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Albert Bravo-Biosca

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Albert Bravo-Biosca
Nesta & Barcelona GSE

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Abstract

We present a newly-developed database that measures the distribution of firm growth across twelve countries, building on confidential microdata from business registers in the US and Europe that cover the universe of firms. We document not just average growth but also the growth rate for all the percentiles of the growth distribution, breaking it down by size, sector and age. We identify a number of stylized facts that hold across countries, but also show that there are significant differences in their growth distributions. Firms in the US grow and shrink more rapidly than in Europe, which has a much larger share of static firms, for which employment does not vary much (up or down). Finally, we find that a more dynamic growth distribution is associated with faster productivity growth, and this relationship becomes stronger as countries converge to the global technology frontier (specifically, a 5pp higher share of static firms is associated with 1pp lower productivity growth).

JEL Classification: D22, L11, O49

Keywords: growth, firm dynamics, productivity

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1 Introduction

Creative destruction is one of the driving forces of economic growth.[2] But despite the importance of firm growth dynamics in this process, there is limited cross-country comparable data on them. This paper aims to fill this gap. We collect harmonized micro aggregated data from official business registers, which provide quasi-universal coverage of business activity in all sectors of the economy, and develop a new database of firm growth distributions for 12 countries, including the US and several small and large European economies.[3] With it, we present a series of stylized facts that hold across the sample, identify differences in firm growth dynamics across countries (particularly between Europe and the US), and examine its effect on productivity growth.

The interest in firm growth dynamics is not new. Gibrat's law, which asserts that firm growth is independent of firm size (Gibrat, 1931), has been intensively scrutinized.[4] Resource-based and evolutionary theories (Penrose, 1959; Nelson & Winter, 1978), learning and selection models (Jovanovic, 1982; Hopenhayn, 1992) and, more recently, financial constraints models (Cooley & Quadrini, 2001; Cabral & Mata, 2003; Arellano, Bai, & Zhang, 2009), customer acquisition models (Arkolakis, 2011; Dinlersoz & Yorukoglu, 2012) and ex-ante heterogeneity theories (Holmes & Stevens, 2010; Hurst & Pugsley, 2011)[5] have been used to explain several stylized facts on firm growth.[6] Recent work has also explored the shape of the firm growth distribution (Bottazzi & Secchi, 2006). And a large literature has examined jobs flows and the contribution of different groups of firms to job creation (see Haltiwanger 2012 for a review). Much of this research has used single country datasets, often based on small sample surveys or incomplete commercial databases, and frequently only capturing manufacturing sectors.[7] Thus, we exploit this more

[2] Schumpeter (1942).

[3] More specifically, the countries currently included are: Austria, Canada, Denmark, Finland, Greece, Italy, the Netherlands, New Zealand, Norway, Spain, the UK and the US.

[4] See for instance Mansfield (1962), Ijiri and Simon (1977), Hall (1987), Hart and Oulton (1996) and Geroski and Gugler (2004).

[5] This includes recent but also earlier work that highlights ex-ante heterogeneity in entrepreneurs' characteristics and/or motivation (i.e., the large proportion of entrepreneurs with non-pecuniary motives (or subsistence-driven) interested in creating lifestyle businesses with no ambition to grow, often characterized as "replicative", "followers" or "imitators") or in the market segments that they intend to serve, even within narrowly defined sectors (i.e., standardized vs. custom or specialty goods).

[6] See Caves (1998) or Coad (2007) for a survey of the literature on firm growth.

[7] For instance, while much of the literature on business growth has looked at publicly traded firms, Davis, Haltiwanger, Jarmin, & Miranda (2007) shows that the dispersion of business growth rates is considerably greater for privately held US firms than public firms (even if both have converged in more recent years).

comprehensive database to discuss several stylized facts on firm dynamics and their robustness across countries and sectors.

Differences in firm growth dynamics across countries have also attracted much interest, particularly among policy makers. Most cross-country research has focused however on firm entry and exit rather than growth due to data constraints, so the evidence is limited. Bartelsman, Haltiwanger and Scarpetta (2004) conclude that entry and exit rates across developed countries are fairly similar, and instead highlight the large US-Europe differences in the growth rate of surviving new entrants.[8] European countries have fewer “gazelles” and high-growth firms than the US (OECD, 2008). And, while the US and Europe have a similar number of companies in the ranking of the world’s 500 largest companies by market capitalization, only 3 of the European companies in the list were founded after 1975, in sharp contrast with 25 in the US (Véron, 2008).[9] We expand upon this work by examining the full distribution of firm growth across countries. In other words, not just looking at the “average firm” or at a subset of firms, whether the young, the largest, or the fastest growing ones, but instead providing a complete picture of how firms expand and shrink in each economy, using comparable data extracted with the same methodology and definitions in partnership with national statistical offices or local researchers. We identify sizeable differences, with US firms growing and shrinking much faster across sectors and sizes, while European firms being much more likely to remain stable.

Firm growth dynamics can help explain differences in aggregate productivity growth across countries, such as the widening productivity gap between Europe and the US over the last two decades (Ark, O'Mahony, & Timmer, 2008). The reallocation of output and labour towards more productive plants accounts for about half of total factor productivity growth in US manufacturing (Baily, Hulten, Campbell, Bresnahan, & Caves, 1992; Haltiwanger, 1997).[10] A more dynamic growth distribution implies faster resource reallocation. It is also a signal of higher competitive pressures, which force firms to improve their performance and raise within-firm productivity growth (Bartelsman, Haltiwanger, & Scarpetta, 2004). We use a differences-in-

[8] Bartelsman, Scarpetta and Schivardi (2003) assemble a new dataset for the 1980s and mid-1990s based on harmonized national microdata sources and provide measures of survival and growth of new entrants for up to seven years for 10 OECD countries, later expanded to 17 with the inclusion of some developing countries (Bartelsman, Haltiwanger, & Scarpetta, 2004).

[9] Respectively, 2% vs. 14% of the European and US companies included in the FT Global 500 ranking in 2007. Aghion and Howitt (2006) provide an illustrative example of what may underlie this difference: “50% of new pharmaceutical products are introduced by firms that are less than 10 years old in the United States, versus only 10% in Europe”.

[10] More recent analysis confirms that over half of within industry labour productivity growth for continuing firms is attributable to employment being reallocated from less productive to more productive firms within the industry (Haltiwanger J. , Jarmin, Kulick, & Miranda, 2016). Differences in allocative efficiency are therefore a substantial driver of cross-country differences in productivity levels (Bartelsman, Haltiwanger, & Scarpetta, 2013).

differences approach to test whether country-industry pairs with fewer static firms are associated with faster productivity growth and find this to be case. Both a larger share of growing and shrinking firms are associated with faster labour and total factor productivity growth.

Schumpeterian growth models also predict that experimentation and selection become more important as industries converge to the global technology frontier (Acemoglu, Aghion, & Zilibotti, 2006). While far from the frontier firms can improve their productivity by imitating what others have already invented, at the frontier they need to innovate. But innovation is risky and the outcome uncertain, so only the successful few expand while the unsuccessful ones shrink. Our findings support this hypothesis. A very static business growth distribution has a particularly strong negative effect on productivity growth the closer industries are from the global technology frontier.

Finally, a growing literature examines the role of factors such as regulation, finance, institutions or culture in explaining differences in firm dynamics across countries.[11] But while entry, expansion, contraction and exit are all part of the resource reallocation process, much of this work has focused exclusively on entrepreneurial activity. This database thus creates a new resource to examine what the drivers and barriers to firm growth are, which Bravo-Biosca, Criscuolo & Menon (2016) exploit to address some of these questions.

Structure of the paper

This paper is organized as follows. Section 2 describes the database, the data collection process and the construction of the growth distributions. Section 3 presents some stylized facts on the distribution of firm growth and employment dynamics, while Section 4 discusses some of the cross-country differences observed.[12] Section 5 examines the links between firm growth dynamics and productivity growth and Section 6 concludes.

A separate appendix available online includes additional information on the database and extensive supplementary tables and figures, which provide data for all the indicators discussed

[11] See for instance Scarpetta, et al. (2002), Desai, Gompers and Lerner (2003), Fogel, et al. (2006), Klapper, Laeven and Rajan (2006), Aghion, Fally and Scarpetta (2007), Aidis, Estrin and Mickiewicz (2007), Alfaro and Charlton (2007) and Klapper, Amit, et al. (2007).

[12] A policy report summarizing some early findings on the differences between Europe and the US is also available online (Bravo-Biosca, Growth Dynamics: Exploring business growth and contraction in Europe and the US, 2010), as a well as a paper with additional information on high-growth firms and job creation, including policy implications (Bravo-Biosca, 2011).

here (and others) at a more disaggregated level. A version of the database as well as "non-technical" summaries are also available for download.[13]

2 The database

We measure the distribution of firm growth using confidential microdata extracted from official business registers in 12 developed countries: Austria[14], Canada[15], Denmark, Finland, Greece, Italy, the Netherlands, New Zealand, Norway, Spain, the UK[16] and the US.

Business registers are assembled with data collected from social security records, tax records, censuses and/or other administrative sources.[17] Thus, they provide the most comprehensive coverage of economic activity in any country, basically covering the universe of firms (in contrast to commercial providers, whose coverage of business activity is limited and differs across countries). However, access to the data is very restricted, so we follow the approach used by other researchers (Bartelsman, Haltiwanger, & Scarpetta, 2004; Brandt, 2004; OECD, 2008) and partner with each country's national statistical offices or, alternatively, with researchers based there with authorized access to the microdata. We provide them with a methodology manual and a code file to extract data, building whenever feasible on the Eurostat-OECD Business Demography Manual (2007), which most business registers are required to follow. The datasets submitted are then scrutinized to identify potential inconsistencies and, if necessary, subjected to a process of revisions with each country partner.

2.1 Data collected

We collect data on employment growth between 2002 and 2005. In addition, whenever feasible we also collect data for other 3-year periods (2004-07 or 2005-08), for longer time periods (5-year growth or longer) and for turnover growth. The population of firms consists of all active

[13] Available at www.nesta.org.uk/wp16-03.
[14] The data for Austria is extracted from social security records, in which the administrative unit can be both the establishment and the firm (the firm chooses how to report), so while it is the most internationally comparable source of data available, there are some limitations in its comparability.
[15] Canada only provided data for firms with 10-250 employees, so any aggregate indicator referring to firms with ten or more employees only includes data for the 10-250 size class for Canada.
[16] This work contains statistical data from ONS which is Crown copyright and reproduced with the permission of the controller of HMSO and Queen's Printer for Scotland. The use of the ONS statistical data in this work does not imply the endorsement of the ONS in relation to the interpretation or analysis of the statistical data. This work uses research datasets which may not exactly reproduce National Statistics aggregates.
[17] See appendix for a detailed description of data sources for each country, as well as coverage, exclusions and limitations.

employer enterprises (with at least one employee) in the private sector (ISIC sector 10_74) that have survived during the measurement period. In addition to non-survivors, enterprises born in the initial year are also excluded from the analysis.[18] The overall number of firms in the participating countries that satisfy these criteria is six million, which employed over 120 million people in 2002 (Table 1 provides a breakdown of the sample by country).

Table 2 provides a breakdown of the sample by firm size. Firms with less than 50 employees account for 95% or more of all surviving firms in all countries, even if typically represent less than half of employment. There are however large differences in the size distribution across countries, also within sectors (see appendix). For instance, countries like Greece, Spain and Italy have the highest proportion of employment in micro firms. Despite being much larger countries, average Spanish or Italian firms are smaller than Danish or Dutch firms. Therefore, comparisons based on commercial databases, which typically only have good data for firms over 50 employees (or just for public companies), not only miss a large share of the economy, but also of a different magnitude in each country.

For each firm we compute the average annualised growth rate[19] and allocate the firm into one of the 11 growth categories.[20] The data is then collapsed into 11 cells that summarize the growth distribution, containing the number of firms for which the growth rate falls within the interval (see Table 3 for summary statistics). In addition, for each cell the initial and final number of employees (and turnover, whenever feasible) are also computed. Overall statistics on the number of employer-firms surviving from time t-i to t relative to the total number of employer-firms at time t-i are also produced.

Growth distributions are constructed at the aggregate country level but also broken down for up to 51 sectors, 10 size classes and 10 age intervals.[21] The sector breakdown is made at the 2-digit ISIC sector level, although data for some 3-digit subsectors is also collected. Size classes

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[18] A firm's operating period in the birth year may be only a few months or weeks long, which would result in distorted annual turnover growth measures. Therefore, to ensure that growth rates in employment and turnover are always identified from the same base population, enterprises born in the first year of the period were excluded from the growth measurement.

[19] Specifically, $growth_{j,t,t-3} = [(employees_{j,t}/employees_{j,t-3})^{1/3}-1] \times 100$. The alternative approach would have been using logs or an averaged denominator (Davis, Haltiwanger, & Schuh, Job Creation and Destruction, 1996), which is better at dealing with micro firms growth rates and regression to the mean effects. While they all have advantages and disadvantages, our choice was ultimately driven by the growth rate being used by most partner countries in their existing work with the OECD-Eurostat EIP programme, as defined in the Eurostat-OECD Manual on Business Demography Statistics (Eurostat & OECD, 2007).

[20] Specifically, the 11 growth intervals considered are:]-∞;-20[, [-20;-15[, [-15;-10[, [-10;-5[, [-5;-1[, [-1;1[, [1;5[, [5;10[, [10;15[, [15;20[and [20; ∞[.

[21] See appendix for a detailed breakdown of the sector, age and size classes considered.

are based on the firm's initial number of employees. Age data is only available for a subset of countries. Age is defined as the age of the firm's oldest establishment at the beginning of the period, and the birth of that establishment corresponds to the first date when it recruited employees. Multiple breakdowns combining some of these categories are also available, although more aggregated to avoid disclosure problems. Any cell containing a number of firms below the confidentiality threshold established by each national statistical office is blanked out and codified as missing to avoid the release of legally-protected confidential information.

2.2 Data limitations

While business registers provide some of the most accurate firm-level data available, there are limitations.[22] The size threshold for payroll taxes or VAT registration can vary across countries. In practice, harmonization efforts imply that differences in the coverage of business registers (if any) are likely to be restricted to very small units. Therefore, they capture almost all the (legitimate) private sector activity in the country. The trade-off for the extensive coverage is the limited information they record, so we measure growth in employment and, whenever feasible, in turnover, but not in value added.

Measuring growth rates requires tracking firms over time. Business registers usually assign to each enterprise a unique identifier that is constant over time regardless of changes in name or ownership. While the quality of longitudinal databases has improved significantly, this is not always the case, which may result in "false" entries and exits. For instance, only some business registers are able to maintain before-and-after linkages for firms involved in mergers, acquisitions or spinouts. Therefore, to maximize participation when collecting the data an acquired firm is coded as an exit,[23] a spinout as a contraction in size and a new merged entity as the entry of a new firm.[24] As a result, we do not distinguish between organic growth and growth

[22] Bartelsman et al. (2005) provide a detailed account of the potential concerns associated with cross-country comparisons of firm dynamics using microdata, most of which are common to other studies that build on similar datasets.
[23] A significant share of firms that exit are actually acquired by other firms, and often they tend to be among the best performing ones (Cosh & Hughes, 2007), so a non-survivor firm is not necessarily a failed firm.
[24] A new identifier is often assigned to the new enterprise resulting from the merger, although there a few exceptions in the data discussed. For instance, the data for New Zealand excludes both mergers and acquisitions, while merged entities in Austria usually maintain the two pre-merger social security numbers in the merged entity. Finally, M&As are not immune to the issues discussed below regarding the treatment of subsidiaries, so whether an acquired entity is integrated into a firm or continues to operate as an independent subsidiary also makes a difference. However, based on the available data, the treatment of M&As appears to have a very limited impact on the resulting aggregate data. For example, unreported analysis shows that excluding acquisitions reduces the overall number of firms with annual average employment growth over the period above 20% in Spain by around five hundred (out of more than 7500), while in the Netherlands the share falls from 3.29% to 3.15%.

by acquisitions. Both strategies are commonly used by firms to expand and, as Jovanovic and Rousseau (2002) point out, both can result in economy-wide productivity improvements (consider for instance an above-average productivity firm that expands by opening new plants - forcing others to close - vs. a similar firm that acquires existing plants and transfers its superior practices to them).

However, including acquisitions when measuring growth implies that the measures of job creation discussed throughout the paper capture all jobs gained by surviving firms, regardless of whether these jobs are actually new or they did already exist in acquired firms. Similarly, job destruction measures all jobs lost, regardless of whether they continue to exist in a divested subsidiary. The alternative approach to measure job flows, using establishment-level data, also has caveats, since employees reallocated across different plants within firms are also counted as job creation and destruction. Matched firm-establishment datasets are necessary to get accurate measures of job creation and destruction, but unfortunately they are not available across all the participating countries (see Haltiwanger, Jarmin, & Miranda, 2010, for an example).[25]

Determining the boundaries of the firm is another concern. The administrative or legal definition of an enterprise (or establishment) used by business registers does not necessarily coincide with the economic definition of the firm (which itself is often diffuse too). For instance, a new subsidiary of a larger firm is generally coded as new entering firm.[26] Shifting of activities from one plant to another is treated differently if the plants belong to the same subsidiary or to two different subsidiaries of the same firm. Outsourcing to an external provider decreases employment growth (but not turnover growth). Employment outside the home country is not measured in business registers, so FDI or offshoring are not properly captured.[27] However, these

[25] Therefore, the inclusion of M&A is likely to distort the distribution of job creation by size and age, given that large and old firms are significantly more likely to engage in M&A than small and young firms. Consequently, the job creation measures discussed here, as in most of the literature, are likely to overestimate the contribution to job creation of large and old firms while underestimate that of small and young firms. Similar biases are likely to emerge when using plant level data, since reallocation of employees across different plants is for obvious reasons more likely in large multi-establishment firms than small single-establishment firms. However, there is no evidence to suggest that the inclusion of M&A impacts the measures on the concentration of job creation. For instance, unreported analysis shows that including growth by acquisitions increases the contribution to job creation of firms with annual average employment growth over the period above 20% (i.e., high-growth firms) from 37% to 38% in the Netherlands. Similarly, Henrekson and Johansson (2010) report that Swedish and Finish studies that distinguish between organic growth and M&A reach similar conclusions with regards to their contribution to job creation.

[26] Business registers often include a maker to identify the business group to which a firm belongs (if any). However, the quality of this marker is very variable even within countries, so we have not used it for this project. There is still a long way to go until business registers can provide something resembling to a "consolidated statement".

[27] The failure to record multinational expansion may have a different impact depending on the size of the country. If a firm opens a new plant 1000 miles away from its headquarters, it is measured as growth in the US but most likely not in the Netherlands, since this plant would fall in a different country.

concerns should not be over-emphasized, since the boundaries of the firm are relatively clear for the majority of firms. After all, as Bartelsman, Scarpetta and Schivardi (2003) point out, the average number of plants per firm is 1.2 in the United States and 1.1 in Finland, despite the large difference in country size.[28]

A final note of caution is needed. Our measures of firm growth are substantially more accurate than the data on job creation. Specifically, job creation measures in this paper are subject to three weaknesses: (i) they ignore job creation and destruction via entry and exit, which account for 15-20% of gross job creation and destruction in the US (Haltiwanger, 2012); (ii) we cannot control for reversion to mean effects (Davis, Haltiwanger, & Schuh, 1996); and (iii) mergers and acquisitions are not accounted for. Therefore, we focus most of the discussion in the paper on the dynamics of firm growth, rather than answering the question of who creates jobs. This later question is better addressed by two other cross-country projects that began after the data collection for this one had been completed: the DYNEMP project led by the OECD in collaboration with national statistical agencies (Calvino, Criscuolo, & Menon, 2015), and the international cohort comparison study (Anyadike-Danes, et al., 2015).

2.3 Building distributions

We use histograms to plot the firm growth distribution, but also the density and cumulative distribution functions (cdf). To obtain the percentiles of the growth distribution, we start from the 11 growth intervals. The 10 finite interval endpoints provide the skeleton of the cumulative distribution function, so we interpolate between them to derive the full distribution.[29] We assume the cdf to be continuous and only compute the cdf when the number of firms in a cell is above 50. We do not use a linear interpolation but instead try to control for the common curvature of the growth cdf using the Laplace distribution, which according to other studies calibrations' fits the empirical distribution of firm growth closely (Bottazzi & Secchi, 2006; Coad, 2007).

[28] These concerns are more significant for the largest firms, for which consolidated statements provided by commercial databases are a useful resource. See Hoffman and Junge (2006) for further discussion.

[29] Non-parametric methods such as kernel density estimation would be an alternative approach to plot the distribution of firm growth rates without need to assume any particular density function. But the structure of the data limits the feasibility of this approach. Using our aggregated data instead of the unavailable underlying microdata results in estimated density functions that are very sensitive to the choice of bandwidths and kernel, and are distorted by the open ended nature of the two extreme intervals.

The Laplace distribution is part of the same family as the normal distribution but exhibits flatter tails (i.e., extreme occurrences are more likely) and has a symmetric tent-shape when plotted in log-scale. The Laplace density function and cdf are:

$$f(x|\mu, b) = \frac{1}{2b} \exp\left(-\frac{|x-\mu|}{b}\right) \qquad F(x) = 0.5\left[1 + \mathrm{sgn}(x-\mu)\left(1 - \exp\left(-\frac{|x-\mu|}{b}\right)\right)\right] \qquad (1)$$

Although the cdf is not differentiable, it can conveniently be solved in a closed form,[30] so we build from this expression to interpolate the cdf. We do not impose that the firm growth distribution follows a Laplace distribution. Instead, we only assume that the Laplace distribution is a good local approximation between interval endpoints for the actual growth distribution, and calculate for each growth interval the two parameters that define it (μ and b). For each growth interval we know: (1) the lower bound rate of growth, (2) the share of firms with smaller growth rates than the lower bound, (3) the upper bound rate of growth and (4) the share of firms with growth rates higher than the upper bound, so we end up with two equations and two unknowns from which we can solve for μ and b. We then obtain an approximation of the cdf for each growth interval and compute the growth rate for each percentile of the distribution of firm growth.

The calculation is different for the top and bottom growth interval (below -20% and above 20%), since they are not bounded. No firm can contract by more than 100%, so we impose this lower bound for the bottom interval and proceed as with all the other growth intervals. For the top growth interval we use the share of firms that fall into the category and their average growth rate[31] to solve for μ and b and obtain the cdf for the top end of the distribution. However, this approximation is very sensitive to the underlying distributional assumptions, so the percentiles for the extremes of the distribution need to be interpreted with care. Table 4 presents the summary statistics for the percentiles resulting from this exercise, which we discuss in more detail in the section that follows.

3 Stylized facts on firm growth and employment dynamics

We first discuss a series of stylized facts that emerge from the analysis of the database and that hold across countries, sectors and time periods. For brevity, the figures in this section focus on

[30] $F^{-1}(p) = \mu - b\,\mathrm{sgn}(p-0.5)\ln(1-2|p-0.5|)$
[31] This corresponds to the average growth rate weighted by initial firm size. In other words, it is computed from the aggregate number of employees for all surviving firms in the cell.

the cross-country average and present only the data collected for the first period (2002-05). In order to avoid the cross-country average being driven by extreme values, the highest/lowest values are replaced by the second highest/lowest values when computing the average. The appendix includes country-by-country data for all the indicators discussed here, as well as data for the second period whenever available. We measure growth in terms of employment, but detailed data on turnover growth for some countries is also provided in the appendix (and it is also briefly discussed at the end of this section).

In order to examine the robustness of some of these facts across sectors and countries, Table 5 presents the summary statistics at the industry-country pair level,[32] and Table 6 reports the proportion of cells for which they are satisfied across the different breakdowns available, whether by country, industry, period, size, age, or, whenever feasible, growth measure.[33] The appendix provides additional figures and tables that confirm that the facts discussed here hold across most (if not all) countries and sectors.

Heterogeneity in firm growth rates, but regularity in the distribution

Figure 1 presents the distribution of firm growth across different sizes and countries. Each column indicates the share of firms with average annual employment growth rates over a three year period falling within that growth interval (with the range covering 11 intervals from less than -20 per cent to more than +20 per cent employment growth per annum).

The growth distribution for all firms with 1 or more employees is relatively polarized. Firms either remain static or experience fast growth or decline. This is due to a combination of two factors. First, micro firms constitute a disproportionate share of the business stock (80% of surviving firms), even if they only account for less than 20% of employment (Table 2). Therefore, they drive the aggregate growth distribution, given that by construction percentiles are not "employment-weighted" (in contrast to the average growth measures used in this paper). Second, the interpretation of growth rates is very sensitive to the initial size of the firm, particularly when measured in employment. A firm with one employee achieves a 100% growth rate by hiring another worker ("a doubling of their workforce"), while a firm with a 100 employees which incorporates another 10 employees has instead 10% growth rate. Because of

[32] Note that some subsectors can have as little as 2 firms, so "outlier" industry-country pairs need to be interpreted with this in mind.
[33] A more extensive table considering additional facts and breakdown combinations is available in the appendix.

this, unless otherwise stated, in the rest of the paper we focus on firms with 10 or more employees when discussing the distribution of firm growth rates.

Looking only at firms with 10 or more employees, the growth distribution becomes more evenly distributed, with a larger mass in the middle than in the extremes. It is unimodal, roughly symmetric and has fat tails. Therefore, extreme bursts of growth or decline occur quite regularly. The mass is higher at the bottom end of the distribution than at the top end, which implies that there are more high-decline firms than high-growth firms. This high level of growth and contraction leads to very high job reallocation rates across surviving incumbents, with the share of jobs created or destroyed by incumbents over a three year period being around 30% on average (Table 3). Going down one level to look at sectors confirms that substantial job reallocation also emerges within industries (Table 5).

The growth distribution looks very similar across all the different participating countries, with the exception of the UK (Figure 1.b).[34] The median firm with 10 or more employees experiences zero or slightly negative growth in most countries and industries (Tables 4 & 5), and therefore existing 10+ firms are more likely to shrink than grow. However, this does not hold across all countries and sectors, even if it is still quite rare that the median firm grows by more than 1% pa (Table 5).[35]

Figure 2 shows that a comparable degree of heterogeneity in growth rates exists within sectors and size classes (as well as within narrowly defined age classes, as seen in the appendix). That is, the shape of the distribution is remarkably similar across sectors, sizes and ages. Therefore, firm growth heterogeneity is not the result of aggregation across different subsets of firms. This contrasts with firm size heterogeneity (and to a lesser extent, productivity heterogeneity), which falls substantially when looking within more disaggregated sectors (e.g., Coad, 2007).

Limited up-or-out dynamics

Standard learning and selection models (Jovanovic, 1982; Hopenhayn, 1992) predict a relationship between an age, survival and growth. Entrepreneurs enter the market, learn about their type and, depending on it, either expand or contract and exit. This up-or-out dynamic has

[34] Data for the UK is derived from a database still under development, so the much larger share of static firms may reflect some issues in the underlying data rather than the structure of the UK economy.
[35] Given that percentiles are computed by interpolating the cdf within each growth interval, not more than one firm can have a growth rate of exactly zero. Therefore, some of the firms that according to the cdf have slightly positive/negative growth (within the -1,1% growth interval) are zero-growth firms in practice. This is why we focus on the (-1,1%) threshold when talking about growth and contraction.

been documented empirically in the literature (e.g., Haltiwanger, Jarmin, & Miranda, 2010) and it is confirmed as well by the top panel in Figure 3.

Young firms have lower survival rates than more mature firms. But conditional on survival, they experience higher growth on average. On the contrary, more mature firms have negative growth and destroy jobs on average (even if there is some significant heterogeneity across countries). This up-or-out dynamic is particularly strong for very young firms (1-2 years). They are 25% more likely to exit than the average firm, but conditional on surviving, they grow 3.5 times faster.

Similar patterns emerge when looking at median instead of average growth. Surviving young firms are more likely to grow than shrink, while older firms are more likely to shrink than grow (even if this is not always the case). As a result, average firm size increases as the cohort matures.

Up-or-out dynamics are clear when looking at averages, yet they appear much more limited when looking at the full distribution of growth. The last two plots in Figure 3 show that there is a large share of firms which neither expand nor contract over a three year period.

Whether young or old, ca. 40% of surviving firms are static, with an average annual employment growth rate between -1 and 1%. If a wider definition is used (-5,5%), ca. half of firms remain stable over the period. Therefore, not only do a majority of young firms survive over the three year period, but conditional on survival, a majority of them do not grow in most countries either.[36] As a result, the size/employment distribution among older firms, even it shifts right, continues to be dominated by SMEs, which account for over 50% of employment and 90% of firms.

Limited up-or-out dynamics are not surprising given that a majority of entrepreneurs set up lifestyle business without ambitions to grow. Yet as Hurst & Pugsley (2011) argues, it raises some challenges for many of the standard models of entrepreneurship and firm growth, which often ignore that the most common motivation for entrepreneurs is becoming their own boss rather than growing the next 1 billion dollars business.

[36] Nevertheless, it is true that across most countries and sectors a majority of young firms either grow or exit, while a majority of old firms neither grow nor exit (even if in many countries a majority of surviving old firms do not shrink either).

The dispersion of the growth distribution falls with size and age

Since Gibrat's law a large literature has examined the relationship between firm size and growth. Relatively less attention has been given to the growth-age link, and the combination of both dimensions. Figure 4 explores this interaction by plotting the firm growth density function by size and age. The density function narrows both with age and size unconditionally, but it is more responsive to changes in age than in size.

We can also look at how the density function varies with age and size conditioning on each other. Holding age constant, the density function narrows with size, although there is heterogeneity in the effect across different age classes. The dispersion falls much more for young firms that for firms with 11+ years, for which differences are more negligible. Keeping instead size constant, the distribution narrows with age. But there is also heterogeneity, since age matters relatively less for larger firms.

In order to appreciate the differences better, Figure 5 presents the main percentiles of the growth distribution, from the 99^{th} percentile to the 10^{th} percentile. The dispersion of growth rates falls with size. It is clear for the extreme top and bottom percentiles, but it is also the case for percentiles closer to the middle (even if more difficult to appreciate). Smaller firms grow and shrink faster than larger firms, and controlling for age does not make a big difference either. The variance of growth rates narrows with size even when we condition on age.

Figure 5.b considers instead the impact of firm age. Consistent with a learning and selection model, it shows higher dispersion of growth rates for younger firms than for more mature firms, as long as they have 10 or more employees, and this is the case regardless of whether we control for size or not. In case of micro firms, the picture is more nuanced. The distribution shows the same narrowing up to percentile 95^{th}, but it does not arise for the two highest percentiles (99^{th}, 98^{th}). Finally, and not surprisingly, both the interquartile range and the p90-p10 range fall with size and age, unconditionally or conditioning on each other.

Table 6 examines the robustness of this stylized fact (as well as others) across the different sectors, countries and time periods available. Specifically, the first two columns report the percentage of country-period pairs for which each statement is satisfied (with the first one considering all firms and the second one only firms with 10+ employees). Columns 3 and 4 add a sector dimension, and therefore show the percentage of country-period-industry combinations for which the statement is satisfied. Finally, columns 5 and 6 consider as well size and age breakdowns, and therefore show how robust the statement is after conditioning for size and/or age. The total number of cells (or combinations) is reported in parenthesis. [37]

In over 95% of the country-industry pairs considered the interquartile range and the p90-p10 range are higher for young firms (1-5 years) than for old firms (11+ years), and this holds as well when conditioning on size class. The firm growth distribution also narrows as firms grow in size, but this fact is more robust at the extremes than closer to the middle of the distribution. In other words, the p90-p10 range is higher for SMEs than for large firms (250+) in 80-100% of the industry-country pairs considered, while for the interquartile range it holds "only" in 70-80% of cells. The robustness falls slightly when conditioning on age, but if it still holds for large majority of age groups across countries and sectors.[38]

What about the centre of the distribution? The median and the average employment growth rate falls with size and age, conditionally and unconditionally (as can be seen in Figure 5 and Table 6). Therefore, as firms become larger and/or older the distribution shifts downwards.

Hence, in contradiction with the strong version of Gibrat's law, [39] size impacts the shape of the growth distribution, and the same picture emerges if we look at shares rather than percentiles.[40] In summary, the average, the median and variance of the growth distribution fall both with size and age, conditionally and unconditionally, and this narrowing emerges at both extremes of the distribution.

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[37] Specifically, Table 8 considers 3 age classes (1-5, 6-10, 11+) and 4 size classes (1-9, 10-49, 50-249, 250+). Country-period-industry-age-size combinations exclude age classes if the statement makes reference to age and size classes if the statement makes reference to size. In both cases, these can be interpreted as examining the validity of the fact after conditioning for size or age respectively. For statements not involving size and age, then it reports the percentage of all country-period-industry-size-age combinations that satisfy the statement. Categories included in one of the breakdowns do not appear in the other two breakdowns. Sectors are considered at different levels of aggregation. Job creation rate refers to gross jobs created as share of initial jobs. Young refers to firms with 1-5 years, while old to firms with 11+ years. SME refers to firms with less than 250 employees, while large refers to firms with 250+ employees.

[38] Note that these relationships are not always strictly monotonic with size and age, since in some cells small firm display relatively similar behaviour than median firms, and similarly in some others young firms display relatively similar behaviour than firms that are 6-10 years old.

[39] The strong version of Gibrat's law states that the distribution of firm growth is independent of firm size, while the weaker version only refers to average growth. While we do not aim to formally test Gibrat's law here, the data shows that Gibrat's law is not satisfied either for large firms, which arguably have already achieved their minimum efficient scale of production. Even when looking at firms above 500 employees, the distribution continues to narrow as firm size increases. The weaker version does not appear to hold either.

[40] Conditioning on size, the shares of static, stable and shrinking firms increases with age, while the share of growing firms decreases with age (see appendix).

Both age and size matter for job creation, but not equally

There is an on-going debate among policy makers, business groups and researchers about which are the firms that matter most for job creation, with answers ranging from the young, the small or the high- growth (see for instance Haltiwanger, Jarmin, & Miranda, 2010; Bravo-Biosca, 2011; Calvino, Criscuolo, & Menon, 2015; for an overview of the different positions).

The top panel in Figure 6 shows that gross job creation falls both with size and age. This negative relationship remains when controlling for each other. Even controlling for age, SMEs have higher job creation rates than large firms, also when they are old (Table 6). In contrast, there is no clear relationship between size and job destruction. Conditional on survival, small and large firms have a similar job destruction rate, particularly when not controlling for age. Comparing firms by their age, we find that job destruction is higher for younger firms than older firms, but not when looking at micro firms. Job destruction rates for firms with less than 10 employees are independent of firm age, with suggests that downward adjustment for small young firms happens through the extensive margin rather than the intensive margin, consistently with the literature showing that job destruction by exit is much larger for young firms (Haltiwanger, Jarmin, & Miranda, 2010).

Figure 6 also shows the substantial job reallocation process among surviving incumbents, with a large gap between net and job gross creation. As discussed earlier, around 30% of jobs are created or destroyed in each period, and this share is significantly larger for young and/or small firms. The last chart in Figure 6 considers an alternative measure of job churning, excess job reallocation. Measured as the sum of job creation and destruction less the absolute value of net change, it captures the total amount of churning jobs over and above that due to net changes (Davis, Haltiwanger, & Schuh, 1996).[41] Similar patterns emerge. It falls substantially with size, particularly as firms get larger, as well as with age, and this holds as well when conditioning on each other (excluding micro firms).

An alternative approach to address the same question is to look at the share of employment, job creation and destruction accounted by each group of firms (Figure 7). Recall that these measures do not control for M&As and only capture surviving firms, and so exclude job reallocation due

[41] This measure corresponds to the employment-weighted mean absolute deviation of firm growth rates (Davis, Haltiwanger, & Schuh, Job Creation and Destruction, 1996), and therefore it is a proxy for employment-weighted firm growth rates dispersion.

to entry and exit.[42] In summary, young SMEs account for a larger share of job creation and destruction than their employment share, and make an overall positive contribution to employment (in fact, they have the highest job creation rate and average employment growth rate of all groups of firms). Large old firms account for a lower share of job creation and destruction than their employment share, and destroy jobs on average. Both of these facts are robust across countries and sectors (Table 6). What about old SMEs? The answer is it depends. They consistently have smaller job creation rates than young SMEs, but also higher than large old firms. However, no clear pattern emerges with regard to their net contribution to employment growth, which can be positive or negative depending on the country and sector considered (Table 6).

Job creation and destruction is concentrated among a minority of firms

Figure 8 plots the distribution of job creation and destruction across firms with different growth rates. While most firms experience small changes in employment, most change in employment is the result of large changes in employment in a small number of firms. Firms in the top growth interval, which corresponds to the share of high-growth firms according to the OECD definition,[43] only represent 4.5% of surviving firms with 10 or more employees, yet they account for ca. 40% of all jobs created by all firms with ten or more employees (even if there are some important differences across countries). Job destruction is also concentrated. Less than 10% of firms decline by more than 20% a year on average over the period, yet they account for 45% of jobs lost by surviving firms with 10 or more employees.

Firm growth and contraction are correlated, controlling for aggregate shocks

Figure 9 examines the correlation between the top and bottom percentiles of the growth distribution, net of shocks that shift the full distribution up or down (i.e., subtracting the median). Each dot represents a country-industry pair (2-digit sector) in the first period, and we report both the unconditional correlation and the conditional correlation after controlling for industry and country fixed effects.

[42] Similar findings on job creation emerge when looking at employment dynamics data that includes entry and exit (Anyadike-Danes, et al., 2015; Calvino, Criscuolo, & Menon, 2015).

[43] The OECD and Eurostat define high-growth firms as all enterprises with 10 or more employees in the beginning of the observation period with average annualised growth in employment (or turnover) greater than 20% over a three year period. See appendix or Bravo-Biosca (2011) for additional evidence on high-growth firms using this database.

A clear relationship emerges. The faster firms grow at the top of the distribution (percentile 90th), the faster firms shrink at the bottom (percentile 10th). Similar, albeit weaker, findings emerge when looking at percentile 75th and 25th respectively.

Results change however if the median is not subtracted to control for aggregate shocks. Shocks typically shift the full distribution upwards or downwards, which creates a strong negative correlation between the share of growing firms and shrinking firms (see appendix). As a result, the negative correlation between the 90th and 10th percentiles becomes weaker, while in the case of the 75th-25th correlation, the sign is reversed. This is consistent with intermediate quartiles (e.g., p75-p25) being more closely correlated with the median than percentiles at the extremes of the distribution.

Some other results

Looking across different sectors, we find that the shape of the growth distribution is broadly similar and these facts continue hold. There are however some differences as well. Services industries display a much more dynamic growth distribution than manufacturing, which suggests that part of the literature that has looked only at the manufacturing sector may underestimate the degree of churn in the economy (in particular given its relative small share relative to services).

Table 7 also reports how robust some of the stylized facts discussed above are if instead of considering employment growth we look at real turnover growth. The distribution of turnover growth also narrows with age (and shifts down too, even if not as strongly), conditionally and unconditionally. But is no longer true that SMEs grow faster than large firms (whether looking at the average or the median), and the turnover growth distribution narrows less strongly with size in comparison the employment growth distribution. This would be consistent with large firms experiencing faster productivity growth (but also more volatile).

Comparing the employment and turnover distribution (bottom panel in Table 8) shows that average turnover growth is consistently higher than employment growth (but not so median growth). Similarly, the dispersion of the growth distribution is consistently higher for turnover than employment. Putting these findings and others in earlier sections together suggest that, as investment, employment adjustment is also lumpy, not fluctuating as much as turnover. Some implications for productivity follow, since increases in employment at firm level will be associated with a fall in their productivity levels as a result.[44]

Finally, several other stylized facts are visible in the data presented in the appendix. Even if not discussed here, we briefly list some of them. We find that: (a) survival rates are more dependent on age than size; (b) the firm size distribution is more skewed to the left for young than old firms, and so average size increases with age. Looking at the growth distribution by country-industry pair, we also find: (a) little or no correlation between aggregate employment growth and most proxies for the dynamism of the growth distribution, such as the share of static firms, interquartile range, p90-p10 range or excess job reallocation; (b) little or no correlation between average employment growth for young firms and the minimum efficient scale (proxied by average firm size in the sector); (c) substantial negative correlation between the dynamism of the growth distribution and survival rates; (d) little correlation between employment growth of the top 5% of firms and median growth, while the correlation with the median is stronger for the rest of percentiles.

4 Cross-country differences on firm growth and employment dynamics

The prior section discussed several stylized facts that hold across countries. Next we briefly consider some of the differences that emerge, which are substantial across several of the metrics collected. It is however difficult to tease out in a definite way what accounts for them. While structural institutional factors certainly play an important role (see Bravo-Biosca, Criscuolo, & Menon, 2016 for evidence on the impact of labour regulation and financial institutions), some of the differences observed may be the result of measurement issues and differential business cycles.

Specifically, as discussed in Section 2.2, while business registers are the most comprehensive and internationally comparable source for firm-level data, they still have some limitations. In addition, the limited time coverage of the database does not allow controlling for potential business cycles effects. Nevertheless, during the period considered here most participating

[44] See appendix for analysis looking at the evolution of productivity (using turnover per employee as proxy) as firms grow and contract.

countries experienced moderate economic growth, and the same patterns emerge in the later period (2004-07/2005-08) in the subset of countries for which data is available (see appendix).

In light of this, this section focuses on the relative performance of different groups of companies within and across countries, rather than on average comparisons, under the assumption that the former will be less dependent on the business cycle than the latter, and therefore better capture more structural differences. See appendix for more cross-country comparisons on the wider range of indicators available.

Figure 1 displays the firm growth distribution for all participating countries, yet it is difficult to observe clearly the existing cross-country differences. Because of this, Figure 10 plots the growth distribution relative to the US. Specifically, each bar indicates how much higher/lower in percentage terms the share of firms with a growth rate falling within that interval is in that country relative to the US.

A clear pattern emerges: Firms in the US grow and shrink more rapidly than in European countries, which have a much larger share of static firms, for which employment does not vary much (up or down). This pattern holds for a majority of countries, sectors and sizes classes (Figure 11). A similar pattern emerges as well when comparing the growth distribution for young firms between the US and the European countries for which we have data (see appendix).

Figure 12 considers two other metrics that also capture the cross-country differences in business dynamism. The left figure displays excess job reallocation for all firms with one or more employees, which (partially) controls for business cycles effects by taking out job churn due to economy-wide net employment changes. This is higher in the US than in all continental Europe countries, with the surprising exception of Greece, suggesting that there is a much more active process of resource reallocation across incumbent firms in the US. The right figure plots the percentiles of the growth distribution and the interquartile and p90-p10 ranges by country, sorted according to the interquartile range. There are also sizeable differences, both when looking at the percentiles at the extremes of the distribution and when looking at the interquartile and p90-p10 ranges, with the US ranking higher than most European countries.

One of the potential effects of a less dynamic growth distribution is that it becomes more difficult to challenge incumbents. Figure 13 looks at the differences in performance between SMEs vs. large firms and young firms vs. old firms across countries. Specifically, the two measures considered are the average employment growth rate and job creation as share of initial jobs (in other words, net and gross job creation rates). Each bar corresponds to the difference in percentage points between the rate for SMEs/young firms and the rate for large/old firms. Again, the differences are substantial, with countries like the US displaying a much larger gap than most European countries in the sample.

One possible interpretation is that a larger gap is a signal that the country's institutional framework makes it relatively easier for younger and smaller firms to challenge incumbents. However, this is not the only possibility. In some circumstances a poor institutional background can also lead to large gaps in the growth rates of younger and smaller firms relative to large firms, which could help explain the position of countries such as Italy and Greece in Figure 13. For instance, Arellano, Bai, & Zhang (2009) show that small firms grow disproportionally faster than larger firms in less financially developed countries, because limited access to external finance constraints their growth to what their current cashflows can fund.

In the appendix we explore in a little bit more detail whether there are cross-country differences on who creates jobs. As discussed in Section 2.2, given the limitations in our data (particularly the fact that it only captures surviving firms and not entry and exit), these results need to be interpreted with care. The data shows that on aggregate surviving firms create jobs in some countries but not in others, even if looking only at economies that are growing. Specifically, we find that surviving firms' job creation is larger than job destruction in most European countries with positive aggregate growth, in contrast to the US, where net job creation is negative (despite also growing during the period). These differences are mostly driven by incumbents with more than 250 employees, that contract significantly in the US but not across Europe. A back-of-the-envelope calculation would suggest that start-ups make a more important contribution to job creation in the US, although more recent U.S. Census data suggest that there has been a substantial decline in the contribution of new firms to job creation (Pugsley & Șahin, 2015; Decker, Haltiwanger, Jarmin, & Miranda, 2016), and this decline has occurred in many other OECD countries (Calvino, Criscuolo, & Menon, 2015).

Overall, there are at least three takeaways from these cross-country comparisons.

First, much of the policy debate in Europe around business growth has been framed around its lacklustre performance at generating high-growth firms that become global champions. This evidence clearly shows that differences go beyond that. The US has more high-growth firms than Europe, but this is only one part of the picture. European countries have a less dynamic firm growth distribution overall, with slower growth and slower contraction, and unless this is recognised, we are likely to draw the wrong policy conclusions.

Second, it is important to understand the institutional drivers behind these differences, and what policy levers exist to address them. While there is a body of work looking at some these questions, there are still many unanswered questions.

Finally, much of the literature on firm dynamics has been developed using US datasets. This data shows that it cannot be taken for granted that the same results that emerge in the US will hold across other countries, and therefore suggests the need for more replication of studies done in one country with other countries' datasets.

5 Firm growth dynamics and productivity growth

We next examine whether differences in the distribution of firm growth impact productivity growth. There are several channels by which a more dynamic firm growth distribution could potentially lead to faster productivity growth. From a pure accounting perspective, it speeds up the reallocation of labour and capital, most likely from unproductive incumbents towards innovative firms that have successfully developed superior practices.[45] It may also have an additional indirect effect, increasing competitive pressures which force firms to improve their internal practices or else shrink and exit.[46] A more dynamic firm growth distribution may as well signal an environment in which firms are willing to experiment and put new ideas into practice, while being able to backtrack and shrink without major consequences if they do not succeed.[47] Hence there is also a dynamic effect, since knowing that it will be easy to scale up tomorrow if an invention is successful increases the incentives to invest in innovation today. On the contrary, a large share of static firms may signal instead an unwillingness to take risks to

[45] Kogan et al. (2012) show that resources in the US are reallocated towards more innovative firms within industries and towards more innovative sectors across industries. The appendix also shows, for the few countries for which data is available, that firms that experience fast employment growth also have higher initial productivity (using as a proxy turnover per employee relative to the average for that cell), even if at the end of the period their productivity tends to converge to the average for the cell. However, the literature has found that productivity levels are typically better at predicting exit than growth, and large heterogeneity in productivity levels within narrowly defined industries remains (see Coad, 2007; Haltiwanger, 2012; for a review).

[46] For instance, Bartelsman, Haltiwanger and Scarpetta (2004) show that a higher pace of firm turnover is associated with faster productivity growth for incumbents (i.e., a larger contribution from the within-firms term in the standard Foster, Haltiwanger and Krizan (FHK) decomposition).

[47] See for instance Bartelsman, Gautier, & de Wind (2010), who show that countries with lower labour market flexibility display slower adoption of risky new technologies, such ICT, which increase both the average but also the variance of firm productivity.

innovate, since trying a new business model, exploring a new technology or launching a new product often requires a firm to expand its capabilities, even if only temporarily and with uncertain success (Saint-Paul, 1997; Bartelsman, Perotti, & Scarpetta, 2008).

These effects are however not unambiguous. High levels of resource reallocation may not lead to higher productivity if, for instance, it is directed towards the more unproductive firms, either because they have better access to finance, they are well-connected, their managers are prone to mistakes[48] or care more about empire-building than improving performance, or when a speculative bubble distorts the allocation process. Even when this is not the case, resource reallocation also creates significant adjustment costs for firms and workers. Firms may lose the intangible capital embedded in their workers, demotivate them to take risks[49] and face disruption in their organization, resulting in lower productivity. Employees are likely to lose firm-specific human capital and face significant uncertainty (Hall R. E., 1995). Moreover, a more dynamic growth distribution can increase frictional unemployment due to job search and matching frictions, particularly in poorly functioning labour markets with high unemployment rates (Mortensen & Pissarides, 1994). Finally, too much competition can also reduce incentives for experimentation (Aghion, Bloom, Blundell, Griffith, & Howitt, 2005).

Which of these effects dominate may depend on the position of the country relative to the world technology frontier. As countries get closer to the frontier, both experimentation and selection become more important (Acemoglu, Aghion, & Zilibotti, 2006). First, at the frontier innovation replaces imitation as the main driver of productivity growth, so experimentation is more important. Second, the reallocation of resources towards more productive firms may also play a more significant role at the frontier, since only a fraction of the firms attempting to innovate succeed, while many others fail to improve their productivity. In contrast, imitation is less uncertain and does not require as much skill, so far from the frontier within-firm productivity improvements across the board are more feasible (Acemoglu, Aghion, & Zilibotti, 2006). Finally, the effect of competition on innovation and productivity growth is also stronger at the frontier (Aghion, Bloom, Blundell, Griffith, & Howitt, 2005; Aghion, Blundell, Griffith, Howitt, & Prantl,

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48 In the same way that entry mistakes by entrepreneurs often create a revolving door mechanism where one low productivity corner shop is replaced by another equally low productivity one, mistakes by managers may lead them to expand when the underlying fundamentals do not justify it, with little or even negative impact on productivity.

49 For instance, Acharya, Baghai and Subramanian (2010) show that stringent labour laws can provide firms with a commitment device to not punish short-run failures and thereby spur their employees to pursue value-enhancing innovative activities.

2009). Altogether, these different channels suggest that the impact of a more dynamic growth distribution should be stronger the closer the country is to the technology frontier.

We use standard OLS to test whether a more dynamic growth distribution is associated with faster productivity growth, as the literature suggests it should. Firm growth dynamics are clearly endogenous, so the results need to be interpreted with this in mind. An alternative approach would have been to use standard productivity growth decompositions (e.g., Bartelsman, Haltiwanger, & Scarpetta, 2005), which compute the share of productivity growth accounted by within-firm improvements, the entry and exit of firms and the reallocation of resources across continuing firms. They however require firm-level productivity data and, in addition, do not capture the indirect effect that a more dynamic firm growth distribution may have on within-firm productivity growth arising, for instance, from stronger competition.

The baseline specification regresses annual total factor productivity growth for industry j in country i in 2002-2005 on the share of static firms, which is a measure of the (lack of) dynamism of the firm growth distribution. The share of static firms is defined as the share of all surviving firms with 10 or more employees[50] with annual average employment growth between -1% and 1% (>1% are growing firms, <-1% are shrinking firms). We include country (μ) and industry (τ) fixed effects in the regression to mitigate omitted variables concerns, and control for the distance to the frontier to account for potential convergence effects. Industry-country specific shocks can shift as well the distribution of firm growth, so we control for employment growth at the industry-country pair level.

$$TFPgrowth_{ij} = \beta_0 share_{ij} + \beta_1 employmentgrowth_{ij} + \beta_2 distancefrontier_{ij} + \mu_i + \tau_j + \varepsilon_{ij} \qquad (2)$$

We use EUKLEMS data for industry-level productivity measures. Annual TFP growth is value added-based and annual labour productivity growth (which we use as a robustness check) is defined as gross value added per hour worked by persons engaged (O'Mahony & Timmer, 2009). We exclude outliers defined as those industry-country pairs with TFP growth more than two standard deviations away from the industry or country mean.[51] Employment growth corresponds to the average annual growth in the industry's number of employees over the period, also from EUKLEMS. Distance to frontier is defined as as $-\ln(TFP_{ij}/TFP^{leader(j)})$ at the

[50] The distribution of firm growth is less informative when firms with 1-9 employees are included, since growth rates for very small firms are of a different order of magnitude by construction, and they dominate the distribution. Therefore here we only consider the distribution for firms with 10 or more employees.
[51] The main conclusions remain if outliers are not excluded (although interactions with distance to frontier lose their significance).

beginning of the period, where $TFP^{leader(j)}$ corresponds to the highest TFP level for industry *j* across countries (as long as it is within 2 standard deviations from the mean for the industry).[52] TFP levels data is obtained from the GGDC Productivity Level Database (Inklaar & Timmer, 2008), which also builds on EUKLEMS, and specifically corresponds to value added-based (double deflated) multi-factor productivity.

Table 6 reports the results of this exercise. Each of the 144 observations corresponds to an industry-country pair, with 8 countries[53] and up to 22 industries included in the regressions. All regressions are estimated using OLS, with standard errors in parentheses clustered both at country and industry level.[54] Column 1 reports the results of the baseline specification, with country and industry effects but without any additional control. The coefficient indicates that a 1pp increase in the share of static firms is associated with -0.187pp lower annual TFP growth, and it is significant at the 1% level. Controlling for convergence effects with the industry's distance to the technology frontier and for potential industry shocks with employment growth does not make a difference (Column 2).[55]

A low share of static firms could be driven both by a high share of growing and/or shrinking firms. Therefore, the results could just be picking up some positive correlation between growing industries and TFP growth not captured by average employment growth, with no relationship to selection processes. Column 3 replaces the share of static firms by the shares of growing and shrinking firms. While the coefficient for the growing share (0.251) is higher than for the shrinking share (0.171), they are both large and significant. Consequently, this supports the hypothesis that industries with a higher degree of selection, that is, with a higher share of growing and shrinking firms and fewer static ones, experience faster productivity growth.

Experimentation and selection may become more important the closer to the technology frontier an industry is. Columns 4-5 examine this hypothesis. The interactions between distance to frontier and the shares of static, growing and shrinking firms are significant and with the right sign. Far from the frontier, a large share of static firms is not associated with lower TFP

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[52] Any TFP level data point higher than the industry mean plus two standard deviations is coded as missing and not used to determine the frontier.

[53] TFP data at the industry level is only available for a subset of countries: Austria, Denmark, Finland, Italy, Netherlands, Spain, UK and US.

[54] For double clustering we use the Stata code provided by Petersen (2009), available at http://www.kellogg.northwestern.edu/faculty/petersen/htm/papers/se/se_programming.htm, and which builds on Cameron, Gelbach and Miller (2006). Using robust standard errors without any clustering leads to similar conclusions.

[55] Controlling in addition for average firm size in the industry leads to the same conclusions as well.

growth, while at the frontier it is. The same finding arises when looking at the share of growing and shrinking firms. Thus, this evidence suggests that a dynamic firm growth distribution becomes more important for productivity growth the closer countries get to the technology frontier, as predicted by Acemoglu, Aghion and Zilibotti (2006).

A variety of methodological issues arise when estimating TFP, which could potentially affect comparisons across countries and industries. Therefore, for robustness we consider as well labour productivity growth as outcome variable, since it is subject to relatively fewer measurement issues. Columns 6-7 show that the same patterns emerge, even if with somewhat lower significance levels.

Summing up, these results suggest that a 5pp higher share of static firms is associated with 1pp lower annual productivity growth (both for TFP and labour productivity), and that this negative effect becomes stronger as countries converge to the technology frontier.

Is this a big or a small effect in economic terms? In the decade prior to the financial crisis, Europe's annual TFP growth lagged the US by 1pp on average (Ark, O'Mahony, & Timmer, 2008), while cross-country differences in the share of static firms average several percentage points. Alternatively, a one-standard deviation increase in the share of static firms is associated with 1.1pp lower annual TFP growth. Therefore, the magnitude of the coefficient and the implied correlation are non-negligible.

6 Final remarks

The new database that this paper introduces captures the heterogeneity of firm growth in a comparable way across different countries, providing a more detailed picture of firm growth dynamics than previously available. It thus provides new insights on how creative destruction (or, more precisely, resource reallocation) happens in different countries, as well as serves to test the robustness of some stylized facts in different settings.

Our results confirm that there is substantial heterogeneity in firm growth rates, but also that the growth distribution displays a very regular pattern across countries and sectors. We find that there are limited up or out dynamics, and that both age and size are negatively related to the mean and variance of the growth distribution. Nevertheless, we also find significant cross-country differences. European countries tend to display a much more static growth distribution, while in the US firms typically grow and shrink much more rapidly. There are also significant differences in the contribution that surviving incumbents make to employment growth, negative in the US but positive in many (even if not all) European countries. Finally, we explore whether this differences matter for productivity growth, and we find this to be the case, particularly as countries converge to the technology frontier.

References

Acemoglu, D., Aghion, P., & Zilibotti, F. (2006). Distance to frontier, selection, and economic growth. *Journal of the European Economic Association, 4*(1), 37-74.

Acharya, V., Baghai, P., & Subramanian, K. (2010). Labor Laws and Innovation. NBER Working Paper No. 13085.

Aghion, P., & Howitt, P. (2006). Appropriate Growth Policy: A Unifying Framework. *Journal of the European Economic Association, 4*(2-3), 269-314.

Aghion, P., Bloom, N., Blundell, R., Griffith, R., & Howitt, P. (2005). Competition and Innovation: An Inverted-U Relationship. *The Quarterly Journal of Economics., 120*(2), 701-728.

Aghion, P., Blundell, R., Griffith, R., Howitt, P., & Prantl, S. (2009). The Effects of Entry on Incumbent Innovation and Productivity. *Review of Economics and Statistics, 91*(1), 20-32.

Aghion, P., Fally, T., & Scarpetta, S. (2007). Credits Constraints as a Barrier to the Entry and Post-Entry Growth of Firms. *Economic Policy, 22*(52), 731-779.

Aidis, R., Estrin, S., & Mickiewicz, T. (2007). Entrepreneurship in Emerging Markets: Which Institutions Matter? UCL SSEES Economics Working Paper No. 81.

Alfaro, L., & Charlton, A. (2007). International Financial Integration and Entrepreneurial Firm Dynamics. NBER Working Paper No. 13118.

Anyadike-Danes, M., Bjuggren, C.-M., Gottschalk, S., Hölzl, W., Johansson, D., Maliranta, M., & Myrann, A. (2015, April). An international cohort comparison of size effects on job growth. *Small Business Economics, 44*(4), 821-844.

Arellano, C., Bai, Y., & Zhang, J. (2009). Firm Dynamics and Financial Development. NBER Working Paper No. 15193.

Ark, B. v., O'Mahony, M., & Timmer, M. P. (2008). The Productivity Gap between Europe and the United States: Trends and Causes. *Journal of Economic Perspectives, 22*(1), 25-44.

Arkolakis, C. (2011). A Unified Theory of Firm Selection and Growth. NBER Working Paper No. 17553.

Baily, M. N., Hulten, C., Campbell, D., Bresnahan, T., & Caves, R. E. (1992). Productivity Dynamics in Manufacturing Plants. *Brookings Papers on Economic Activity. Microeconomics*, 187-267.

Bartelsman, E. J., Gautier, A. P., & de Wind, J. (2010). Employment Protection, Technology Choice, and Worker Allocation. CEPR Discussion Paper 7806.

Bartelsman, E. J., Haltiwanger, J. C., & Scarpetta, S. (2013). Cross-Country Differences in Productivity: The Role of Allocation Efficiency and Selection. *American Economic Review, 103*(1), 305-334.

Bartelsman, E. J., Haltiwanger, J., & Scarpetta, S. (2004). Microeconomic Evidence on Creative Destruction in Industrial and Developing Countries. World Bank Policy Research Working Paper No. 3464.

Bartelsman, E., Haltiwanger, J., & Scarpetta, S. (2005). Measuring and Analyzing Cross-country Differences in Firm Dynamics. *NBER Conference on Research in Income and Wealth. Producer Dynamics: New Evidence from Micro Data.*

Bartelsman, E., Perotti, E., & Scarpetta, S. (2008). Barriers to Exit, Experimentation and Comparative Advantage. *mimeo.*

Bartelsman, E., Scarpetta, S., & Schivardi, F. (2003). Comparative Analysis of Firm Demographics and Survival: Micro-Level Evidence for the OECD Countries. OECD Economics Department Working Papers No. 348.

Bottazzi, G., & Secchi, A. (2006). Explaining the Distribution of Firm Growth Rates. *The RAND Journal of Economics, 37*(2), 235-256.

Brandt, N. (2004). Business Dynamics in Europe. OECD Science, Technology and Industry Working Papers no. 2004/1.

Bravo-Biosca, A. (2010). *Growth Dynamics: Exploring business growth and contraction in Europe and the US.* London: FORA-NESTA Research Report.

Bravo-Biosca, A. (2011). A look at business growth and contraction in Europe. Nesta Working Paper No. 11/02.

Bravo-Biosca, A., Criscuolo, C., & Menon, C. (2016, October). What drives the dynamics of business growth? *Economic Policy, 31*(88), 703-742.

Cabral, L. M., & Mata, J. (2003). On the Evolution of the Firm Size Distribution: Facts and Theory. *American Economic Review, 93*(4), 1075-1090.

Calvino, F., Criscuolo, C., & Menon, C. (2015). Cross-country evidence on start-up dynamics. OECD Science, Technology and Industry Policy Papers No. 2015/06.

Cameron, C. A., Gelbach, J. B., & Miller, D. L. (2006). Robust Inference with Multi-way Clustering. NBER Technical Working Paper No. 327.

Caves, R. E. (1998, December). Industrial Organization and New Findings on the Turnover and Mobility of Firms. *Journal of Economic Literature, 36*, 1947-1982.

Coad, A. (2007). Firm Growth: A Survey. mimeo.

Cooley, T. F., & Quadrini, V. (2001). Financial Markets and Firm Dynamics. *American Economic Review, 91*(5), 1286-1310.

Cosh, A., & Hughes, A. (2007). *British Enterprise: Thriving or Surviving?* Centre for Business Research, Cambridge University.

Davis, S. J., Haltiwanger, J. C., & Schuh, S. (1996). *Job Creation and Destruction.* Cambridge, MA: MIT Press.

Davis, S. J., Haltiwanger, J., Jarmin, R., & Miranda, J. (2007). Volatility and Dispersion in Business Growth Rates: Publicly Traded versus Privately Held Firms. *NBER Macroeconomics Annual 2006. 21.* MIT Press.

Decker, R. A., Haltiwanger, J., Jarmin, R. S., & Miranda, J. (2016, July). Where has all the skewness gone? The decline in high-growth (young) firms in the U.S. *European Economic Review, 86*, 4-23.

Desai, M., Gompers, P., & Lerner, J. (2003). Institutions, Capital Constraints and Entrepreneurial Firm Dynamics: Evidence from Europe. NBER Working Paper No. 10165.

Dinlersoz, E. M., & Yorukoglu, M. (2012). Information and Industry Dynamics. *American Economic Review, 102*(2), 884-913.

Eurostat & OECD. (2007). *Eurostat-OECD Manual on Business Demography Statistics.*

Fogel, K., Hawk, A., Morck, R., & Yeung, B. (2006). Institutional Obstacles to Entrepreneurship. In M. Casson, B. Yeung, A. Basu, & N. Wadeson (Eds.), *Oxford Handbook of Entrepreneurship.* Oxford University Press.

Geroski, P., & Gugler, K. (2004). Corporate Growth Convergence in Europe. *Oxford Economic Papers, 56*(4), 597-620.

Gibrat, R. (1931). *Les Inégalités Économiques.* Paris: Librairie du Recueil Sirey.

Hall, B. H. (1987). The Relationship Between Firm Size and Firm Growth in the United States Manufacturing Sector. *Journal of Industrial Economics, 35*(4), 583-606.

Hall, R. E. (1995). Lost Jobs. *Brookings Paper on Economic Activity, 1*, 221-256.

Haltiwanger, J. (1997). Measuring and Analysing Aggregate Fluctuations: The Importance of Building from Microeconomic Evidence. *Federal Reserve Bank of St. Louis Economic Review*, 55-77.

Haltiwanger, J. (2012). Job Creation and Firm Dynamics in the US. In J. Lerner, & S. Stern (Eds.), *Innovation Policy and the Economy, Volume 12* (pp. p. 17 - 38). Cambridge: NBER.

Haltiwanger, J., Jarmin, R. S., & Miranda, J. (2010). Who Creates Jobs? Small vs. Large vs. Young. NBER Working Paper No. 16300.

Haltiwanger, J., Jarmin, R. S., Kulick, R., & Miranda, J. (2016). High Growth Young Firms: Contribution to Job, Output, and Productivity Growth. In J. Haltiwanger, E. Hurst, J. Miranda, & A. Schoar, *Measuring Entrepreneurial Businesses: Current Knowledge and Challenges.* University of Chicago Press. Forthcoming.

Hart, P. E., & Oulton, N. (1996). Growth and Size of Firms. *Economic Journal, 106*(438), 1242-52.

Henrekson, M., & Johansson, D. (2010). Gazelles as Job Creators: A Survey and Interpretation of the Evidence. *Small Business Economics, 35*, 227-244.

Hoffmann, A. N., & Junge, M. (2006). Documenting Data on High-growth Firms and Entrepreneurs across 17 countries. mimeo.

Holmes, T. J., & Stevens, J. J. (2010). An Alternative Theory of the Plant Size Distribution with an Application to Trade. NBER Working Paper No. 15957.

Hopenhayn, H. A. (1992). Entry, Exit, and Firm Dynamics in Long Run Equilibrium. *Econometrica, 60*(5), 1127-1150.

Hurst, E., & Pugsley, B. W. (2011). What do Small Businesses Do? *Brookings Papers on Economic Activity, 43*(2), 73-142.

Ijiri, Y., & Simon, H. A. (1977). *Skew distribution and the sizes of business firms.* Amsterdam: North-Holland.

Inklaar, R., & Timmer, M. P. (2008). GGDC Productivity Level Database: International comparisons of output, inputs and productivity at the industry level. GGDC Research Memorandum 104.

Jovanovic, B. (1982). Selection and Evolution of Industry. *Econometrica, 50*(3), 649-670.

Jovanovic, B., & Rousseau, P. L. (2002). Mergers as Reallocation. NBER Working Paper No. 9279.

Klapper, L., Amit, R., Guillén, M. F., & Quesada, J. M. (2007). Entrepreneurship and Firm Formation across Countries. World Bank Policy Research Working Paper 4313.

Klapper, L., Laeven, L., & Rajan, R. (2006). Entry regulation as a barrier to entrepreneurship. *Journal of Financial Economics, 82*, 591-629.

Kogan, L., Papanikolaou, D., Seru, A., & Stoffman, N. (2012). Technological Innovation, Resource Allocation, and Growth. NBER Working Paper No. 17769.

Mansfield, E. (1962). Entry, Gibrat's Law, Innovation and the Growth of Firms. *American Economic Review, 52*(5), 1023–51.

Mortensen, D. T., & Pissarides, C. A. (1994). Job Creation and Job Destruction in the Theory of Unemployment. *The Review of Economic Studies, 61*(3), 397-415.

Nelson, R. R., & Winter, S. G. (1978). Forces Generating and Limiting Concentration under Schumpeterian competition. *The Bell Journal of Economics, 9*(2), 524-548.

O'Mahony, M., & Timmer, M. P. (2009). Output, Input and Productivity Measures at the Industry Level: the EU KLEMS Database. *Economic Journal*, 119(538), pp. F374-F403.

OECD. (2008). *Measuring Entrepreneurship: A Digest of Indicators.*

Penrose, E. E. (1959). *The Theory of the Growth of the Firm.* New York: Wiley.

Petersen, M. A. (2009). Estimating Standard Errors in Finance Panel Data Sets: Comparing Approaches. *The Review of Financial Studies, 22*(1), 435-480.

Pugsley, B., & Şahin, A. (2015). Grown-Up Business Cycles. Federal Reserve Bank of New York Staff Report No. 707.

Saint-Paul, G. (1997). Is labour rigidity harming Europe's competitiveness? The effect of job protection on the pattern of trade and welfare. *European Economic Review*, 499-506.

Scarpetta, S., Hemmings, P., Tressel, T., & Woo, J. (2002). The Role of Policy and Institutions for Productivity and Firm Dynamics: Evidence from Micro Data and Industry Data. OECD Economics Department Working Paper 342.

Schumpeter, J. A. (1942). *Capitalism, Socialism, and Democracy.* New York: Harper and Brothers.

Véron, N. (2008). The Demographics of Global Corporate Champions. Bruegel Working Paper no. 2008/03.

Table 1: Number of firms and employment (2002-05)

Country	Number of surviving firms	Surviving firms with 10+ employees	Initial employment in surviving firms	Final employment in surviving firms
Austria	120423	26404	1677829	1722476
Canada		124680	3682250	3424940
Denmark	61453	15198	1023517	1021740
Finland	74404	12107	959437	999660
Greece	186217	13836	1148575	1146086
Italy	776810	133575	8159771	8694780
Netherlands	200204	57793	4053281	4005303
New Zealand	57592	14215	697370	772370
Norway	74377	16021	965149	927514
Spain	827777	123943	7966228	8645430
United Kingdom	968006	164619	15300542	16771191
United States	2517598	710621	75946344	73786696
All	5864861	1413012	121580293	121918186

Note: Data for Canada only covers firms with 10-250 employees.

Table 2: Distribution of firms and employment by initial size

	Firms				Employment			
Size:	1-9	10-49	50-249	250+	1-9	10-49	50-249	250+
Austria	78.1	17.6	3.7	0.7	17.1	24.8	26.9	31.2
Denmark	75.3	20.2	3.7	0.8	15.1	24.1	22.2	38.6
Finland	83.7	13.3	2.4	0.6	19.6	20.7	18.8	40.9
Greece	92.6	6.1	1.1	0.2	29.4	19.3	17.1	34.1
Italy	82.8	14.8	2.0	0.3	23.3	26.3	18.6	31.8
Netherlands	71.1	23.6	4.5	0.8	12.0	23.5	21.0	43.5
New Zealand	75.3	21.4			22.9	33.2		
Norway	78.5	18.3	2.6	0.6	20.3	26.7	19.8	33.2
Spain	85.0	12.8	1.8	0.3	24.9	26.0	18.6	30.5
United Kingdom	83.0	13.9	2.5	0.6	14.6	17.1	15.8	52.5
United States	71.8	23.0	4.3	0.9	8.4	15.4	13.8	62.5

Table 3: Summary statistics

	N	Mean	Median	Std. Dev	Min	Max
			All firms			
Average firm size	11	14.6	13.0	6.4	6.2	30.2
Average 3-year employment growth rate	11	3.1	2.7	5.2	-3.9	10.8
Share of static firms (-1%,1%)	11	38.2	35.9	12.6	17.2	60.3
Share of stable firms (-5%,5%)	11	48.4	46.7	8.1	36.9	64.1
Share of growing firms	11	32.9	34.2	8.1	19.3	45.0
Share of shrinking firms	11	28.9	27.6	5.9	20.1	39.2
Jobs created as share of initial jobs	11	16.1	15.9	4.0	11.3	22.8
Jobs destroyed as share of initial jobs	11	13.0	12.5	2.7	9.3	17.7
Job reallocation as share of initial jobs	11	29.1	29.1	4.4	22.4	36.0
Excess job reallocation rate	11	24.5	24.9	4.2	18.7	34.9
			10+ employees			
Average firm size	12	56.8	55.0	18.2	29.5	97.9
Average 3-year employment growth rate	12	0.0	-0.5	5.4	-7.0	8.2
Share of static firms (-1%,1%)	12	12.5	11.5	5.3	9.2	28.7
Share of stable firms (-5%,5%)	12	42.9	44.2	5.0	36.5	49.9
Share of growing firms	12	41.2	41.4	4.8	31.8	51.5
Share of shrinking firms	12	46.3	45.8	4.2	38.7	51.6
Jobs created as share of initial jobs	12	13.7	13.5	3.7	9.2	21.9
Jobs destroyed as share of initial jobs	12	13.7	12.7	3.6	8.8	20.5
Job reallocation as share of initial jobs	12	27.4	26.1	4.9	20.2	35.5
Excess job reallocation rate	12	22.7	22.9	3.6	17.5	28.0

Table 4: Percentiles of the growth distribution

Percentile	N	Mean	Median	Std. Dev	Min	Max
			All firms			
99	11	338.5	315.1	75.8	256.6	494.2
98	11	262.0	246.4	53.7	197.7	366.4
95	11	160.8	155.7	29.3	119.9	206.0
90	11	86.3	87.0	21.3	57.0	120.6
75	11	22.1	22.9	12.8	2.1	41.7
50	11	0.5	0.2	0.7	-0.4	2.1
25	11	-10.5	-9.9	7.3	-23.2	-2.3
10	11	-46.5	-49.0	6.8	-55.9	-33.3
5	11	-60.0	-60.8	5.1	-66.1	-46.4
p75-p25	11	32.6	37.4	15.9	4.5	51.6
p90-p10	11	132.8	136.0	23.9	91.4	163.4
			10+ employees			
99	12	223.7	202.8	70.9	148.7	390.7
98	12	156.1	142.5	48.8	104.4	271.8
95	12	74.5	67.6	17.4	56.4	114.6
90	12	43.8	42.0	6.5	34.9	54.2
75	12	16.6	15.4	4.0	12.1	25.9
50	12	-1.3	-1.1	2.2	-4.1	4.0
25	12	-20.7	-20.1	5.1	-32.3	-15.0
10	12	-44.5	-44.6	7.1	-56.4	-34.6
5	12	-58.4	-58.7	4.6	-66.5	-51.4
p75-p25	12	37.3	35.0	5.8	29.9	47.0
p90-p10	12	88.3	87.2	10.8	71.2	101.1

Table 5: Industry-level summary statistics

	N	Mean	Std. Dev	Min	p10	Median	p90	Max
				All firms				
Average 3-year employment growth rate	589	2.1	14.0	-53.2	-10.8	1.4	14.1	184.4
Median 3-year employment growth rate	572	0.8	3.8	-31.6	-1.2	0.4	2.0	47.6
Share of static firms (-1%,1%)	598	35.2	14.5	0.0	19.1	32.1	56.9	88.9
Share of stable firms (-5%,5%)	582	47.6	10.5	21.1	36.1	46.0	63.2	90.3
Share of growing firms	574	33.9	9.6	6.0	21.1	34.6	44.3	100.0
Share of shrinking firms	574	31.0	9.0	0.0	19.2	31.6	42.1	67.1
Jobs created as share of initial jobs	545	15.8	11.4	0.4	7.0	14.2	25.2	191.3
Jobs destroyed as share of initial jobs	540	13.8	6.8	0.0	7.5	12.4	20.8	73.5
Job reallocation as share of initial jobs	539	29.6	13.0	2.7	17.9	27.8	41.2	198.1
Excess job reallocation rate	539	21.5	8.6	0.0	11.1	21.0	32.2	76.0
Interquartile range (p75-p25)	572	37.1	19.6	1.9	5.1	37.9	57.2	151.6
p90-p10 range	569	132.8	55.7	4.4	84.5	128.5	178.6	964.3
				10+ employees				
Average 3-year employment growth rate	481	-0.6	11.2	-44.3	-11.8	-1.1	11.2	79.7
Median 3-year employment growth rate	444	-1.5	5.1	-41.3	-6.6	-0.9	3.0	32.3
Share of static firms (-1%,1%)	494	12.6	6.2	0.0	7.4	11.1	23.2	50.0
Share of stable firms (-5%,5%)	490	44.2	10.4	16.1	31.2	44.7	54.3	100.0
Share of growing firms	476	41.5	8.3	12.5	31.7	41.5	50.0	75.0
Share of shrinking firms	475	46.1	8.8	0.0	36.3	46.4	55.9	81.6
Jobs created as share of initial jobs	432	13.3	8.9	0.6	6.0	11.3	21.9	94.1
Jobs destroyed as share of initial jobs	429	13.5	6.3	0.0	6.7	12.3	21.0	46.5
Job reallocation as share of initial jobs	426	26.7	10.7	2.7	15.8	25.3	38.2	108.5
Excess job reallocation rate	426	19.6	8.2	0.0	10.5	18.9	30.5	56.7
Interquartile range (p75-p25)	444	37.0	10.7	13.6	26.4	35.0	52.3	81.5
p90-p10 range	443	88.1	24.1	33.1	62.4	84.4	115.3	274.5

Table 6: Stylized facts robustness

	Country x Period		x Industry		x Age x Size	
Employment growth distribution	1+	10+	1+	10+	1+	10+
Average growth (SME > Large)	93%	93%	87%	82%	88%	81%
	(15)	(15)	(77)	(77)	(163)	(165)
Median growth (SME > Large)	80%	73%	65%	57%	74%	70%
	(15)	(15)	(65)	(65)	(87)	(87)
Interquartile range (SME > Large)	73%	80%	77%	85%	70%	74%
	(15)	(15)	(65)	(65)	(87)	(87)
p90-p10 range (SME > Large)	100%	87%	98%	82%	94%	69%
	(15)	(15)	(64)	(65)	(78)	(84)
Job creation rate (SME > Large)	100%	100%	93%	90%	91%	90%
	(15)	(15)	(68)	(68)	(135)	(135)
Average growth (Young > Old)	100%	89%	82%	68%	81%	74%
	(10)	(9)	(56)	(56)	(223)	(165)
Median growth (Young > Old)	100%	100%	100%	94%	83%	74%
	(10)	(9)	(57)	(49)	(164)	(109)
Interquartile range (Young > Old)	90%	100%	95%	100%	96%	97%
	(10)	(9)	(56)	(49)	(164)	(109)
p90-p10 range (Young > Old)	100%	100%	98%	100%	98%	97%
	(10)	(9)	(50)	(49)	(161)	(108)
Job creation rate (Young > Old)	100%	100%	94%	85%	84%	77%
	(10)	(9)	(47)	(46)	(195)	(142)
Most surviving young firms don't grow	86%	77%	91%	65%	73%	68%
	(14)	(13)	(195)	(194)	(295)	(217)
Young SMEs vs. old SMEs vs. old large firms						
Job creation rate (Young SME > Old SME)	100%	100%	98%	94%		
	(7)	(7)	(48)	(48)		
Job creation rate (Old SME > Old large)	100%	100%	88%	83%		
	(7)	(7)	(48)	(48)		
Average growth >0 (Young SMEs)	100%	100%	97%	86%		
	(10)	(10)	(71)	(71)		
Average growth <0 (Old SMEs)	25%	44%	39%	47%		
	(8)	(9)	(56)	(58)		
Average growth <0 (Old large)	78%	78%	74%	74%		
	(9)	(9)	(57)	(57)		
Turnover growth distribution						
Average growth (SME > Large)	60%	60%	60%	60%	72%	69%
	(5)	(5)	(20)	(20)	(64)	(64)
Median growth (SME > Large)	43%	29%	36%	36%	30%	40%
	(7)	(7)	(25)	(25)	(47)	(47)
Interquartile range (SME > Large)	86%	57%	88%	72%	78%	68%
	(7)	(7)	(25)	(25)	(46)	(47)
p90-p10 range (SME > Large)	83%	83%	80%	82%	78%	68%
	(6)	(6)	(20)	(22)	(40)	(41)
Average growth (Young > Old)	83%	60%	70%	62%	76%	67%
	(6)	(5)	(27)	(26)	(120)	(86)
Median growth (Young > Old)	100%	100%	100%	93%	87%	80%
	(6)	(5)	(32)	(29)	(104)	(71)
Interquartile range (Young > Old)	100%	100%	100%	100%	98%	97%
	(6)	(5)	(30)	(28)	(103)	(71)
p90-p10 (Young > Old)	100%	100%	100%	100%	99%	98%
	(6)	(5)	(29)	(26)	(92)	(61)
Employment vs. turnover growth distribution						
Average growth (Turnover > Employment)	100%	100%	82%	90%	80%	84%
	(6)	(8)	(361)	(239)	(299)	(216)
Median growth (Turnover > Employment)	29%	38%	58%	75%	70%	73%
	(7)	(8)	(258)	(165)	(254)	(173)
Interquartile range (Turnover > Employment)	100%	89%	87%	86%	93%	95%
	(7)	(9)	(366)	(221)	(254)	(173)
p90-p10 range (Turnover > Employment)	83%	100%	69%	98%	86%	99%
	(6)	(8)	(348)	(210)	(248)	(170)

Table 7: Firm growth dynamics and productivity growth

Each observation corresponds to an industry-country pair, with 8 countries and up to 22 industries included in the regressions. All columns are estimated with OLS, with standard errors in parentheses clustered both at country and industry level. EU KLEMS data is used for productivity measures. Annual TFP growth is value added based and annual labour productivity growth is defined as gross value added per hour worked by persons engaged (O'Mahony and Timmer 2009). The share of static firms is the share of all surviving firms with 10 or more employees with annual average employment growth between -1% and 1% (>1% are growing firms, <-1% are shrinking firms). Annual employment growth at the industry-country pair level controls for potential business cycles effects. Distance to frontier is defined as $-\ln(TFP_{ij}/TFP^{leader(j)})$ at the beginning of the period. TFP levels used to compute distance to frontier are value added based and double deflated (Inklaar and Timmer 2008). Columns 4-7 include interactions between distance to frontier and the share of static/growing/shrinking firms. All regressions include country and industry fixed effects. *, **, *** indicate significance at the 10%, 5% and 1% level respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	TFP growth	TFP growth	TFP growth	TFP growth	TFP growth	LP growth	LP growth
Share of static firms	-0.187***	-0.193***		-0.265***		-0.220**	
	(0.068)	(0.065)		(0.080)		(0.107)	
Share of growing firms			0.251***		0.342***		0.352**
			(0.082)		(0.119)		(0.136)
Share of shrinking firms			0.171**		0.233***		0.164*
			(0.070)		(0.078)		(0.093)
Average employment growth		-0.123	-0.154	-0.142	-0.177***	-0.393***	-0.452***
		(0.115)	(0.100)	(0.094)	(0.064)	(0.125)	(0.093)
Distance to frontier		0.0315	0.0513	-2.009	12.67**	-2.239**	12.86***
		(0.563)	(0.580)	(1.240)	(5.719)	(1.061)	(4.644)
Distance to frontier x							
Share of static firms				0.143**		0.144***	
				(0.064)		(0.054)	
Share of growing firms					-0.177*		-0.209**
					(0.097)		(0.082)
Share of shrinking firms					-0.124*		-0.107
					(0.073)		(0.067)
Observations	144	144	144	144	144	144	144
R-squared	0.538	0.544	0.555	0.561	0.574	0.616	0.647

Figure 1: Distribution of firm growth - Shares

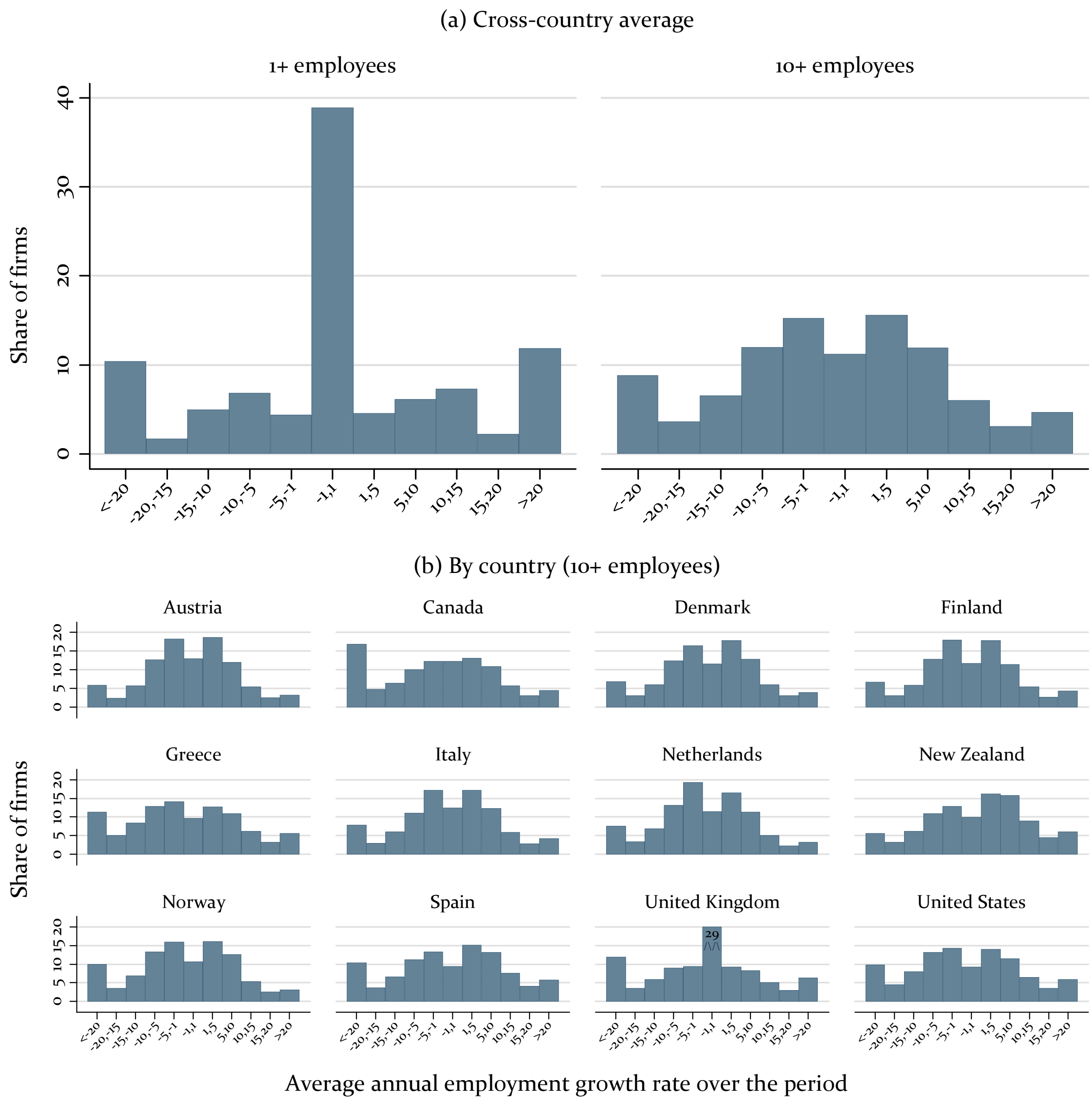


Figure 2: Firm growth distribution by size and sector

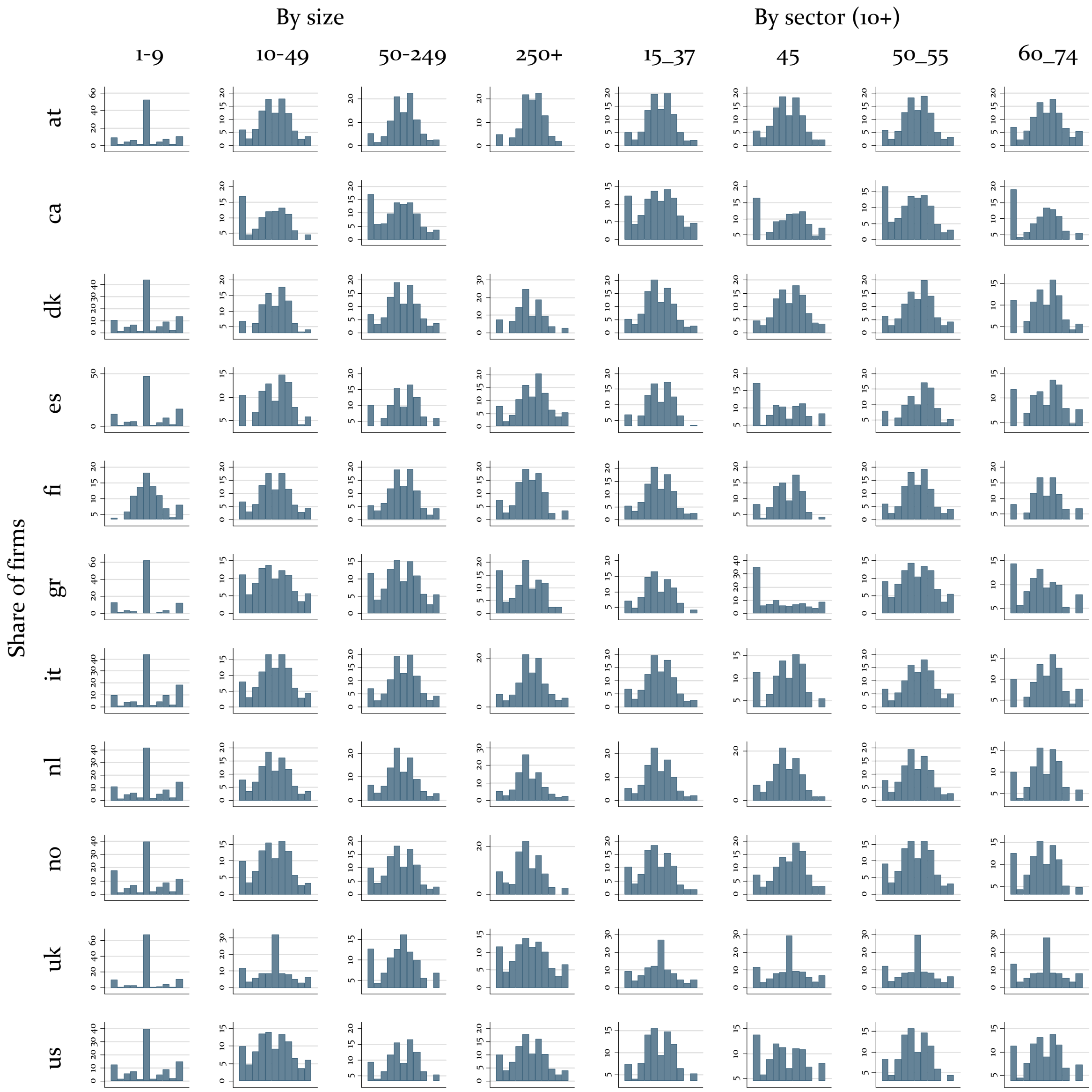


Figure 3: Firm dynamics by age (1+ employees)

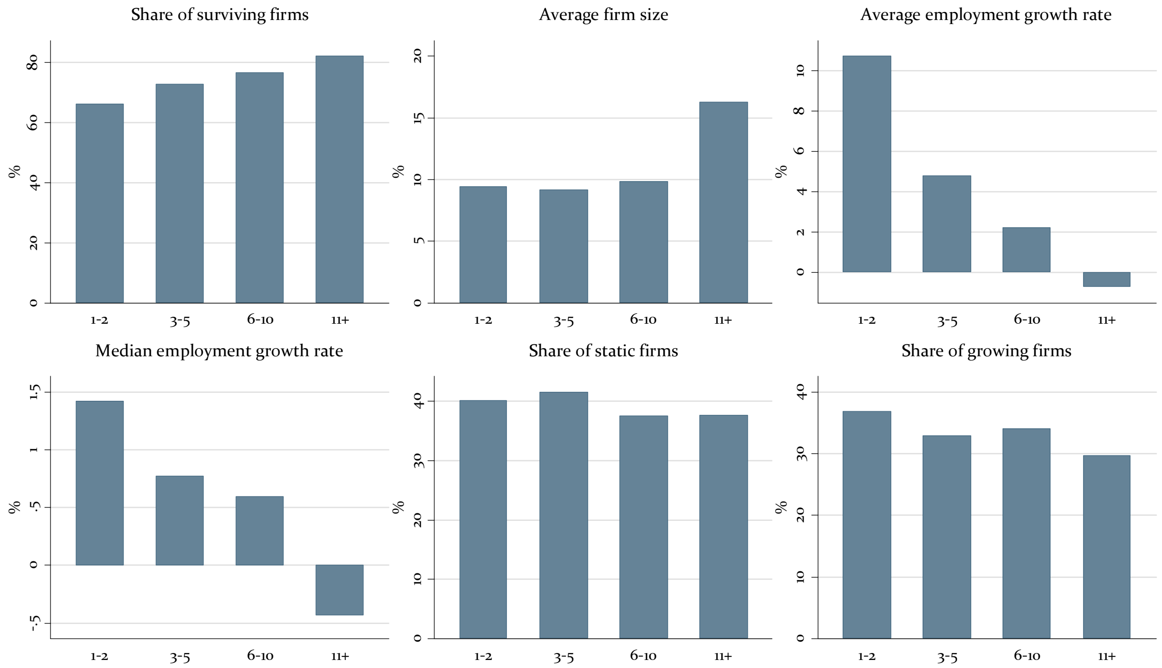


Figure 4: Firm growth density function by size and age

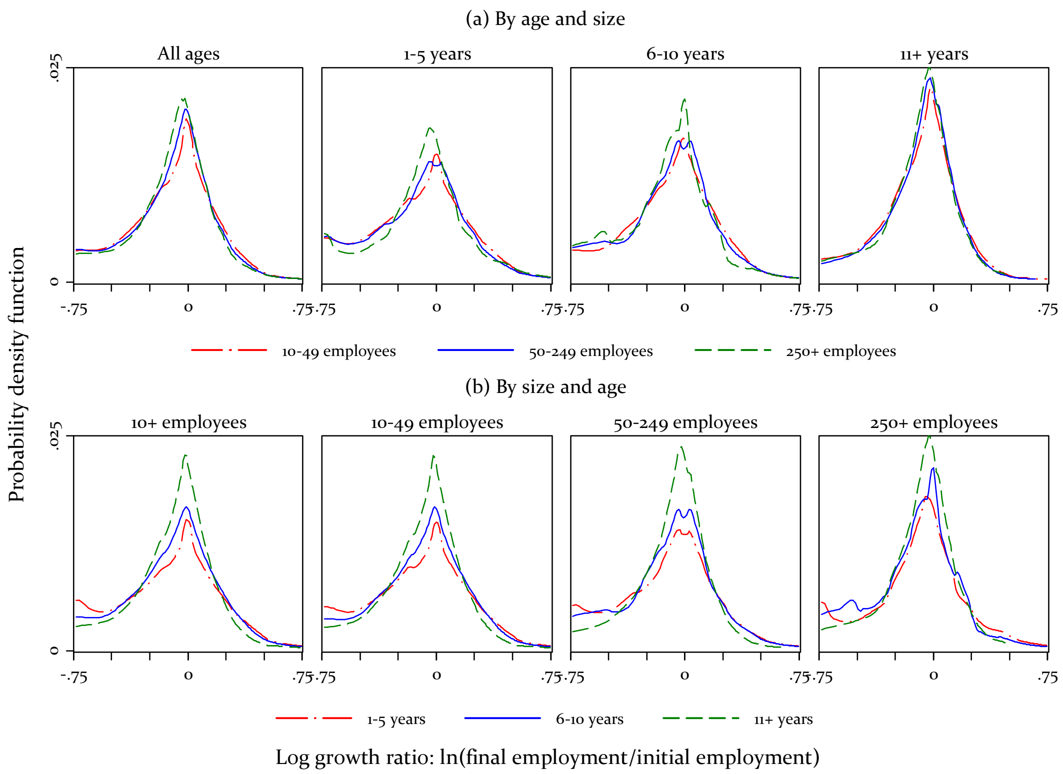


Figure 5: Percentiles of the growth distribution by size and age

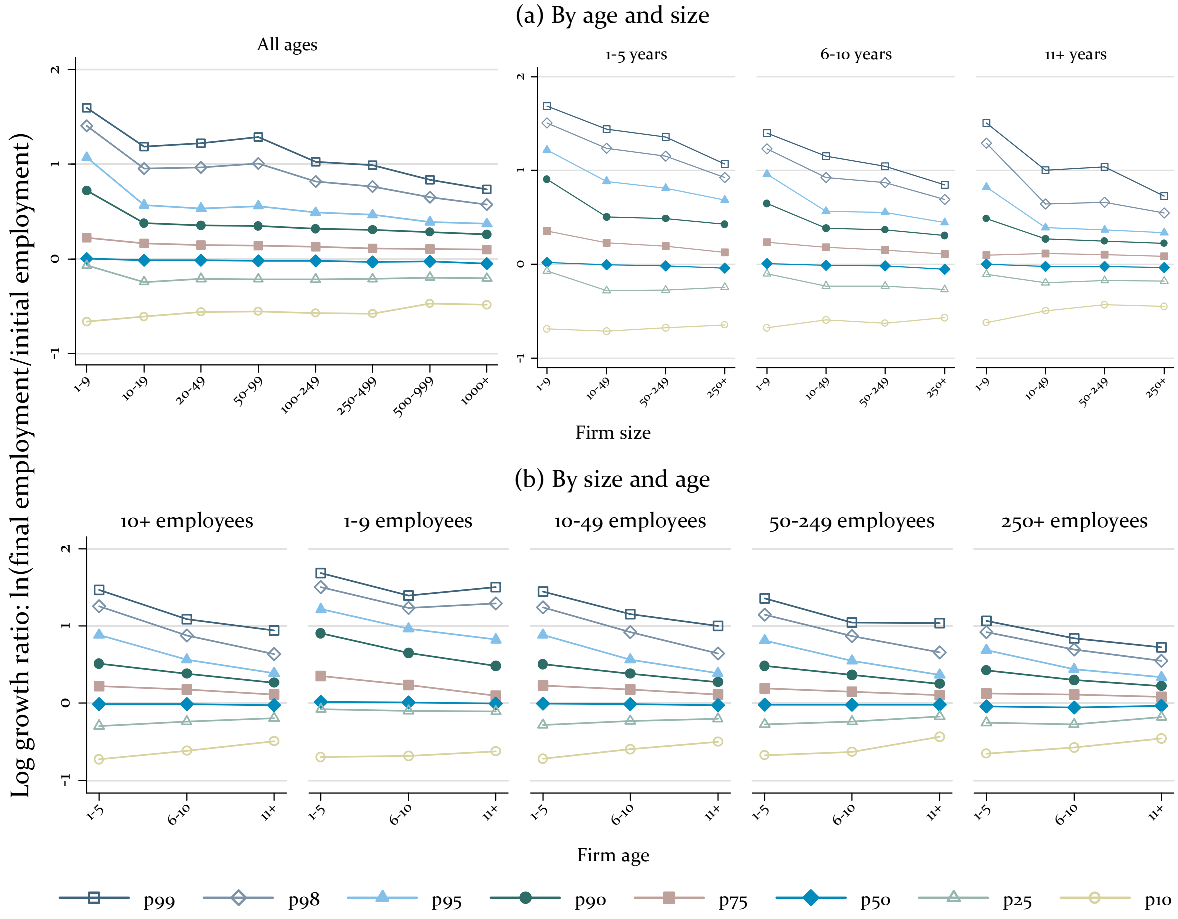


Figure 6: Employment dynamics by size and age (1+ employees)

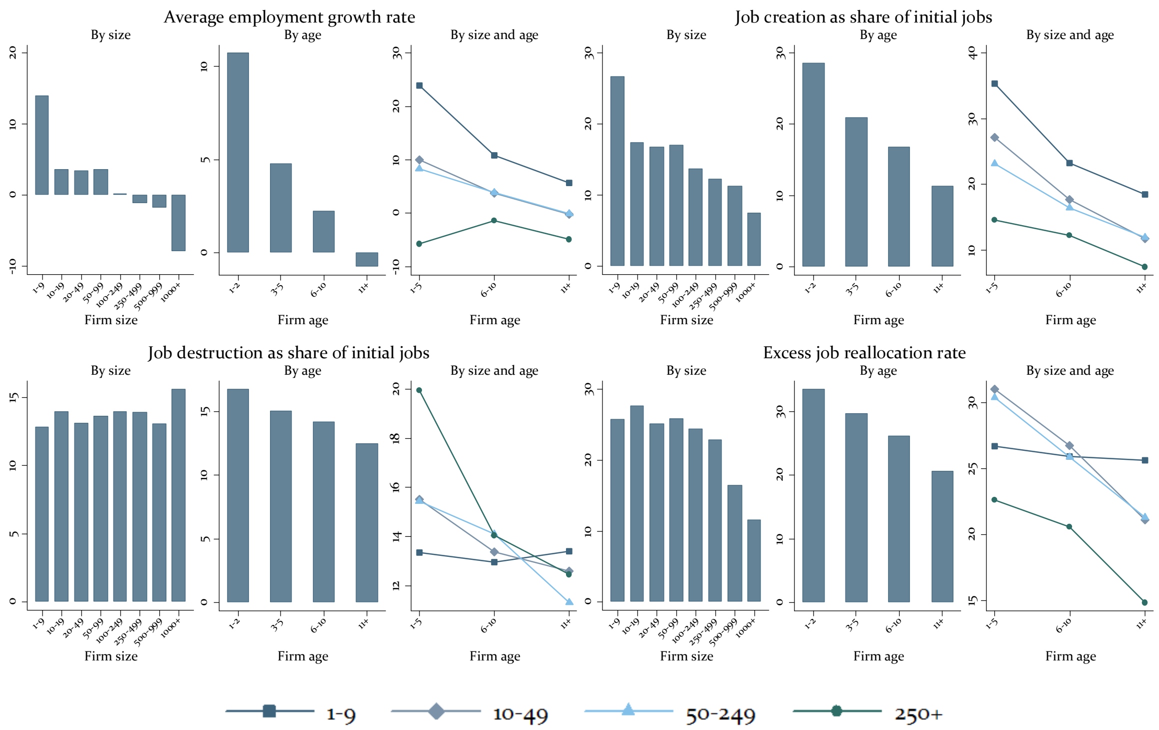


Figure 7: Distribution of job creation and destruction by size and age

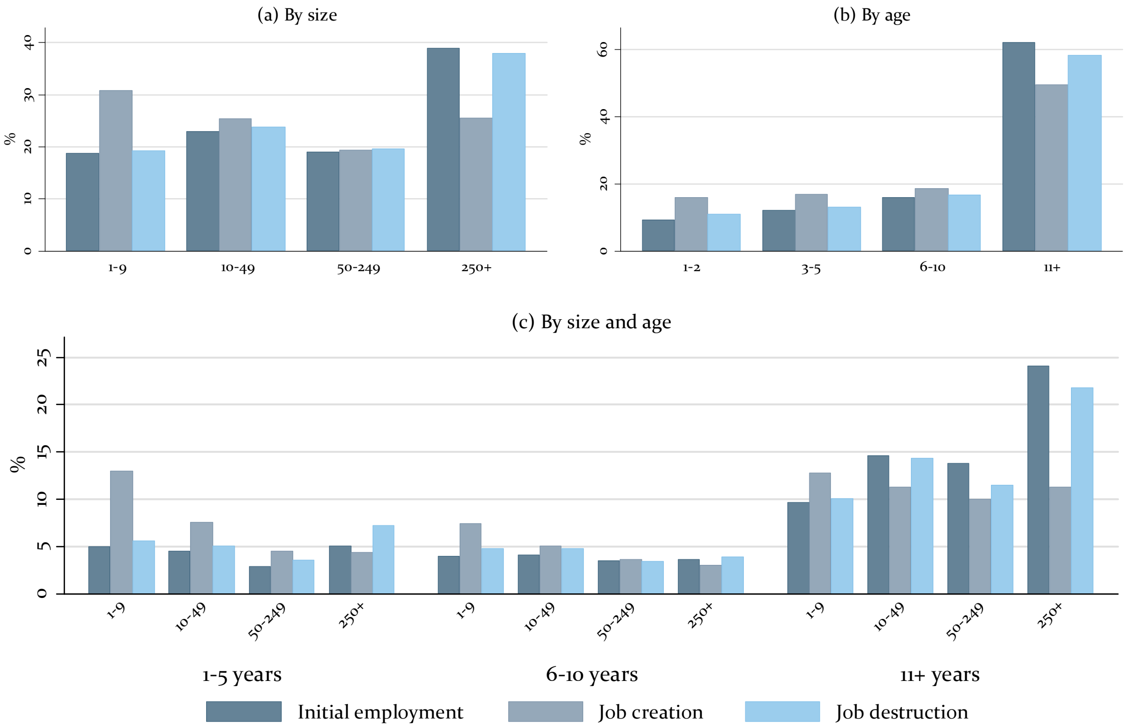


Figure 8: Distribution of job creation/destruction

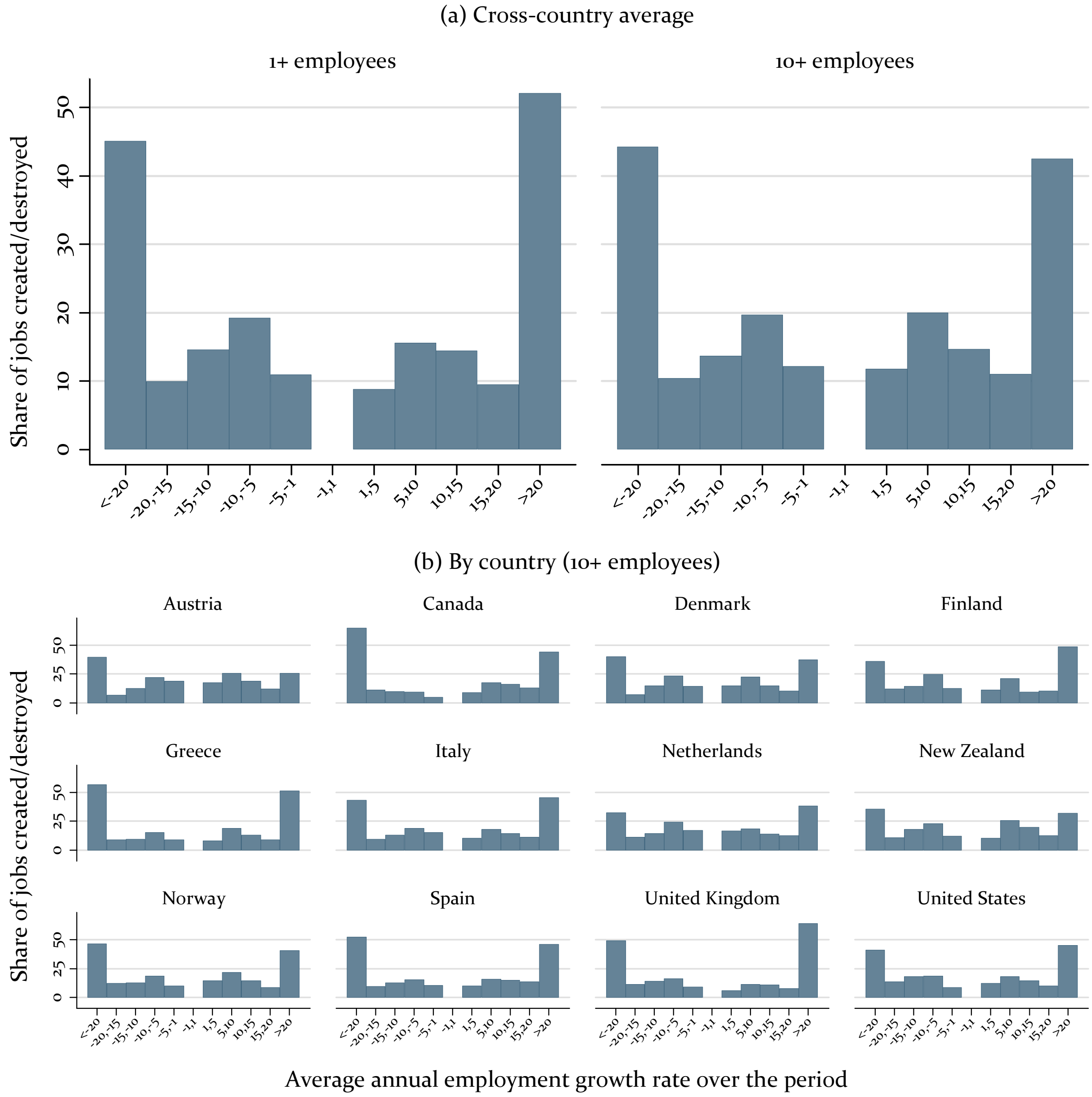
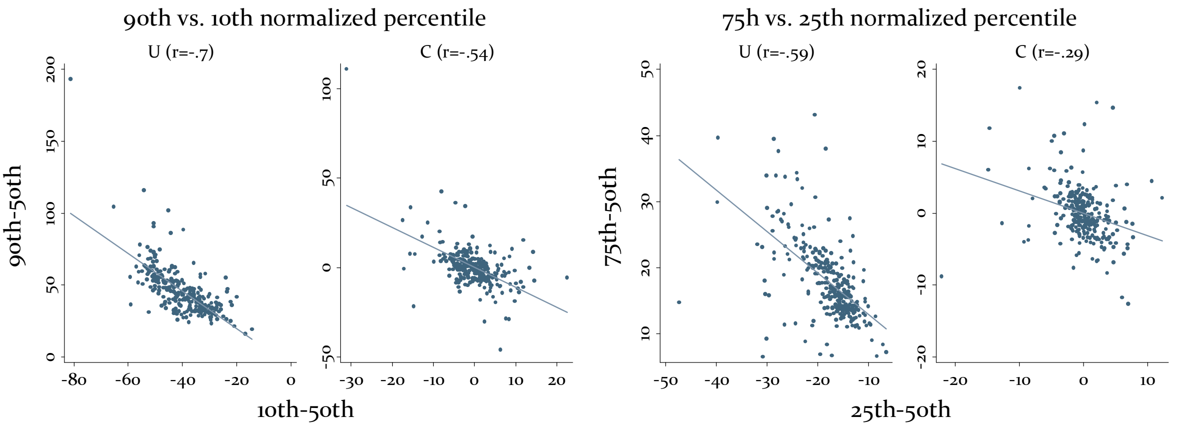


Figure 9: Growth and contraction (10+ employees)



Note: Correlation coefficient reported in parenthesis. U: unconditional - C: conditional correlation after controlling for industry and country fixed effects.

Figure 10: Firm growth distribution relative to the US (10+ employees)

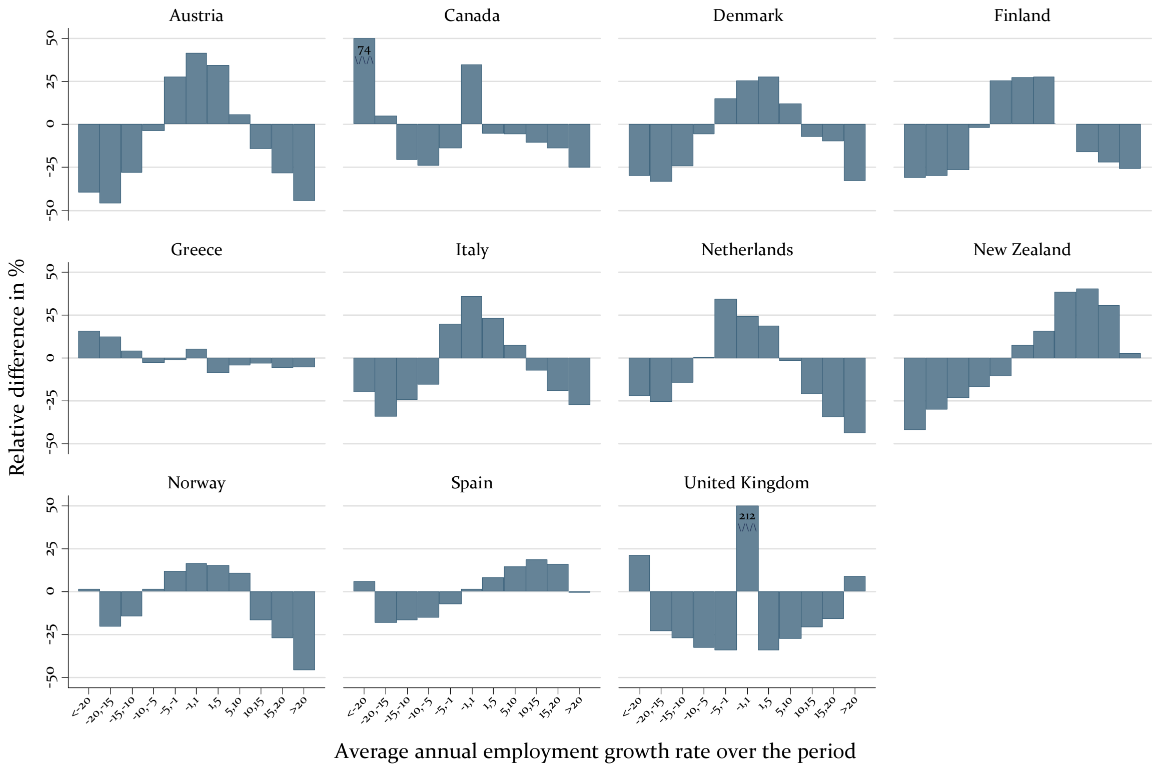


Figure 11: Firm growth distribution relative to the US by size and sector

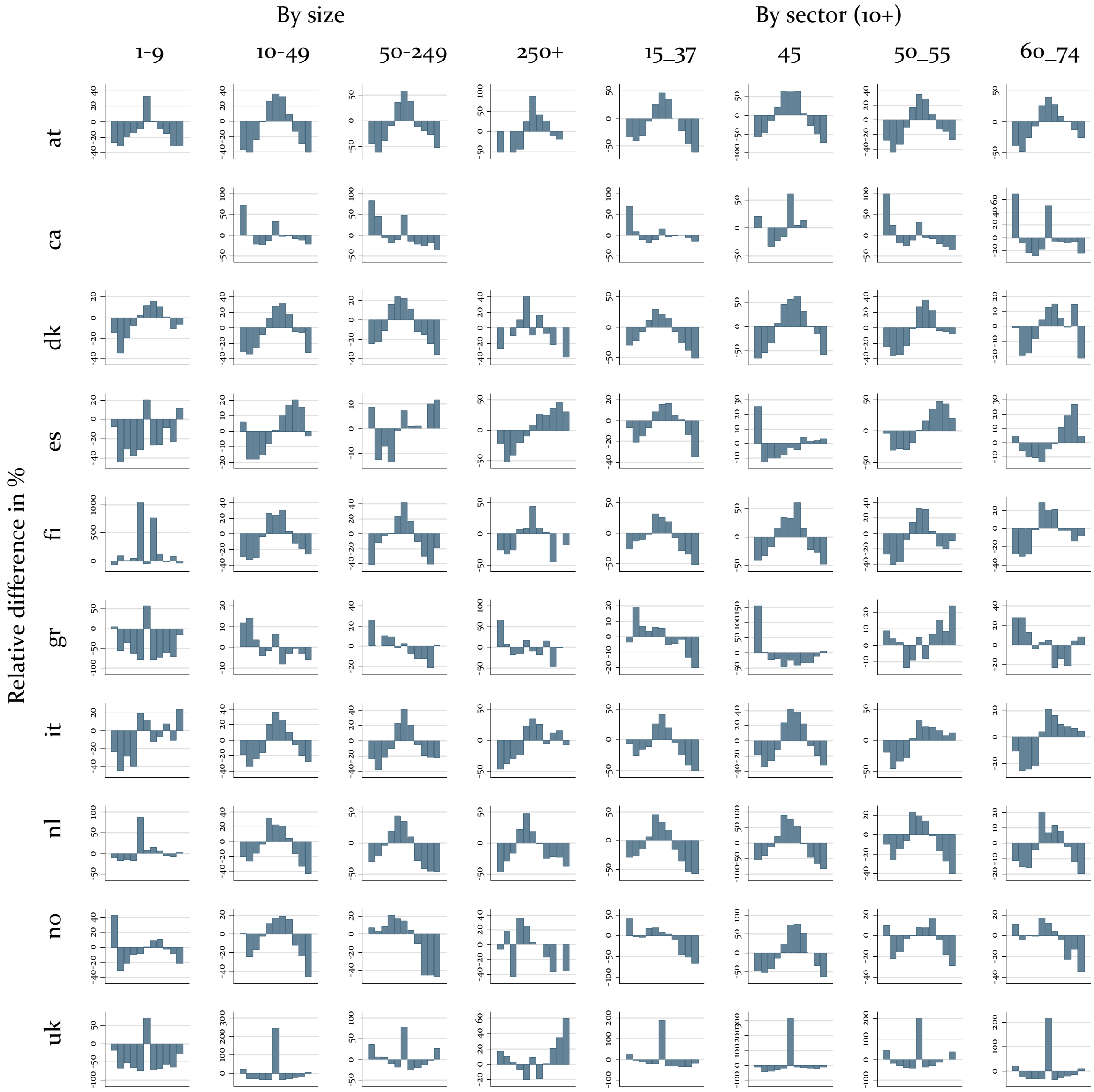


Figure 12: Business dynamism across countries

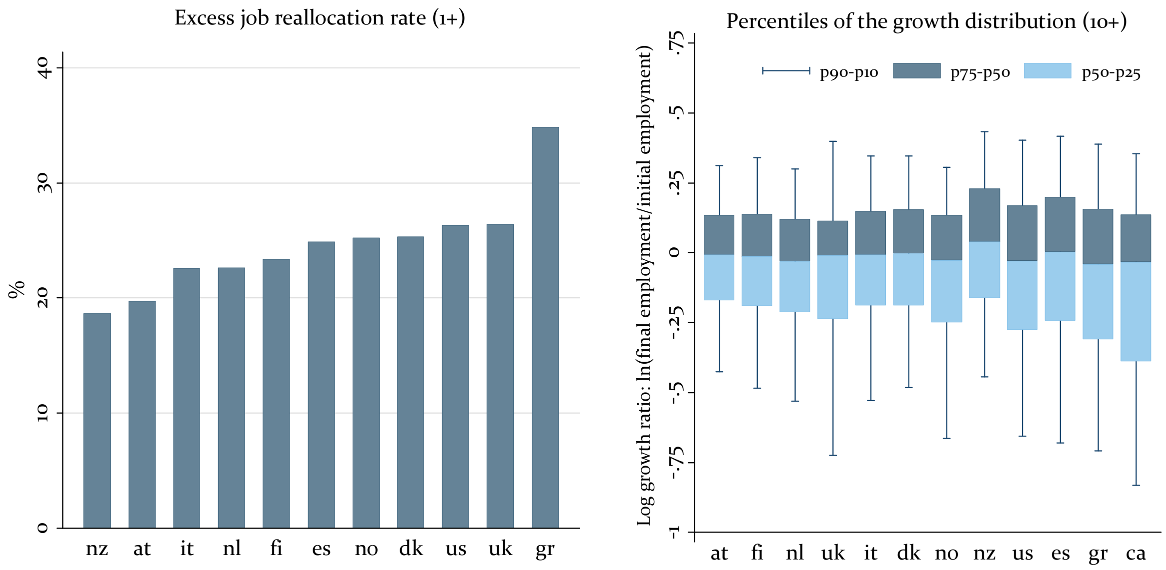
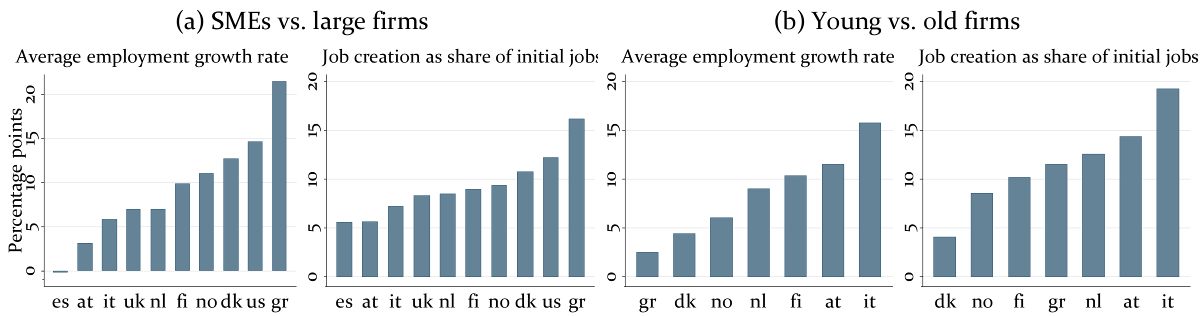


Figure 13: Challenging incumbents – gap by country (1+ employees)



Note: Each bar corresponds to the difference in pp between the rate for SMEs/young firms and the rate for large/old firms.