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An international cohort comparison of size effects on job growth*

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Abstract

The contribution of different-sized businesses to job creation continues to attract policymakers' attention, however, it has recently been recognized that conclusions about size were confounded with the effect of age. We probe the role of size, controlling for age, by comparing the cohorts of firms born in 1998 over their first decade of life, using variation across half a dozen northern European countries Austria, Finland, Germany, Norway, Sweden, and the UK to pin down size effects. We find that a very small proportion of the smallest firms play a crucial role in accounting for cross-country differences in job growth. A closer analysis reveals that the initial size distribution and survival rates do not seem to explain job growth differences between countries, rather it is a small number of rapidly growing firms that are driving this result.

Keywords: birth cohort; firm age; firm size; firm survival; firm growth
JEL codes: L25; E24; M13

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1 Introduction

Much of the discussion of firm and job dynamics since the late 1970s has centred on contrasting the job creation performance of small and large firms. More recently, and following the analysis of newly constructed datasets, a consensus seems to be emerging that the age of firms may also be an important part of the story – age having been initially confounded with size because most firms are born small (Haltiwanger et al. (2013)). However this 'consensus' does not yet extend to settled conclusions about small versus large (Neumark et al. (2011), Headd (2010)).

The purpose of this study is to unravel the impact of firm size, survival and growth on overall job growth. We probe the role of size, controlling for age, by comparing the post-entry performance of cohorts of firms born in 1998 (cohort98) in their first decade of life, using variation across half a dozen northern European countries – Austria, Finland, Germany, Norway, Sweden, and the UK – to pin down the effects. There are three distinctive features of our approach: first, we use a purpose-built dataset constructed by national experts using a commonly agreed measurement framework to make comparisons across countries; second, this allows us to use a finer grained treatment of small size than is usual – we divide firms with less than twenty employees into three size-bands; third, by analysing birth cohort data, we cut through many of the measurement-related complications produced by the potential confounding of age and size effects.

Cohort98 varies considerably across countries in a number of important ways. We develop a measurement framework which accounts for differences in job growth across countries due to differences in: 'initial conditions' – the average size of firms at birth by size-band, and the distribution of firm as across size-bands; and 'transforming factors' – survival rates by size-band, and growth by size-band. The framework allows us to build on what is already known to be true of most countries,

- the bulk of firms – more than 80% in almost all cases – are born very small, into the smallest size-band we distinguish, with between 1 and 4 jobs
- smaller firms have lower survival rates than larger firms
- smaller firms record faster growth than larger firms

and show the extent to which these differences between countries account for differences in country-level job growth. Firms' contribution to aggregate job growth is contingent on their survival and growth rates, which vary systematically with firm age and size. Previous research has had difficulties in disentangling these different effects. Our approach makes it possible to distinguish the effects of size, survival and growth while effectively controlling for age compared across countries. We are also able to uncover a key factor, contributing much of the variation in job growth across countries: the performance – over three different aspects – of the firms born into the ***smallest***, less than five employee, size-band. These aspects are: the proportion of these firms that survive;

the proportion that make a transition to the largest size-band; and the average job growth recorded by them during the transition.

We find that:

- the very smallest firms in the cohort play a relatively large role in accounting for overall job growth
- a few rapidly growing small firms play a crucial role in accounting for cross-country differences in job growth
- cross-country differences in the initial size distribution and survival rates contribute relatively little to the differences in job growth

Our findings have a significance which extends beyond the job creation "debate", they have implications for both theory and policy. Evidence on patterns of change by age and size are important for models of firm dynamics of the "selection and learning" variety, associated with Jovanovic (1982), Hopenhayn (1992) and Ericson and Pakes (1995). And, in respect of policy, as Haltiwanger *et al* observe, "... targeting firms based on size without taking account of the role of firm age are unlikely to have the desired impact on job creation." (Haltiwanger et al. (2013, p. 360)).

The cohort analysis is conducted in three consecutive steps. First, we investigate the relative importance of different size categories, their survival and growth rates. Here we find that overall job growth is explained mainly by the contribution of the smallest and the largest firms. Second, we compare job growth between countries and observe that overall differences are explained by the growth rate of the smallest firms, and not mainly by the initial size distribution or survival rates. Third, based on the finding that the smallest firms were decisive for differences between countries, we investigate this size group in more detail. We find that the growth in this size band is driven by a very small number of rapidly growing firms.

The rest of the paper proceeds as follows. In Section 2 we briefly review the literature, section 3 introduces the data and describes how it is put together whilst section 4 summarises some of its main characteristics. Section 5 introduces the primary decomposition and identifies the principal proximate determinants of job growth, whilst section 6 explores the key role of the smallest firms. Section 7 sums up.

2 Literature review

This paper stands at the intersection of three separate (though not entirely distinct) literatures: it is a cross-country cohort study of firm demography and job growth; and will take each of these three in turn.

2.1 job growth

David Birch's 1979 report on the job generation process (Birch (1979)) – produced as part of a programme of work intended to inform policy on urban and regional regeneration – sparked a debate which has now continued (albeit somewhat intermittently) for more than thirty years. There were two novelties in Birch's report (subsequently updated and expanded in a book-length study, Birch (1987)): first, its use of firm-level records (compiled for the study from Dun and Bradstreet data); and second, the emphasis in its findings on what he claimed was the hitherto neglected contribution of small firms to job creation.[1] Since one of the most recent contributions to the "job creation debate" has reviewed its history quite carefully (Neumark et al. (2011, pp. 16-19)) and this account met with the approval of at least one of Birch's sternest critics (Haltiwanger et al. (2013)), this history need not be rehearsed here.

The debate still continues although the issues and the methods used to address them have become considerably more refined. For example, in a new and notable contribution Haltiwanger et al. (2013) draw a rather nuanced conclusion:

> "We find some evidence in support of the popular perception that small businesses create most jobs ... If one looks at the simple relationship between firm size and net growth rates, there is evidence that net growth rates tend to be higher for smaller as opposed to larger businesses...
>
> Our results show that the more important and robust finding is the role of firm age and its relationship with growth dynamics. We find that once we control for firm age, the negative relationship between firm size and net growth disappears ... Our findings suggest that it is particularly important to account for business startups." Haltiwanger et al. (2013, p. 360)

Whilst we do address the "small versus large" question here – it is still the substantive, core, issue – we do so whilst taking particular account of the Haltiwanger et al. (2013) argument and controlling for the effects of age. So our job growth question is a very precise one: what are the relative contributions to job growth after a decade by firms born into different size-bands?[2]

2.2 cross-country

In most countries the use of firm-level data for analytical purposes is relatively new, consequently the characteristics of the data are not always fully understood: in particular, much of it derives from information systems designed for administration rather than research and so definitions do not necessarily

[1] Indeed, the subtitle of his 1987 book was:"how our smallest companies put the most people to work".

[2] Alternatively, this study might be seen as a contribution to fleshing out the evocatively described "up or out dynamics" which Haltiwanger et al. (2009), Haltiwanger (2012), Haltiwanger et al. (2013) regard as central to an understanding of the dynamism of the economy.

match at all well researchers' conceptual frameworks. Following from cross-country differences in administrative systems are cross-country differences in definitions and so some (often considerable) effort must be invested into trying to harmonise data before any meaningful cross-country comparisons can be made.[3] We have adopted the approach pioneered by Bartelsman (with various collaborators) and referred to as "distributed micro-data analysis" (a term introduced in Bartelsman et al. (2009, section 1.2)), where each country's data is prepared by local experts, thereby building in local knowledge of data sources, definitions and disclosure policies.

Over the last 20 years the number of countries for which firm-level datasets are compiled has increased markedly. Work making use of this data for cross-country studies is, however, still in its infancy. There are still not many more than a handful of studies using such datasets, amongst the most well-known are: Bartelsman et al. (2003) on firm demographics and survival; Bartelsman et al. (2009) on business dynamics (demography and productivity; Bartelsman et al. (2004) on creative destruction; and Haltiwanger et al. (2006) and Haltiwanger et al. (2010) on job creation and destruction. These studies (Bartelsman et al. (2003) excepted) feed into two distinguishable (though closely related) areas of research, one focuses on labour market dynamics, the other on productivity, but in both cases the key comparative concern is the association between cross-country differences in performance and cross-country differences in "institutions".

There does not seem to have been much discussion of the connection between the size of firms, their survival, growth and contribution to job creation in cross-country comparisons built on harmonised datasets. For example, although two of the cross-country studies just cited discuss differences in survival rates by size at birth (see Bartelsman et al. (2003, p. 25) and Bartelsman et al. (2009, p. 53)) neither connect this discussion with the job creation records of different *sized* firms; whilst the discussion of job creation and destruction by size in (Haltiwanger et al., 2006) and Haltiwanger et al. (2010) is not connected to variations in survival by size and age.[4]

We compare data from six countries: Austria; Finland; Germany; Norway; Sweden; and the United Kingdom (UK). Bartelsman et al. (2009), which is closest to us in subject focus, compares many more, twenty-four in all (see Bartelsman et al. (2009, Table 1.1, p. 25), but about half are transition or industrialising countries. There is some geographical overlap, but less than appears at first sight. The German data in Bartelsman et al. (2009) covers only West Germany

[3] For a, now slightly dated, summary of different cross-country datasets see Vale (2006)

[4] Two other OECD studies make cross-country comparisons of (amongst other things) job creation and destruction: the first uses the Amadeus and Orbis databases and excludes firms with less than 20 employees, see Bassanini and Marianna (2009, pp. 33–35); the second, Schreyer (2000), was organised as a cross-country project involving researchers from six participating countries, the data was compiled from a range of administrative, public and private surveys, in most cases it excluded firms with less than 20 employees and considered only firms which survived the study period (between three and nine years, depending on the country). Moreover, as its "Methodological Annex" recorded: ".. major methodological differences remain and the present analysis is faced with the problem of harmonisation and consistency. The results obtained in each country are strongly marked by these differences."Schreyer (2000, p. 40)

and their UK data only manufacturing, indeed the only country in Bartelsman et al. (2009) with coverage similar to ours is Finland.

2.3 cohort approach

Since our central concern is firm and job dynamics by age, it seems natural to organise firm-level date into 'birth cohorts' which allows us, quite straightforwardly, to keep track of the size distribution of firms as the cohort matures. So rather than focusing on data averaged over a period of years, and treating the distribution of ages as a by-product, we will follow a cohort of firms from birth, using firm age to index the measurement of size, survival and growth. Using a cohort approach locates our study within the field of business demography or, to use the term suggested by van Wissen (2002), "demography of the firm".

A cohort approach is not very commonly applied to firm-level studies of size, survival and growth. However there is a strand of work which (since it investigated the post-entry performance of start-ups) has relied on the cohort as an organising principle, one notable exponent of this approach has been Kirchhoff,[5] with Cabral and Mata (2003) a significant and rather better known example.[6] More recently, the U.S. Bureau of Labor Statistics published a brief study of cohort98 using their new Business Employment Dynamics dataset Knaup and Piazza (2007), but without any size-band detail, whilst Stangler and Kedrosky (2010) have used the cohort approach, and stylised facts about survival by size, to simulate the evolution of the size distribution of firms.

Whilst much of the cross-country analysis of firm dynamics in Bartelsman et al. (2009) makes use of period averages, a cohort approach is deployed (necessarily) in the discussion of "post-entry performance" Bartelsman et al. (2009, section 1.5.4). Indeed, one of their overall conclusions specifically recommends a cohort approach: "Measuring post-entry performance within countries appears to be somewhat more robust than the analysis of firm dynamics, since it implies following a cohort over time within a country." Bartelsman et al. (2009, p.73). However, their cohort-based study of post-entry performance did not discuss the connection between size and growth *within* countries, they considered the average size of all survivors across countries at three different ages.[7]

In brief, whilst it seems quite widely recognised that a cohort approach might be a useful way to approach the study of business dynamics,[8] cohort-based

[5] see, for example: Kirchhoff (1994); Phillips and Kirchhoff (1989); and most recently Headd and Kirchhoff (2009).

[6] Cabral and Mata (2003) compared a cohort of Portugese manufacturing firms at birth and age 7 to provide the empirical foundation for the suggestion that 'financial constraints' play a key role in the early growth performance of firms. However, of the many papers which cite Cabral and Mata (2003) and claim to be following their approach, relatively few have analysed cohort data.

[7] They do, however, offer some somewhat speculative remarks about the contrast between US and European growth performance and its connection with size at birth (Bartelsman et al. (2009, pp.53-57).

[8] For example Haltiwanger *at al* draw the following methodological conclusion given the character of business dynamics, "Lumping together all firms of the same age is clearly misleading, given this 'up or out dynamic'."Haltiwanger et al. (2009, p. 2)

studies are still relatively rare, and cross-country cohort-based studies rarer still.

3 Data and method

As mentioned earlier, the data here has been produced by "distributed microdata analysis", using local experts to build in local knowledge of data sources, definitions and disclosure policies but guided here by the measurement framework and definitions set out in the **Manual of Business Demography** OECD-EUROSTAT (2008).

The simplest way to proceed is to summarise the key dimensions of our 'benchmark' dataset and then list, in Table 1, the ways in which national datasets depart from it. The 'standard' is,

1. definition of a firm – an employer enterprise, that is a business with at least one employee
2. definition of employee – a person who receives a wage or salary from a firm
3. enumeration of employees – head count with no distinction between full-time and part-time employees
4. firm birth date – first employee joins
5. firm death date – last employee leaves
6. sectoral coverage – the 'private' or 'business' sector (NACE rev1.1: 15 to 74; 90 to 93)
7. enumeration of firms – all employer enterprises in the private sector

As may be inferred from this list, the choice of definitions is designed to be implemented using the administrative databases of a kind compiled by either, or both of, the tax authorities and the social security system. The strength of such databases is typically their universal coverage which follows from their role in administering the revenue and welfare systems. A common weakness, though, is that it is not always possible to distinguish between a *de novo* birth and firms which are 'born' following the break-up of an existing enterprise (or the parallel distinction between death and the sale of a firm), so we have not tried to make that distinction here.

There is one important matter of measurement where we have not been able to harmonise the data entirely, the counting of jobs. In Austria, Germany, Norway, and the UK, we have a head count measure of jobs; in Finland the data is for "full time equivalents" (FTE); whilst in Sweden we count persons (each person has a single "main job").[9] Whilst these differences are obviously important, it is not clear that they will significantly affect the answer to our key

[9]This may also affect Sweden's firm count: if firms in which every employees main job is elsewhere would not be included.

question: the relative importance of the smallest firms to job growth (in fact, for Norway we have parallel datasets on all three bases, and some high-level summary statistics on these differences will be reported in the next section). Indeed the same criterion should be applied to other (perhaps as yet undetected) differences in national statistical practice: how might it affect our conclusions about the links between firm and job dynamics?[10]

Our study focuses on the cohort of firms born in 1998, measured at birth and then again a decade later in 2008. The key data analytical construct here is an 'origin/destination' (O/D) matrix whose 'origin' rows are four broad size-band categories at birth and whose 'destination' columns are size-band categories in 2008. Each country team was asked to provide three of these matrices,

1. an O/D matrix of firm counts: this is a 4×5 matrix, an extra column is needed for firms from each size-band which are 'dead' by 2008
2. an O/D matrix of employee counts in 1998: this is a 4×5 matrix, an extra column is needed for firms from each size-band which are 'dead' by 2008
3. an O/D matrix of employee counts in 2008: this is a 4×4 matrix, by definition only 2008 survivors are counted

Whilst this is quite a modest dataset, it nevertheless provides sufficient raw material to give some insight into how business dynamics and job growth vary across countries.

4 Key facts

4.1 size of the cohort

There is (unsurprisingly) considerable variation in the size at birth of cohort98 across our six countries, it varies by a factor of 16: from 240 thousand in the UK to 13 thousand in Norway (Table 2 panel (a) column (1)). Finland is closest in size to Norway, Germany is (relatively) close to the UK, while Austria and Sweden – at around 30 to 40 thousand – are in between. If we scale the number of firms by (human) population size, as a crude adjustment for the size of an economy, countries look much more similar (Table 2, panel (a) column (5)). In five out of six there are between three and four cohort98 businesses per thousand population, the only outlier is Germany where the figure is a little less than two, so the range of cross-country variation is reduced to about 2.25.

4.2 survival of firms

It is well-known that a relatively large proportion of firms die young and although this is true of all countries, rates do vary internationally. In our case survival rates at age 10 from (Table 2, panel (a) column (4)) vary by a factor of about 2.5: in Sweden just 11.8% of cohort98 remains alive in 2008, whilst 30.7%

[10]For a discussion of the implications of measurement issues in harmonised cross-country datasets see Bartelsman et al. (2009, pp. 27 – 32).

survive in Austria. Most of the rest fall at one or other end of this spectrum, Germany and Norway record survival rates very similar to those in Austria, whilst the UK is closer to Sweden, only Finland sits mid way between the two 'groups'.

4.3 number of cohort jobs

The first three columns of Table 2 panel (b) record the jobs which correspond to the firm numbers displayed first three columns of panel (a): jobs at birth; jobs in 2008 survivors at birth; and jobs in 2008. The number of firms in the cohort varied across countries by a factor of 16, but the number of jobs born into the cohort varies by considerably more: the number of cohort98 jobs at birth in the UK (1123.7 thousand) is about 30 times the number of cohort98 jobs at birth in Finland (38.7 thousand).

Between birth and 2008 the number of cohort jobs shrinks dramatically, and the shrinkage is largely driven by the death of cohort members. For example, in the countries with the lowest survival rate – the UK and Sweden – jobs *at birth* in 2008 survivors are less than one fifth of all cohort jobs at birth (Table 2 panel (b) (column (2) ÷ column (1))) – mortality over the decade cost Sweden more than 200 thousand 1998 jobs and the UK almost one million (Table 2 panel (b) column(4)). Substantial numbers of jobs are lost in the other countries too but, unsurprisingly, given the higher survival rates the proportion of jobs in the survivors at birth is rather higher, around two thirds.

4.4 jobs per firm at birth

The mean is not an ideal measure of central tendency for distributions as skewed as those of firm sizes, nonetheless the number of jobs per firm can provide a useable guide to the scale of inter-country differences.[11] Finland records the smallest number of jobs per firm at birth (although this is certainly an under-estimate, since it is computed from full-time equivalent data) at 2.62 (Table 2 panel (c) column (1)), with Germany and Austria quite close by, both less than 3.5 and the UK around 4.5. Norway and Sweden are at the other end of the size distribution, with figures almost twice as large, more than seven jobs per firm at birth.

As mentioned earlier, we have 'person count' and FTE data for Norway, and the alternative measures based on these definitions have been included as a 'Memo' row to panel (c) of the table. You will see that – in the case of Norway at least – counting persons instead of jobs makes very little difference to the results. The FTE measure makes more of a difference to jobs/firm, as might have been anticipated, average firms sizes are smaller. The growth ratio and average growth rates for the person count are very close to those based on the benchmark jobs definition, the FTE figures are lower, but not sufficiently to alter Norway's ranking.

[11] We will return to this issue later and look at the size distribution in a little more detail.

4.5 survival rates

No more than 30% of cohort98 firms survive the decade, and in some countries rather less. If we compute jobs per firm at birth of the 2008 survivors (Table 2 panel (c) column (2)), we find that – in every case – survivors are (on average) larger at birth than the birth cohort as a whole, and in the case of Finland, survivors are considerably larger (again, a likely side-effect of the full-time equivalent measure). This is evidence, at the aggregate level, of some size-related 'selection effect' – smaller firms die younger.

4.6 growth

The ratio of jobs per firm in 2008 to jobs per firm in *survivors at birth* (Table 2 panel (c) column (3)) provides a measure of the growth in the number of jobs since, by definition, the denominator of jobs per firm, the number of 2008 survivors is fixed.[12] The UK recorded a doubling of jobs per firm, the strongest growth in jobs per firm, and by implication in overall jobs, since number of surviving firms is given. The UK is followed closely by Finland, then Germany and Austria with each of the latter two recording about 80% growth over the decade. Norway and Sweden[13] posted more modest gains of 50% and 33% respectively. The final column of panel (c) translates job growth into a more conventional measure, the annual average growth rate over the decade. Notice that even the slowest growing country, Sweden, records a 'respectable' 3% per annum, whilst at the top end of the scale the UK figure at 7.5% is more than twice as large (and Finland is close by at 7.3%).

5 Digging below the surface: decomposing job growth

Both firm survival and growth vary systematically with age and size, but we condition on age by using cohort data to expose the extent and nature of the connection between cross-country variation in size-specific firm survival and growth rates and cross-country variation in overall jobs growth. Here we use just four size-bands to capture the size-specific character of survival and growth effects, measured in terms of employee numbers they are: 1 to 4; 5 to 9; 10 to 19; and 20+.

Whilst summarising a firm size distribution in just four categories might, *a priori*, appear to be an oversimplification, as we shall see, the only (empirically) plausible alternatives would have involved slicing the size-bands even more finely at the small end.[14] In any event, in practice, this size-band classification

[12] An alternative measure of growth over the decade would be the ratio of jobs in 2008 to jobs *in all firms* in 1998, but this measure confounds survival and growth, which we keep separate here. In any event, the ordering on the alternative growth measure is rather similar.

[13] It might be conjectured that Sweden's *relatively* slow growth might be connected to the different measure of employees. Of course, it is not possibly to know, however, to make such a difference to the growth calculation would require not just multiple job holding but *increased* multiple job holding in cohort98 over the decade.

[14] Moreover, in smaller countries, with relatively few firms born very large, the statistical authorities do not permit publication of data which might allow individual firms to be identified.

pinpoints quite effectively the similarities and differences between countries, and allows us to uncover the impact of size on the pattern of job growth.

We make use of an expression which represents *overall* growth in jobs per firm as a weighted sum of the size-specific growth rates of firms. The 'weights' in this sum of the size-band specific growth rates can be expressed in terms of five factors which, when combined, connect firms in the cohort at birth to all those which survive. These five components fall into two groups. The first two are initial conditions,

- the average size at birth in each size-band ($avjob_i^b$)
- the share of each firm size-band at birth ($firmsh_i^b$)

and the other three capture the transforming effects of survival and growth. Since the two relative survival ratios may be less familiar they are explained in more detail,

- within size-band relative survival effects ($rsrw_i$): this ratio operates on the average job by size-band figure, and it is a variety of 'selection' effect which arises because we use size-bands rather than single sizes, and survival rates vary by size inside the size-band. So, for example, differential survival ratios by size within size-band 1– 4 (where, say, survival ratios for firms size 1 are lower for firms born size 1 for firms born size 2, etc) will produce an average jobs per firm figure for surviving firms in the size-band 1 – 4 larger than for the firms in the size-band 1 – 4 at birth. This survival ratio is computed, size-band by size-band, as the ratio between the average jobs per in surviving firms at birth in a size-band ($avjob_i^{bs}$) and the average size of all firms at birth in that size-band ($avjob_i^b$)
- between size-band relative survival ratio ($rsrb_i$): this ratio operates on the firm share (size) distribution, it captures the fact that different size-bands have different survival ratios, typically larger size-bands have higher survival ratios than smaller size-bands. This term, another size-related 'selection' effect, is computed, size-band by size-band, as the ratio between the average survival ratio for firms in a size-band and the average survival ratio for all firms
- size-band specific growth rates ($growth_i$)

where the i subscript denotes the size-band.

The relationship between these factors and overall growth is set out formally in equation (1)[15],

$$growth = \frac{\sum_{i=1}^{4}(avjob_i^b \times firmsh_i^b \times rsrb_i \times rsrw_i \times growth_i)}{\sum_{i=1}^{4}(avjob_i^b \times firmsh_i^b \times rsrw_i \times rsrb_i)} \quad (1)$$

Table 1 provides some intuition about the logic of this relationship. It is a

[15]Precise definitions and a derivation are provided in the Appendix section A.1.

graphic which displays the way the factors combine. Across the table we represent the effects of survival and growth on firm performance, affecting average jobs/firm and the firm size distribution. As explained above, because survival rates depend on size, both 'initial conditions' – average jobs per firm at birth and the firm size distribution at birth – are scaled by a *relative survival ratio*. Both of these represent different varieties of selection effect: a *within* size-band relative survival ratio (in the first row) because the average size of survivors within a size-band may differ from the average size at birth; a *between* between size-band relative size band ratio (in the second row) because survival rates may differ by size-band. So the middle ('survivors') column records the average jobs per firm for survivors *at birth* and the firm size distribution of survivors *at birth*. Multiplying the average jobs/firm of survivors at birth by size-band specific growth rates (in the 'growth' column) yields the average jobs/firm in the terminal year. Down the table we represent the combination of jobs/firm by size-band and the firm size distribution into weighted components which sum to the aggregate job/firm figures and from which, ultimately, the measure of overall job growth can be computed.

5.1 a tour of the decomposition

Rather than start with the specifics of each of the national datasets, we use data from one country – Austria[16] – to introduce and illustrate the decomposition. Not only is Austria towards the 'middle' of the growth rate distribution, it turns out to have 'middling' values for most components of the decomposition. The Austrian data on the components of the decomposition is displayed in Table 4[17], which is laid out using the same 'matrix' display as was used to illustrate the relationship between the concepts in Table 3.

The cohort at birth is described in the first column. The first block of four rows is average jobs/firm. Since the first three size-bands are bounded we already know the range within which the average jobs per firm will fall, what we can see though is that, in each case, the size-band average is below the mid-point of the size-band. This suggests there is some skew in each distribution towards the bottom of its range. The largest size-band is unbounded and there the average size is almost 70 employees per firm. In the next block we have the firm share distribution, and its principal feature is the extraordinary concentration in the smallest size-band – 89% of all firms have less than five employees. Only 6% are in the 5 – 9 size- band, with the rest shared almost equally by the other two. From the third block going down the column – the weighted average terms – it is immediately apparent that the contributions to the overall jobs/firm at birth reflect the balance between the very large number of very small and the very small number of the very large. In fact, the weighted contributions of the 1 – 4 size-band and that of 20+ size-band are both about 40%.

[16] Austria was chosen after some experimentation with alternative approaches to constructing a cross-country 'average'.

[17] A more detailed treatment of the Austrian decomposition is laid out in the Appendix A.2 and its accompanying table. It displays the size-band detail which evidences some of the comments in the text about the relative importance of different effects.

So the average size at birth – 3.40 jobs per firm – is (proximately and largely) determined by the two ends of the distribution.

As we know the effect of death flows through different channels: it alters the average size within each size-band; and it changes the balance between the size-bands. The first effect is recorded in the first block in the 'survival' column and is, in most cases, relatively small. The only impact much larger than 1% is in the smallest size-band, where average size increases by about 12%, although the resulting average size at birth (in the 'survivors' column) at 1.72, is still well below the mid-point of the distribution. By contrast, the 20+ jobs per firm figure, at 67.42, is virtually unchanged. The effects of death on the firm share distribution recorded in the second block are, by contrast, quite substantial. Although the shrinkage at the small end (about 5% off the 1 – 4 share) is quite modest, there is a huge (proportionate) expansion at the larger end (in each case by more than 40%). Nonetheless, as you will notice from the firm size distribution of survivors (the second block in the survivors column), and notwithstanding the size of the relative survival rate effects, the share of 20+ firms is still just about 3%. Looking further down the 'survivor column to the next block, we see that the balance in the weighted contributions has shifted quite noticeably, and the 1 – 4 contribution now rather smaller than the 20+ share. The resulting average job figure, at 4.52, is one third larger than the comparable figure at birth: clearly the size-related selection effect on the firm size distribution has had quite a substantial impact.

In the 'growth' column we have the effects of differences in size-band specific growth ratios.[18] The gradient in the size-band effect is the most obvious feature: the growth ratio for the 1 – 4 size-band is almost twice that of the 20+ size-band. Even the two larger size bands show around 50% more growth than does 20+. In the 'terminal' column we see the significance of the size differential in growth. After ten years the average jobs/firm exceeds the upper bound for each of the bounded size-bands, whilst the largest firms are (on average) not very much larger. When weighted by the firm share distribution (which is, of course, that of the survivors at birth), we see that the weighted contributions have shifted quite strikingly towards the small end of the distribution: the smallest firms, by age ten, contribute almost half the cohort average, whilst the contribution of the 20+ group, is now less than one third. The pattern of contributions now looks quite different to either the whole cohort at birth or the survivors at birth. The distribution is still bi-modal – a large share of size-band 1–4 firms, a small share of 20+ firms – but the contribution of the smallest firms is very considerably more important. As we shall very soon see, it is a small but significant group of the survivors from the 1 – 4 size-band, having out-grown their size-band at birth, which are driving this finding.

The 2008 figure for average jobs per firm is 7.73, 70% larger than the corresponding figure for survivors at birth, equivalent to annual average job growth of 5.5% over the cohorts first decade of life. Figure 1 serves as a graphical summary of the role of the three transforming factors in this outcome. The data

[18] Remember growth is being measured here as the ratio between average jobs per firm in survivors at birth and in the terminal period, ten years later.

have been plotted on a log scale to make them more readily comparable (since they enter the relationships multiplicatively). The display provides visual confirmation of what is generally known: survival prospects are better for larger firms; and post-entry growth performance is stronger for smaller firms. We will now examine how their relative importance contributes to cross-country job growth.

5.2 cross-country variation and the decomposition: a counterfactual analysis

Quite some time has been devoted to the Austrian data, using it to introduce the components of the decomposition. Now we will investigate the extent to which other countries depart from the Austrian 'average' and which of these departures play the most important role in accounting for the differences in job growth which, as we saw earlier, varies markedly with the UK growing 30% faster than Austria, and Sweden 50% slower.

Using Austrian data as the baseline we have constructed Table 5. It records the difference between a country growth ratio and that of Austria as the sum of the differences between that country and Austria, component by component. It is constructed by replacing each of the elements of the Austrian decomposition, one at a time, and recording the difference from the Austrian growth ratio. These elements are the two initial conditions: average number of jobs per firm at birth ($avjob^b$); the firm size distribution at birth ($firmsh^b$); and the three transforming factors: the two selection effects, the 'between' relative survival ratio ($rsrb$) and the 'within' relative survival ratio ($rsrw$); and the growth ratio ($growth$).

If all the components of the decomposition were additively related the sum of these individual differences for a country would exactly equal its overall difference from Austria, but of course we know the relationship is not additive. In particular, within a size-band, the elements are combined multiplicatively, so there may be a discrepancy between the sum of the 'marginal' effects of each component and the country's growth ratio. We refer to this discrepancy as an 'interaction effect' and it is recorded in column (6) of the table. The data on the components of the decomposition for all countries used in the construction of Table 5 and the (other) analytical tables is provided in an Appendix.

As noted earlier, three of our four size-bands are bounded[19] so the pattern of contributions in column (1) reflects, almost entirely, the negative association between overall growth and the average size of firms in the 20+ size-band. The negative differences for UK, Finland and Norway indicate that, for them, the average size of the 20+ firms exceeds that of Austria, whilst the average size of 20+ firms in Germany is rather smaller. Notice that there is only a weak association between these differences and the growth rate ranking.

[19] With the partial exception of Finland where the job numbers are full-time equivalents and so some firms in the 1 – 4 size-band have, in practice, less than one job.

We see straight away from column (2) of Table 5 that Germanys firm share distribution at birth is essentially the same as Austria's. However, the two countries lower down the growth rate distribution than Austria – Norway and Sweden – record sizeable negative differences, whilst for Finland and the UK, the two countries higher up the growth rate distribution, the differences are positive. What differentiates these two pairs of countries is that the UK and Finland have a larger share of firms (than Austria) in the 1– 4 size-band – positively associated with growth and a smaller share of firms (than Austria) in the 20+ size-band – negatively associated with growth; whilst for Norway and Sweden (relative to Austria) the position is reversed. Simplifying, the firm size distribution in the UK and Finland is more more positively skewed than in Austria, whilst in Norway and Sweden it is more negatively skewed.

We can also see from columns (2) and (3) of the table that differences in relative survival rates play almost no role in accounting for job growth differences. By implication, most countries have survival rate curves which resemble quite closly those for Austria depicted in Figure 1. The only substantial figures are for Finland, and again these are likely a by-product of the full-time equivalent effect since the firms with very smallest number of employees seem most prone to die.

Finally we come to the growth terms. These produce most of the more sizeable contributions (both positive and negative) to the growth rate differences, so it is worth examining them in some detail. The UK and Finland record the largest positive contributions from size-band specific growth and Figure 2, which displays the growth ratio data for all six countries, helps us understand why: the UK and Finland both have more rapid growth than in Austria in every size-band (although the difference in 20+ is very small). The largest negative contribution is recorded by Sweden where growth in the 1 – 4 size-band is extraordinarily modest, and much lower than Austria. Germany's growth most closely resembles the UK and Finland at the small end of the size distribution, but the relatively rapid growth of the smallest firms is not sufficient to offset very much slower growth elsewhere (and indeed the contraction of jobs in the 20+ size-band), so for Germany overall the contribution is negative.

One feature of Figure 2 – the 'big picture' – that stands out is that, for most countries, size and growth are negatively related, though by no means monotonically. Since the data has (again) been plotted on a log scale, the inter-size-band differences between datapoints within a country can be interpreted as additive contributions to the overall country growth.

6 Job growth under the microscope

We have seen that size-band specific job growth typically plays a larger role than the firm size distribution, average size at birth, or survival rates in accounting for relative growth performance. We know too that growth rates vary by size-band, and that – comparing size-bands – smaller firms typically grow faster than do the larger. It is possible to perform a more focused decomposi-

tion to tease out the relative importance of each size-band specific growth rate, and here again we use Austria as the benchmark. Country by country, we replace each of the size-band specific growth rates one at a time. The results of this exercise are recorded in Table 6. In every country the growth rate of the 1 – 4 size-band produces the contribution to the overall growth rate with the largest absolute value.[20] By extension, then, it is growth rate differences between the 1 – 4 size-band across countries which account for the bulk of the overall variation in job growth between countries. Indeed, only in Germany, where 20+ firms actually contracted, does any other size-band play a substantial role.

6.1 decomposing the growth rate contribution of the smallest firms: Austria

Let us now drill a little deeper. Not all firms born in size-band 1 – 4 remain there: in the case of Austria we know from Table 4 that the 2008 *average* size of firms born 1 – 4 firms fell just outside the size-band. So 2.341 is the growth ratio of all firms born in the size-band 1 – 4, and is a weighted average of the growth ratios of some firms which remain in size-band 1– 4 and others which are now in a larger size-band.[21] The first row of Table 7 records Austrian data on the growth ratio of firms born in size-band 1 – 4 classified by their 2008 size-band. The dispersion around the size-band 1– 4 average of 2.341 is considerable: firms which remained in size-band 1 – 4 recorded half the average growth at 1.13; whilst firms which made the transition to 20+ reported *ten times* the average.

It turns out to be quite straightforward to uncover the effects of transitions by firms born 1 – 4 by decomposing the 1 – 4 growth ratio according to the size-band in 2008. This decomposition involves three size-band specific ratios,

- the first, we have just seen, is the size-band specific growth ratios, one for each of the four 'destination' size-bands (gr_i)
- second, we have a 'selection' adjustment, which captures the fact that the average size of 1 – 4 firms at birth varies slightly across their 'destination' size-bands – those which move into larger size-bands turn out to have been slightly larger at birth (sel_i)
- finally, a 'mobility ratio', the proportion of firms born in size-band 1 – 4 which are in each 'destination' size-band in 2008 (mob_i)

We can represent jobs growth in the 1–4 size-band as the sum over all four 'destination' size-bands (so including 1–4 as a destination for those firms who finish in 1–4) of the product of these three terms,

[20] In Germany, as we saw from Figure 2, 20+ firms contracted and this produces a negative contribution of equal absolute value to size-band 1 – 4 growth.

[21] Our data does not allow us to infer whether these firms remained in the same size-band throughout the decade: they may have moved out and moved back, though *a priori* this does not seem very likely to be a widespread phenomenon.

$$\frac{avjob^t}{avjob^b} = \sum_{i=1}^{4}(gr_i \times sel_i \times mob_i) \quad (2)$$

The growth ratio for all firms born in size-band 1 – 4 is the sum over all size-bands of these contributions. The data corresponding to the components and their contributions are set out in the rows of Table 7. A formal derivation of this decomposition is provided in the Appendix, section A.2.

We have already looked at the growth row in the table, and by contrast the selection adjustment in the second row is relatively small and hardly varies. Essentially, firms which grow out of the 1 – 4 size-band are about one third larger than the birth size-band average (that is 2.3 rather than 1.72), while those which remain are about 8% smaller (1.58 rather than 1.72). The mobility ratio is quite small too, but, importantly, it varies considerably across the row – 80% of size-band 1 – 4 firms remain 1 – 4, 2.2% grow into the 20+ size-band – the proportion remaining is larger by a factor of 36 than the proportion becoming 20+.

Overall then we have a set of contributions, recorded in the bottom row, which are bi-modal: a large proportion of relatively slow growing firms which remain in size-band 1 – 4, and a very small proportion of relatively fast growing firms which move into the 20+ size-band. From the shares, recorded in the last row, we see that these two largest contributions account for about two thirds of the overall size-band 1–4 growth ratio. Whilst it may be, as we saw in the previous section, that it is size-band 1 – 4 growth which drives the overall rate of job growth, it is now clear that in Austria it involves just 20% of the 2008 survivors, and that much of it is contributed by the 2.2% which grew to have more than 20 jobs.

6.2 decomposing the growth rate contribution of the smallest firms: a counterfactual with an Austrian baseline

We now perform a final counterfactual exercise to determine which of the three factors – growth, adjustment and mobility – plays the largest role in the variation across countries in the growth of firms born in size-band 1 – 4, again measured as differences from Austria. Table 8 records the results of the contributions to growth of the three ratios (together with a residual 'interaction' effect). First, it is worth noticing that the ranking of 1 – 4 job growth (column (5) of the Table) is the same as the ranking on overall job growth. Unsurprisingly the 'selection' effects are no more important across countries than they were for Austria. The mobility effect is relatively large in most countries, and in all the four countries which recorded more growth in size-band 1 – 4 than Austria its contribution is positive. However, in Sweden, which recorded lower growth than Austria, the mobility effect is large and negative: a smaller proportion of firms leave the 1 – 4 size-band. The contributions of the growth rate effect are more variable. It plays an important and positive role in the UK and Finland, and an equally important and negative role in Sweden, but it contributes relatively little to accounting for the cross country growth differential in Germany

or Norway.

The overall conclusion here is that a greater degree of mobility – a relatively large proportion of firms leaving their size-band at birth – seems to be necessary, but not sufficient, for faster job growth. The strongest performance is recorded in those countries where mobility is accompanied by relatively rapid growth.[22] It is also worth noticing that in all countries, most of this (potentially) crucial group of very small firms do not leave their birth size-band, in every case 70% or more of those that survive (typically around 90% to 95% of the all firm average) after a decade still record no more than four jobs .

7 Summing up

Following a cohort of firms over time using a unique cross country dataset, we find that a very small proportion of the smallest firms play a crucial role in accounting for cross-country differences in job growth. By using a purpose built dataset we are able to get a finer grained treatment of small size than is usual, and the cohort approach cuts through many of the measurement-related complications produced by the potential confounding of age and size effects.

We analyse the variations in job growth in three consecutive steps. First, we use Austria as a benchmark to investigate the relative importance of different size categories, their survival and growth rates. We find that overall job growth is explained mainly by the contribution of the smallest size-band (1-4) and the largest (20+). Second, we compare the other five countries with Austria and find that the overall difference in job growth between countries is explained by the smallest size band (1-4). Moreover, the differences between countries are due to different growth rates rather than different rates of survival or the initial size distribution of firms. Third, based on the finding that the size band (1-4) was decisive for differences across countries we decided to investigate this group of firms in more detail. We find that the growth in this size band is driven by a very small number of rapidly growing firms.

The analysis of job creation using data on birth cohorts of firms is quite rare, the international comparison of birth cohorts is rarer still. We have adopted this approach for two reasons. First, the perennial argument about the role of firm size in generating job growth has been complicated, it is now appreciated, by the confounding effects of age because most young firms are small. By observing a cohort of firms at birth in 1998 and at age ten in 2008, we can compute job growth comparisons for firms across size-bands which are, *by construction*, uncontaminated by the effect of differences in age. Second, applying the same method to datasets for a number of countries – Austria, Finland, Germany, Norway, Sweden, and the UK – which recorded quite widely varying rates of job growth over the decade 1998 to 2008, helps to provide a clearer perspective on the relative importance of size.Third, the cohort approachmakes it possible

[22] In Norway, for example, with the greatest mobility, much of the movement out of the birth size-band, much more than in other countries is into the 5 – 9 and 10 – 19 size-bands, see Appendix for details.

to unravel the impact of survival and growth on overall job growth. It is important to be clear, though, that our findings about size reported here refer to size at birth. Of course, this is not an inherent feature of cohort-based comparisons: we could have made a ten year comparison between the cohort at five and at age 15. What is inherent to the cohort approach is an intuitive and effective means of disentangling age and size effects which does not rely on an indirect accounting for the (possibly non-linear) effects of age as is required when comparing cross-sections of firms of mixed age at two different points of time.

Although the data used in this study is novel there are some limitations which should be noted – only six countries, a single cohort, one point to point comparison over time – which suggest immediately directions in which it might be generalised. There are now many more countries which compile the necessary data, for most of the countries covered by this study at least two more cohorts (up to age ten) are already available, and of course it would be interesting to follow job growth (and the contributory dynamics of selection and survival) year by year. Of course, data of the kind analysed here – especially the annual time series version – could provide a much deeper insight into the dynamics of employment change. It could, for example, help to extend and enrich the conventional job creation and destruction accounts by tracking the movement of expansion, contraction and exit by age.

The cross-country cohort design employed here adds to the body of evidence on post-entry firm performance and job growth. First, it confirms some widespread perceptions about newly born firms: they are typically very small, more than three-quarters in each of our six countries have less than five employees; relatively few survive ten years (and fewer still of the smallest); but the firms born smallest, which survive, grow faster. What we have discovered, and what does not seem to have been previously appreciated, is the nature and extent of the contribution to job growth made by the smallest firms in the cohort: a very small proportion of them account for a disproportionate amount of overall job growth, whilst the rest of those that survive hardly grow at all.[23] More broadly these findings serve to underline the importance of taking a dynamic view, emphasising the role that each new cohort of firms plays in 'topping up' the stock of survivors of earlier cohorts, and the significance of age for understanding firm survival and job growth.

[23]We are though implicitly assuming that the cross-country comparison of this relationship is unaffected by the extent to which countries are at different stages of the business cycle.

Table 1: Data: sources and departures from 'benchmark'

Sources	
Austria	Social Security Data
Finland	Statistics Finland
Germany	Mannheimer Unternehmenspanel (Mannheim Enterprise Panel)
Norway	Statistics Norway
Sweden	Statistics Sweden
UK	Office of National Statistics
Benchmark Departures	
Austria	NACE 1 to 74
Finland	employees: full-time equivalent jobs
Germany	birth: "foundation"; death: "closure"; NACE 10 to 93
Norway	none
Sweden	employees: count of persons
UK	none

Notes:
1. data for countries except Germany (see note 2 below) are compiled from official statistics. Detailed information on the sources and construction of the data will be provided by the authors on request.
2. data for Germany compiled from the Mannheimer Unternehmenspanel (MUP) dataset which currently covers nearly seven million firms, three million of which are active, with a further circa 0.7 million being categorized as insolvent and three million voluntarily closed. The data are provided biannually by the leading German credit rating agency – Creditreform. Creditreform collects information on legally independent, active firms derived from the German official register of firms, the German insolvency register, company reports, newspapers, and firm interviews. MUP has information on: identity of owners, ownership structure, location, industry classification, number of employees, sales, legal status, firm age and pathways to market exit. The panel structure of the MUP enables observing enterprises over the 1999-2012 period.

Table 2: Cohorts of firms born in 1998, number of firms and job growth in Austria, Finland, Germany, Norway, Sweden & the UK

	all firms at birth	surviving firms in 2008 at birth	surviving firms in 2008 at end	ratios, rates differences	
(a) number of firms				survival ratio (%)	firms/pop ratio
	(1)	(2)	(3)	(4)	(5)
Austria	27403	8362	8362	30.7	3.4
Finland	14737	3539	3539	23.8	2.9
Germany	151075	45786	45786	30.3	1.8
Norway	13463	4100	4100	30.5	2.9
Sweden	36506	4284	4284	11.8	4.1
UK	239649	40836	40836	17.0	4.1
(b) number of jobs ('000)				differences	
				(2)-(1)	(3)-(4)
Austria	93.1	37.8	64.6	-55.3	26.8
Finland	38.7	15.9	32.3	-22.81	16.3
Germany	472.3	171.3	315.9	-301.0	144.6
Norway	120.7	46.6	71.2	-74.1	24.6
Sweden	259.9	43.6	58.4	-216.3	14.8
UK	1123.7	223.6	460.3	-900.1	236.7
(c) jobs per firm				growth	
				ratio	rate (%)
Austria	3.40	4.52	7.72	1.708	5.5
Finland	2.62	4.51	9.12	2.024	7.3
Germany	3.13	3.74	6.90	1.844	6.3
Norway	8.96	11.37	17.36	1.527	4.3
Sweden	7.12	10.19	13.64	1.339	3.0
UK	4.69	5.47	11.27	2.059	7.5
Memo:					
Norway, alternative job measures					
persons	8.24	10.62	16.07	1.514	4.3
FTE	7.04	9.43	13.14	1.393	3.4

Note: Birth refers to 1998 and end refers to 2008. Survival ratio is col(2) ÷ col(1); bus/pop is business per 1,000 population; growth ratio is col(3)÷ col(2); growth rate is the compound annual average rate.

Table 3: The decomposition

	birth to survivors					*survivors to terminal*				
	birth		survival		survivors	survivors		growth		terminal
	$avjob_i^b$	$\times$	$rsrb_i$	$\equiv$	$avjob_i^{bs}$	$avjob_i^{bs}$	$\times$	$growth_i$	$\equiv$	$avjob_i^t$
weighted by										
	$firmsh_i^b$	$\times$	$rsrw_i$	$\equiv$	$firmsh_i^{bs}$	$firmsh_i^{bs}$			$\equiv$	$firmsh_i^t$
form weighted sums										
	$wavjob_i^b$				$wavjob_i^{bs}$	$wavjob_i^{bs}$				$wavjob_i^t$
	$\sum_{i=1}^4 wavjob_i^b$				$\sum_{i=1}^4 wavjob_i^{bs}$	$\sum_{i=1}^4 wavjob_i^{bs}$				$\sum_{i=1}^4 wavjob_i^t$
summed over size-bands										
	$avjob^b$				$avjob^{bs}$	$avjob^{bs}$				$avjob^t$

$$growth \equiv avjob^t \div avjob^{bs}$$

Definitions:
$avjob$, jobs per firm; $rsrb$, relative survival rate between size-bands; $rsrw$, relative survival rate within size-bands; $firmsh$, firm size distribution; $wavjob$, average jobs per firm weighted by firm size distribution; $growth$, ratio of average jobs per firm in survivors to average jobs per firm in the terminal year; the superscript: b, refers to birth, bs, refers to surviviors at birth; t, refers to the terminal year; and the subscript i refers to firm size bands

Table 4: The decomposition, Austria

size-band	birth	survival	survivors	growth	terminal
	$avjob_i^b$	$rsrb_i$	$avjob_i^{bs}$	$growth_i$	$avjob_i^t$
1–4	1.526	1.125	1.717	2.340	4.018
5–9	6.273	1.001	6.280	1.903	11.952
10–19	13.498	1.012	13.662	1.751	23.923
20+	67.573	0.998	67.417	1.192	80.361
	$firmsh_i^b$	$rsrw_i$	$firmsh_i^{bs}$		$firmsh_i^t$
1–4	0.893	0.945	0.844		0.844
5–9	0.064	1.432	0.092		0.092
10–19	0.023	1.475	0.034		0.034
20+	0.020	1.541	0.030		0.030
	$wavjob_i^b$		$wavjob_i^{bs}$		$wavjob_i^t$
1–4	1.363		1.449		3.391
5–9	0.403		0.577		1.099
10–19	0.311		0.464		0.812
20+	1.322		2.032		2.422
all	$\sum_{i=1}^4 wavjob_i^b$		$\sum_{i=1}^4 wavjob_i^{bs}$		$\sum_{i=1}^4 wavjob_i^t$
	3.398		4.522		7.725

$$growth \equiv 7.725 \div 4.522 \equiv 1.708$$

Definitions:
$avjob$, jobs per firm; $rsrb$, relative survival rate between size-bands; $rsrw$, relative survival rate within size-bands; $firmsh$, firm size distribution; $wavjob$, average jobs per firm weighted by firm size distribution; $growth$, ratio of average jobs per firm in survivors to average jobs per firm in the terminal year; the superscript: b, refers to birth, bs, refers to surviviors at birth; t, refers to the terminal year; and the subscript i refers to firm size bands

Table 5: Counterfactual decomposition by country of contributions to job growth ratio birth to 2008, Austria baseline

	avjob^b (1)	fsd^b (2)	rsrb (3)	rsrw (4)	growth (5)	inter (6)	total (7)
UK	-0.19	0.05	0.00	0.04	0.56	-0.10	0.35
FI	-0.21	0.09	-0.08	0.12	0.58	-0.18	0.32
GE	0.20	0.00	-0.01	-0.03	-0.12	0.09	0.14
NO	-0.13	-0.15	-0.01	0.02	0.11	-0.03	-0.19
SW	0.02	-0.18	0.04	-0.09	-0.30	0.14	-0.37

Key: avjob$_b$, average number of jobs per firm at birth; fsd$_b$, the firm size distribution at birth; rsrb , the between relative survival ratio; rsrw, the within relative survival ratio; growth, the growth ratio; inter, interaction effect; total, overall difference in growth ratio.
Note: for construction see text.

Table 6: Counterfactual decomposition of effect of size-band specific growth ratios by country, contribution to job growth ratio, birth to 2008, Austria baseline

	growth ratio by size-band					
	1 – 4	5 – 9	10 – 19	20+	inter	total
	(1)	(2)	(3)	(4)	(5)	(6)
UK	0.43	0.04	0.05	0.05	-0.02	0.55
FI	0.35	0.05	0.14	0.05	-0.01	0.58
GE	0.18	-0.06	-0.05	-0.18	-0.01	-0.12
NO	0.11	0.00	-0.02	0.04	-0.01	0.12
SW	-0.24	-0.05	-0.01	0.02	-0.01	-0.29

Note: This is a decomposition of the growth rate term from Table 3. Column (6) of this table corresponds to column (5) of Table 4; for construction see text.

Table 7: Contributions of 1 – 4 size-band at birth to job growth ratio by destination (2008) size-band, Austria

	destination (2008) size-band			
	1-4	5-9	10-19	20+
	(1)	(2)	(3)	(4)
growth	1.13	2.74	5.97	23.23
selection	0.92	1.33	1.29	1.32
mobility	0.800	0.134	0.044	0.022
contrib	0.829	0.489	0.339	0.675
share(%)	35.6	21.0	14.5	28.9

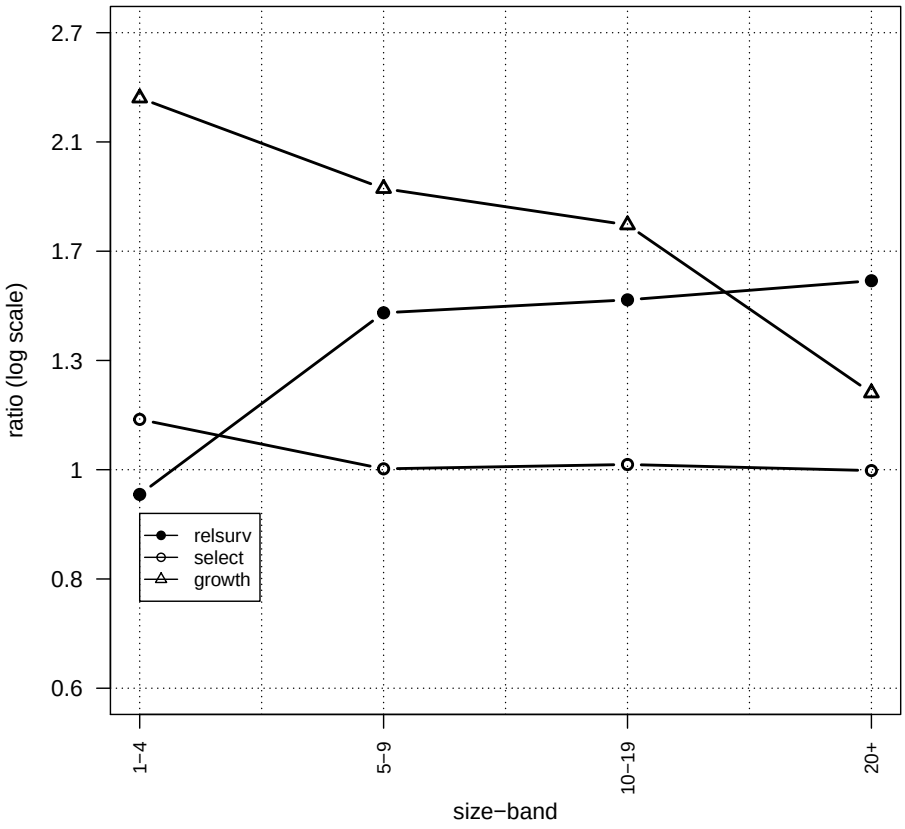
Memo: sum of contributions is 2.332, the growth ratio for Austrian firms born in size-band 1 – 4, see Appendix ; differences due to rounding.
Note: for construction see text.

Table 8: Counterfactual decomposition by country of contributions to 1 – 4 size-band job growth ratio, birth to 2008, Austria baseline

	growth (1)	select (2)	mobility (3)	inter (4)	total (5)
UK	0.68	-0.09	0.54	0.21	1.33
FI	0.59	0.23	0.25	0.02	1.10
GE	0.20	-0.18	0.69	-0.16	0.54
NO	-0.20	-0.12	0.84	-0.19	0.33
SW	-0.46	-0.02	-0.60	0.31	-0.77

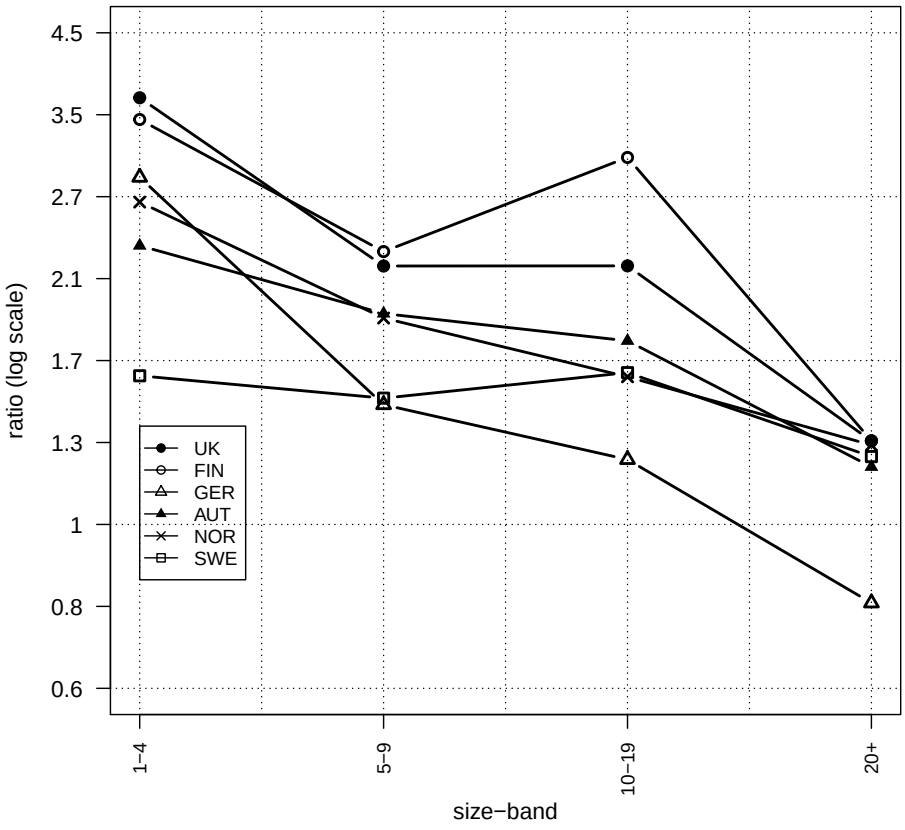
Note: This is a counterfactual calculation of the difference between Austria's 1–4 size-band growth rate decomposition from Table 6 and the other countries. Column (5) of this table is overall 1–4 growth rate for Austria less each country's 1–4 growth rate from Appendix Table 1 column (5); for construction see text.

Figure 1: Austria, relative survival ratios and growth ratio, by size-band, ratio (log scale)



Source: Appendix Table 1, Austria, columns (2), (5) and (7).
Note: for description of the construction of the ratios see text.

Figure 2: growth ratios by size-band, all countries, ratio (log scale)



Source: Appendix Table 1, column (5).

Appendix

A.1 A framework for the decomposition of survivor job growth

Firms at birth (in the present case 1998) are denoted by $firm^b$, and jobs at birth by job^b, so average firm size (measured by jobs per firm) at birth, $avjob^b$, can be defined as,

$$avjob^b = \frac{job^b}{firm^b} \tag{3}$$

and we can denote average firm size for each of the four size-bands by $avjob_i^b$ where i runs from 1 to 4.

Let us also define a set of shares, $firmsh_i^b$, where,

$$firmsh_i^b = \frac{firm_i^b}{firm^b} \tag{4}$$

(and, of course, $\sum_{i=1}^{4} firmsh_i^b = 1$)

We can now use the expression for shares to expand the definition of $avjob^b$,

$$avjob^b = \sum_{i=1}^{4}(firmsh_i^b \times avjob_i^b) \tag{5}$$

Consider next the firms which survive to the 'terminal' period (in the present case 2008) $firm^{bs}$. The ratio of survivors to all firms at birth is the survival rate, denoted here by δ,

$$firm^{bs} = \delta \times firm^b \tag{6}$$

We can also define, in a parallel fashion, a survival rate δ_i for each size-band category and use it to re-write the definition of $firmsh$ for the survivors,

$$firmsh_i^{bs} = \frac{\delta_i \times firm_i^b}{\delta \times firm^b} \tag{7}$$

So we can write the average firm size for survivors *at birth*, $avjob^{bs}$, as,

$$avjob^{bs} = \sum_{i=1}^{4}(firmsh_i^b \times rsrb_i \times avjob_i^{bs}) \tag{8}$$

where $\frac{\delta_i}{\delta}$ is the between 'relative survival ratio' (rsrb$_i$).

The survival rate varies *within* size-bands as well as *between* size-bands, so we account for this by defining a between 'relative survival ratio' effect ($rsrw_i$) – the ratio of the average size at birth of survivors in a size-band to the average size at birth of all firms in that size-band,

$$rsrw_i = \frac{avjob_i^{bs}}{avjob_i^b} \tag{9}$$

Combining these two expressions we can write,

$$avjob^{bs} = \sum_{i=1}^{4}(firmsh_i^b \times rsr_{bi} \times rsrw_i \times avjob_i^b) \tag{10}$$

Finally, if we define a growth ratio ($growth_i$), expressing average firm size in the terminal period ($avjob_i^t$) as a ratio to the average size of survivors at birth,

$$avjob_i^t = avjob_i^{bs} \times growth_i \tag{11}$$

So we can now write,

$$avjob^t = \sum_{i=1}^{4}(avjob_i^b \times firmsh_i^b \times rsrb_i \times rsrw_i \times growth_i) \tag{12}$$

by definition,

$$growth = \frac{avjob^t}{avjob^{bs}} \tag{13}$$

so finally,

$$growth = \frac{\sum_{i=1}^{4}(avjob_i^b \times firmsh_i^b \times rsrb_i \times rsrw_i \times growth_i)}{\sum_{i=1}^{4}(avjob_i^b \times firmsh_i^b \times rsrb_i \times rsrw_i)} \tag{14}$$

and this is the expression which appears in the main text.

A.2 The decomposition of the Austrian growth ratios

The average job/firm at birth, for survivors at birth, and survivors at age 10 can be written as the sum of weighted average jobs/firm ($wavjob$) overs size-bands. So the difference between birth, survivors at birth and survivors at age 10 can be written as differences in the weighted average terms. As we can see from Table 3 of the paper, the first pair of differences depend on the effect of the two relative survival rates, whilst the second pair depend only on relative growth rates.

In general,

$$\Delta(a \times b) \equiv \Delta a \times b + \Delta b \times a + \Delta a \times \Delta b \tag{15}$$

Using equation (1) we can calculate the difference – $wavjob^{bs}$ less $wavjob^{b}$ – as the sum of terms (by size-band) involving: $\Delta avjob^{b}$ ($avjob^{bs}$ less $avjob^{b}$) and $\Delta firmsh^{b}$ ($firmsh^{bs}$ less $firmsh^{b}$). The results of this calculation are shown in panel (a) of the table. Similarly, we can calculate the difference – $wavjob^{t}$ less $wavjob^{bs}$ – as the sum of terms (by size-band) involving: $\Delta avjob^{bs}$ ($avjob^{bs}$ less $avjob^{b}$).[24] The results of this calculation are shown in panel (b) of the table.

Although the interpretation of the results in panel (a) of the table is complicated by the fact that some entries are positive and others negative, nevertheless the overall pattern seems quite clear. The effects of the 'between' survival ratio – which drives the difference in column (2) – is considerably more important than the effects of the 'within' survival ratio in column (1). Indeed, the only figure of any size in column (1) is that for the smallest size-band and, remember from Table 4 in the paper, this is the only 'within' ratio of any size). The interpretation of the results in panel (b) is more straightforward since we only have the growth terms to consider, and the finding is very clear-cut: it is the growth rate of the 1 – 4 size-band which has very much the largest effect.

[24] There is $\Delta firmsh^{bs}$ term because, by definition, $firmsh^{t}$ is equal to $firmsh^{bs}$.

A.3 The decomposition of the size-band 1 – 4 growth ratio

The strategy here follows along similar lines, as the 'principal decomposition', using where possible the same notation. Since all the firms and jobs being referred to here originate from the 1–4 size-band this subscript has been suppressed, and since we are now concerned *only* with 2008 survivors, by definition, the stock of firms at birth and in 2008 is the same, so the 'survivor' superscript (bs) is no longer necessary. However, we do need to distinguish size-bands at birth from size-bands in 2008, these will be denoted by b for birth and t for 2008.
Let us define a set of shares which record the proportions of surviving firms from size-band 1–4 in each 'destination' size-band (i), mob_i , where,

$$mob_i = \frac{firm_i^t}{firm^t} \tag{16}$$

(and, of course, $\sum_{i=1}^{4} mob_i = 1$)

We can now use the expression for shares to expand the definition of $avjob^t$,

$$avjob^t = \sum_{i=1}^{4}(mob_i \times avjob_i^t) \tag{17}$$

We are interested in the growth of firms, so we can divide by size at birth ($avjob^b$),

$$\frac{avjob^t}{avjob^b} = \sum_{i=1}^{4} \frac{(mob_i \times avjob_i^t}{avjob^b}) \tag{18}$$

Now expanding the denominator on the right hand side we can re-write the expression as,

$$\frac{avjob^t}{avjob^b} = \sum_{i=1}^{4}(mob_i \times \frac{avjob_i^t}{avjob_i^b} \times \frac{avjob_i^b}{avjob^b}) \tag{19}$$

The second term on the right hand side is the ratio of $avjob$ in 2008 to $avjob$ at birth for a destination size-band, so it can be interpreted as the size-band specific growth rate gr_i. The third term is the ratio of $avjob$ for firms in a destination size-band to the average size of 1–4 size-band firms at birth, so it is a variety of 'selection' effect, denoted sel_i. So we have,

$$gr_i = \frac{avjob_i^t}{avjob_i^b} \tag{20}$$

and,

$$sel_i = \frac{avjob_i^b}{avjob^b} \tag{21}$$

Now re-writing the expression,

$$\frac{avjob^t}{avjob^b} = \sum_{i=1}^{4}(mob_i \times gr_i \times sel_i) \tag{22}$$

and this is the expression which appears in the main text.

Appendix Table 1: Job growth decomposition: birth to 2008, Austria, Finland, Germany, Norway, Sweden & UK

		initial		transforming		
		$avjob^b$	$firmsh^b$	$rsrb$	$rsrw$	$growth$
		(1)	(2)	(3)	(4)	(5)
Austria	1-4	1.53	0.893	0.945	1.122	2.341
	5-9	6.27	0.064	1.432	1.002	1.903
	10-19	13.50	0.023	1.475	1.012	1.751
	20+	67.57	0.020	1.541	0.998	1.192
Finland	1-4	0.81	0.944	0.942	1.526	3.440
	5-9	6.62	0.030	1.875	1.016	2.299
	10-19	13.60	0.012	1.910	0.990	3.064
	20+	112.72	0.013	2.306	0.789	1.291
Germany	1-4	1.88	0.877	0.949	1.013	2.884
	5-9	6.19	0.077	1.297	1.013	1.441
	10-19	13.71	0.026	1.398	1.009	1.219
	20+	32.68	0.020	1.564	1.023	0.787
Norway	1-4	1.82	0.740	0.907	1.101	2.674
	5-9	6.40	0.144	1.216	1.006	1.877
	10-19	13.20	0.066	1.234	0.983	1.569
	20+	117.71	0.049	1.457	0.925	1.274
Sweden	1-4	1.82	0.704	0.958	1.032	1.574
	5-9	6.54	0.167	1.046	0.999	1.470
	10-19	13.15	0.078	1.090	1.006	1.589
	20+	71.41	0.052	1.292	1.383	1.230
UK	1-4	1.54	0.886	0.969	1.053	3.676
	5-9	6.32	0.072	1.148	1.007	2.200
	10-19	13.07	0.026	1.340	0.995	2.201
	20+	157.59	0.016	1.526	0.803	1.290

Note: for definitions and derivation of the decomposition see Appendix, A.1

Appendix Table 2: The decomposition of the Austrian growth ratios

size-band	(1)	(2)	(3)	sum
(a) the effects of survival				
1–4	0.170	-0.075	-0.009	0.086
5–9	0.000	0.174	0.000	0.175
10–19	0.004	0.148	0.002	0.153
20+	-0.003	0.715	-0.002	0.710
all	0.172	0.961	-0.009	1.124
(b) the effects of growth rates				
size-band	(1)	(2)	(3)	sum
1–4	1.942	na	na	1.942
5–9	0.522	na	na	0.522
10–19	0.348	na	na	0.348
20+	0.390	na	na	0.390
all	3.203	na	na	3.203

Notes:
1. panel (a) columns are: (1) $\Delta avjob^b \times firmsh^b$; (2) $\Delta firmsh^b \times avjob^b$; (3) $\Delta avjob^b \times \Delta firmsh^b$; (4) sum of (1) to (3)
2. From Table 4 in the paper the difference between $wavjob^{bs}$ and $wavjob^b$ is 1.124 (= 4.522 – 3.398) which matches 'all' in column (4)
3. panel (b) columns are: (1) $\Delta avjob^{bs} \times firmsh^{bs}$; col (4) = col (1)
4. From Table 4 in the paper the difference between $wavjob^t$ and $wavjob^{bs}$ is 3.203 (= 7.725 – 4.522) which matches 'all' in column (4)

Appendix Table 3: Austria, Finland, Germany, Norway, Sweden & UK: contributions of 1 – 4 size-band at birth to job growth ratio by destination (2008) size-band

		destination (2008) size-band			
		1-4	5-9	10-19	20+
Austria	growth	1.127	2.741	5.975	23.232
	selection	0.920	1.330	1.290	1.320
	mobility	0.800	0.134	0.044	0.022
Finland	growth	1.599	4.030	6.901	21.920
	selection	0.880	1.380	1.540	1.680
	mobility	0.789	0.130	0.052	0.029
Germany	growth	1.233	3.538	7.433	19.553
	selection	0.970	1.080	1.110	1.150
	mobility	0.746	0.143	0.073	0.038
Norway	growth	1.070	2.791	5.290	18.749
	selection	0.920	1.150	1.240	1.240
	mobility	0.690	0.188	0.087	0.036
Sweden	growth	1.118	2.427	4.459	12.633
	selection	0.920	1.380	1.490	1.140
	mobility	0.831	0.134	0.030	0.005
UK	growth	1.252	3.444	6.583	37.907
	selection	0.930	1.170	1.230	1.280
	mobility	0.752	0.147	0.066	0.034

Note: for definitions and derivation of the decomposition see Appendix, A.2

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