
30	Manufacture of other transport equipment	Digital intensive	High
31	Manufacture of furniture	Digital intensive	High
32	Other manufacturing	Digital intensive	High
33	Repair and installation of machinery and equipment	Digital intensive	High
35	Electricity, gas, steam and air conditioning supply	Less digital intensive	Medium-Low
36	Water collection, treatment and supply	Less digital intensive	Low
37	Sewerage	Less digital intensive	Medium-Low
38	Waste collection, treatment and disposal activities; materials recovery	Less digital intensive	Medium-Low
39	Remediation activities and other waste management services	Less digital intensive	Medium-Low
41	Construction of buildings	Less digital intensive	Low
42	Civil engineering	Less digital intensive	Low
43	Specialised construction activities	Less digital intensive	Low
45	Wholesale and retail trade and repair of motor vehicles and motorcycles	Digital intensive	Medium-Low
46	Wholesale trade, except of motor vehicles and motorcycles	Digital intensive	Medium-High
47	Retail trade, except of motor vehicles and motorcycles	Digital intensive	Medium-Low
49	Land transport and transport via pipelines	Less digital intensive	Medium-Low
50	Water transport	Less digital intensive	Medium-Low
51	Air transport	Less digital intensive	Low
52	Warehousing and support activities for transportation	Less digital intensive	Medium-Low
53	Postal and courier activities	Less digital intensive	Medium-Low
55	Accommodation	Less digital intensive	Low
56	Food and beverage service activities	Less digital intensive	Low
58	Publishing activities	Digital intensive	High
59	Motion picture, video and television programme production, sound recording and music publishing activities	Digital intensive	High
60	Programming and broadcasting activities	Digital intensive	High
61	Telecommunications	Digital intensive	Medium-High
62	Computer programming, consultancy and related activities	Digital intensive	High
63	Information service activities	Digital intensive	High

SNI 2007	Description	Digital intensity	Intangible asset intensity
68	Real estate activities	Less digital intensive	Low
69	Legal and accounting activities	Digital intensive	High
70	Activities of head offices; management consultancy activities	Digital intensive	High
71	Architectural and engineering activities; technical testing and analysis	Digital intensive	High
72	Scientific research and development	Digital intensive	High
73	Advertising and market research	Digital intensive	High
74	Other professional, scientific and technical activities	Digital intensive	High
75	Veterinary activities	Digital intensive	High
77	Rental and leasing activities	Digital intensive	Medium-Low
78	Employment activities	Digital intensive	Medium-High
79	Travel agency, tour operator and other reservation service and related activities	Digital intensive	Medium-High
80	Security and investigation activities	Digital intensive	Medium-High
81	Services to buildings and landscape activities	Digital intensive	Medium-High
82	Office administrative, office support and other business support activities	Digital intensive	Medium-High

Note: "Digital intensive" are sectors in the upper two quantiles of the digital intensity index according to Calvino et al. (2018), while "Less digital intensive" are sectors in the lower two quantiles. In the last column, Low, Medium-Low, Medium-High and High correspond to the bottom quantile, 2nd quantile, 3rd quantile and top quantile of firms according to the sectors' average expenditure on intangible asset.

Figure A1 Labour productivity dispersion in Sweden (Swedish data)

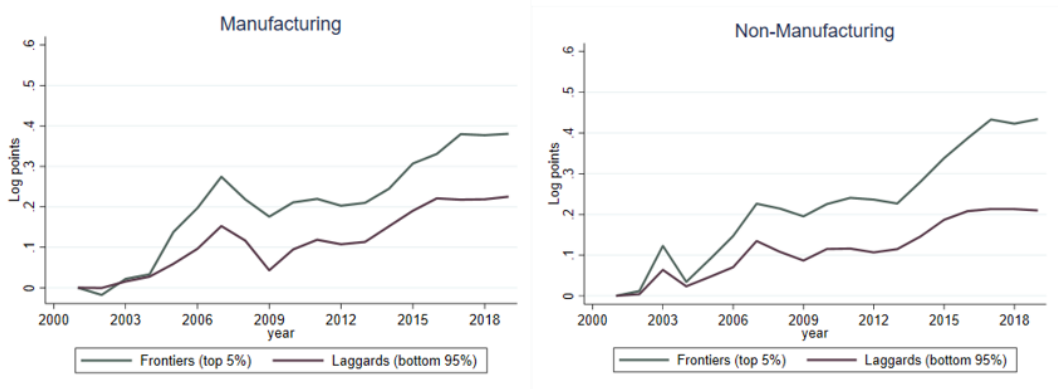

Figure A2 Development of labour productivity dispersion in OECD countries taken from Andrews et al. (2016)

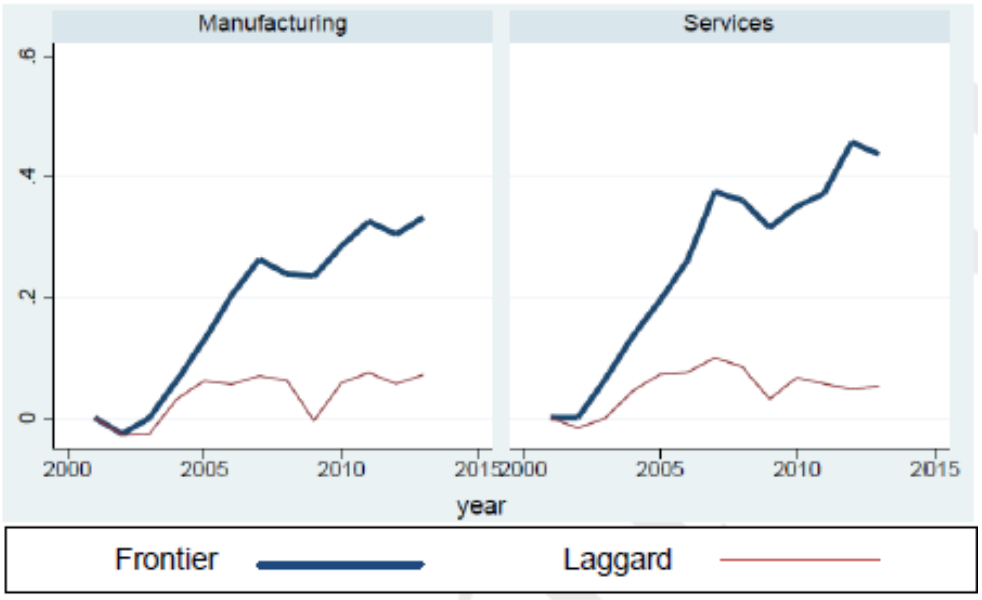

Figure A3 Dummy variable regressions of labour productivity dispersion over time

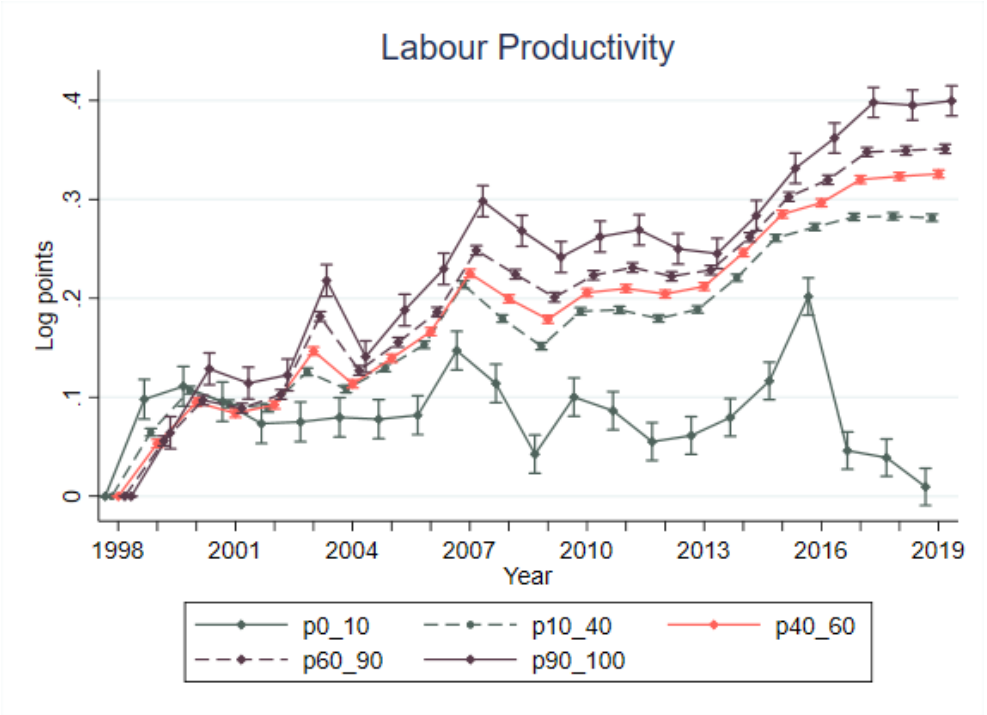

Figure A4 Firm size by year

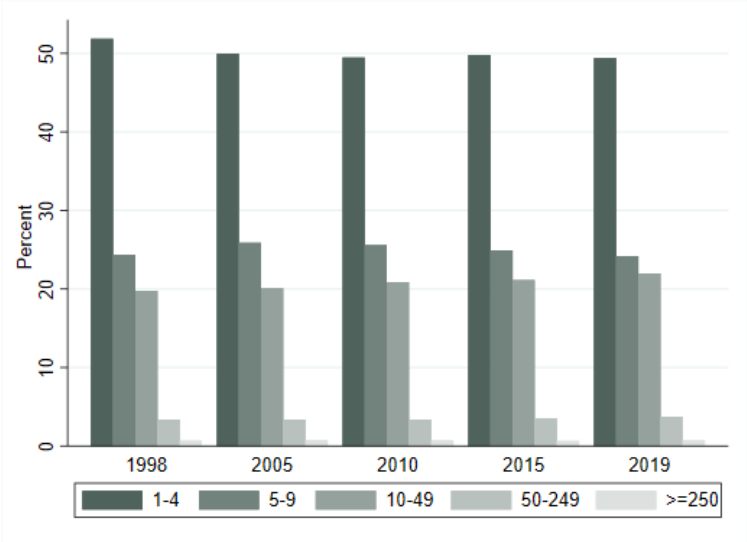

Figure A5 Share of zombie firms over time

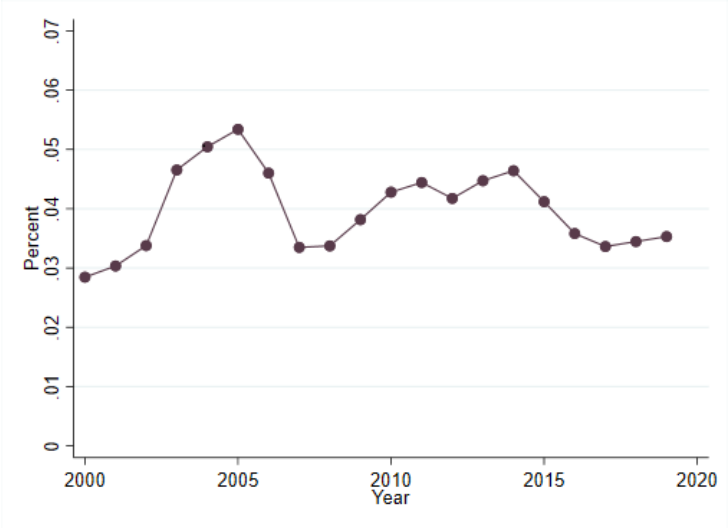

Table A2 Share of firms that remain zombies over time

	Productivity groups				
Variables	p0_10	p10_40	p40_60	p60_90	p90_100
Zombie	.10	.06	.03	.02	.01
Zombie t+1	.04	.03	.01	.007	.004
Zombie t+3	.01	.007	.004	.002	.001

Table A3 Summary statistics of the productivity groups for digital intensive sectors

	Productivity groups				
Variables	p0_10	p10_40	p40_60	p60_90	p90_100
Labor productivity (log)	11.60	12.61	12.96	13.27	13.93
Employment	8.53	10.53	17.31	24.59	28.51
Age	11.81	12.40	13.06	13.67	13.42
Share of employment	0.05	0.20	0.20	0.41	0.15
Value added (log)	12.70	14.12	14.76	15.24	15.65
Share of value added	0.01	0.10	0.14	0.42	0.32
Capital-labor ratio (log)	11.60	11.57	11.74	12.01	12.47
Net sales (log)	14.16	15.20	15.81	16.29	16.67
Wage rate (log)	11.46	12.17	12.43	12.59	12.82
Stay *t*+1*	0.48	0.57	0.39	0.60	0.60
Stay *t*+1, *t*+2 & *t*+3	0.18	0.27	0.09	0.31	0.34
Change LP group at *t*+1	0.46	0.38	0.57	0.37	0.37
Change LP group at *t*+1, *t*+2 & *t*+3	0.70	0.65	0.85	0.64	0.62
Exit the economy at *t*+1	0.07	0.04	0.04	0.03	0.02
Exit the economy at *t*+1, *t*+2 & *t*+3	0.12	0.07	0.06	0.05	0.04
Share of zombie firms (baseline sample) **	0.06	0.04	0.02	0.01	0.01
Share of zombie firms (Sub-sample of firms aged>=10)	0.11	0.07	0.03	0.02	0.01
Observations	139,401	417,185	277,694	416,487	138,573

Note: Each cell reports the average values of the variables list in the left column during the period 1998-2019.

** The variables Stay t+1, Change LP group at t+1 and exit the economy at t+1, respectively, indicate the fraction of firms that would stay, change productivity group and leave the economy after one year. Similarly, the variables Stay t+3, Change LP group at t+3 and exit the economy at t+3, respectively, indicate the fraction of firms that would stay, change productivity group and leave the economy after three years.*

*** The share of zombie firms appears smaller in the baseline sample because the reference group includes all firms (i.e., also age<10), a group that normally are excluded from the analysis when zombie firms are studied.*

Source: Own calculations based on data from SCB.

Table A4 Summary statistics of the productivity groups for less digital intensive sectors

	Productivity groups				
Variables	p0_10	p10_40	p40_60	p60_90	p90_100
Labor productivity (log)	11.78	12.62	12.93	13.23	13.85
Employment	6.72	11.31	15.44	21.03	20.02
Age	11.46	12.13	13.04	13.81	13.96
Share of employment	0.05	0.20	0.20	0.41	0.15
Value added (log)	12.97	14.27	14.81	15.15	15.37
Share of value added	0.01	0.10	0.14	0.42	0.32
Capital-labor ratio (log)	12.08	12.04	12.28	12.76	13.51
Net sales (log)	14.15	15.12	15.63	15.97	16.15
Wage rate (log)	11.52	12.15	12.36	12.47	12.62
Stay *t*+1*	0.44	0.54	0.37	0.57	0.56
Stay *t*+1, *t*+2 & *t*+3	0.16	0.23	0.08	0.28	0.30
Change LP group at *t*+1	0.50	0.41	0.59	0.40	0.42
Change LP group at *t*+1, *t*+2 & *t*+3	0.73	0.70	0.86	0.68	0.66
Exit the economy at *t*+1	0.06	0.04	0.04	0.03	0.02
Exit the economy at *t*+1, *t*+2 & *t*+3	0.11	0.07	0.05	0.04	0.04
Share of zombie firms (baseline sample) **	0.05	0.03	0.02	0.01	0.01
Share of zombie firms (Sub-sample of firms aged>=10)	0.09	0.06	0.03	0.02	0.01
Observations	110,678	330,548	220,659	330,161	109,784

Note: Each cell reports the average values of the variables list in the left column during the period 1998-2019.

** The variables Stay t+1, Change LP group at t+1 and exit the economy at t+1, respectively, indicate the fraction of firms that would stay, change productivity group and leave the economy after one year. Similarly, the variables Stay t+3, Change LP group at t+3 and exit the economy at t+3, respectively, indicate the fraction of firms that would stay, change productivity group and leave the economy after three years.*

*** The share of zombie firms appears smaller in the baseline sample because the reference group includes all firms (i.e., also age<10), a group that normally are excluded from the analysis when zombie firms are studied.*

Source: Own calculations based on data from SCB.

På vilket sätt statens insatser bidrar till svensk tillväxt och näringslivsutveckling står i fokus för våra rapporter.

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