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Contents

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 the 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.

JEL codes: L25; E24; M13

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.* [2012]). However this 'consensus' does not yet extend to settled conclusions about small versus large (Neumark et al. [2011] , Headd [2010]).

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 finer grained treatment of small size than is usual – we divide firms with less than twenty employees into three size-bands; second, we cut through many of the measurement-related complications produced by the potential confounding of age and size effects by analysing birth cohort data; third, we use a purpose-built dataset constructed by national experts using a commonly agreed measurement framework to make comparisons across countries.

Cohort98 varies considerably across countries in a number of important ways: average size of firm; ten year survival rate; and, of special interest here, the average growth of jobs over ten years. However, by digging a little below the surface, and looking at the distribution of firms across size-bands, we find some important similarities:

- 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

Using a series of decompositions which link together the characteristics of the cohorts by size-band, we provide a counterfactual accounting for the relative rates of job growth. The key factor, contributing much of the variation in job growth across countries, is the performance – over three different dimensions – of the firms born into the ***smallest*** size-band, these dimensions are:

- the proportion of firms that survive
- the proportion that make a transition to the largest size-band
- the average job growth recorded during the transition

Of course, we are not able to describe the time path of job growth by comparing just two points in the life of a cohort; nor, confining ourselves to just one cohort, can we judge the relative importance of 'age' and 'size'. However we show that the very smallest firms in the cohort play a relatively large role in accounting for overall job growth, but it is just a very modest proportion of the smallest firms, the rest of them hardly grow at all.

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."[10, p.28].

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.* [2012]), 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.* [2012] 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...

[1] 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.* [2012] regard as central to an understanding of the dynamism of the economy.

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* [2012, p. 26]

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.* [2012] 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 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-

[2] For a, now slightly dated, summary of different cross-country datasets see Vale [2006].

[3] 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].

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, twentyfour 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

[4] see, for example: Kirchoff [1994]; Phillips and Kirchoff [1989]; and most recently Headd and Kirchoff [2009].

appears at first sight. The German data in Bartelsman *et al*. [2009] covers only West Germany 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 Kedrovsky [2010] have used the cohort approach, and stylised facts about survival by size, to simulate the evolution of the size distribution of firms.

[5] .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.

[6]. 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].

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 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 micro-data 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

[7] 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 *at al* [2009, p. 2].

[8] In Finland, though, as noted in Table 1 the data are "full time equivalents".

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 completely across countries: in Austria, Finland,[9] Germany, Norway, and the UK, we count jobs; in Sweden we count persons. So in all but Sweden it is possible, to the extent that there is multiple job holding, for a person to be counted more than once. Whilst this difference is obviously important, it should not make a significant difference to the answer to our key question: the relative importance of the smallest firms to job growth.[10] Indeed the same criterion should be applied to other (perhaps as yet

[9] For Norway we have, in fact, parallel datasetson the two different bases, and the very small difference that the 'persons' measure makes to some high-level summary statistics will be reported in the next section.
[10] For a discussion of the implications of measurement issues in harmonised cross-country datasets see Bartelsman *et al* [2009, pp. 27 -- 32].

undetected) differences in national statistical practice: how might it affect our conclusions about the links between firm and job dynamics?[11]

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

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

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% 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.[12] 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' data for Norway, and since it is in the jobs/per firm figures that we would expect to see the impact of this alternative measure these 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. All three jobs/firm figures are within 1 unit of the job count measures, consequently the growth ratio and the growth rate remain virtually unchanged.

4.5 Selection effects

No more than 30% of cohort98 firms survive the decade, and in some countries rather fewer. 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.

[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.

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.[13] 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[14] 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

The strategy for identifying the factors which might account for the cross-country variation in jobs growth relies on an exercise in decomposition, splitting overall job growth into the contribution of each of four employee size-bands: 1 to 4; 5 to 9; 10 to 19; and 20+. Whilst summarising the 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. In practice, this decomposition pinpoints quite effectively the similarities and differences between countries, and allows us to better uncover some factors which contribute importantly to the pattern of job growth.

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

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[15] – 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 3, and (unless otherwise specified) all references in this section are to that table, with the panels and columns in parentheses (e.g. panel (a) column (1) is referred to as (a) (1)).

The decomposition (with precise definitions and a derivation provided in the Appendix section A.1) can be written as,

$$growth = \frac{\sum_{i=1}^{4}(avjob_i^b \times firmsh_i^b \times rsr_{bi} \times rsr_{bi} \times growth_i)}{\sum_{i=1}^{4}(avjob_i^b \times firmsh_i^b \times rsr_{bi} \times rsr_{bi})} \qquad (1)$$

The starting point – the primary split – exploits the fact that if we multiply the average size at birth in each size-band ('avjob^b', (a)(4)) by the share of each size-band at birth ('fsd^b', (a) (1)), we obtain the weighted average size at birth ('wavjob^b', (b) (1)) which, when summed over size-bands yields the average size at birth, 3.43 jobs per firm ((b) (1)). The shares being used as weights here depend on the firm size distribution at birth which is (notoriously) extremely skewed. For Austria, at the small end, 89% of firms are in the 1 – 4 size-band, whilst at the large end just 2% are in the 20+ size-band. Three of our four size-bands are bounded, so the limits of average size for those size-bands are quite tightly constrained, only the 20+ size-band is unbounded and its average is 68 jobs per firm ((a) (4)).

[15] In Table 2, panel (c) we see that the average jobs per firm figure in 1998 for all firms is 3.40, the difference here is due to rounding. There are similar-sized differences in the figures for average jobs per firm for survivors at birth and for survivors in 2008.

The combination of these two (oppositely skewed) share and size numbers produces a bi-modal distribution of weighted components ('share^{b}' ((b) (2)). So the overall average size of 3.43 jobs per firm [16]depends almost equally on the large proportion of small firms and the small proportion of large firms.

- There are three ratios which connect 3.43, the average number of jobs per firm at birth ('wavjob^{b}' (b) (1)), to 7.79, the average number of jobs per firm in 2008 ('wavjob^{t}' (b) (5)):
- the ratio of the size-band specific survival ratio to the overall survival ratio – the between-size-band relative survival ratio ('rsr$_{b}$', (a) (2))
- the ratio of the size-band specific average size of *survivors* at birth to the size-band specific average size of all firms in the size-band at birth – the ratio which picks up the intra-size-band, or 'within' size-band, relative survival effects ('rsr$_{w}$', (a) (5))
- the ratio of the birth size-band specific average size of survivors in 2008 to the size-band specific average size of survivors at birth – the growth ratio ('growth', (a) (7))

These three ratios are displayed in Figure 1 plotted on a log scale. This makes their relative importance easier to visualise – the ratios are combined multiplicatively within each size-band so on a log scale the relationship between them is additive.

The 'between' relative survival ratio ('rsr$_{b}$', (a) (2)) re-shapes the firm size distribution at birth to reflect the impact of differential survival rates by size-band. Here the ratio is less than unity for the 1 – 4 size-band: the smallest firms have worse prospects for survival over the period 1998 to 2008 – in this case about 6% (= 1/0.94) worse than average[17] – whilst the largest firms, in the 20+ size-band, have a more than 50% better than average chance of

[16] Of course since as we just saw 90% of firms are in the 1 – 4 size-band the average survival rate over all firms is necessarily quite close to that of the smallest firms.
[17] The positive association between size and survival is well-established, see for example Bartelsman *et al* [2003].

survival.[18] Multiplying the firm size distribution of *all firms* at birth by the relative survival ratio transforms it into the firm size distribution of *survivors* at birth ('fsd^{bs}', (a),(3)). The share of firms in 1 – 4 size-band has shrunk by about five percentage points from 89% to 84%, whilst at the other end of the size distribution, the share of 20+ firms has expanded by one percentage point, from 2% to 3% (a 50% increase).

The size differential in mortality is also responsible for the 'within' size-band relative survival ratio effect. It picks up the impact of death rates *within* size-bands on average firm size by size-band. As might have been anticipated it is, disproportionately, the smaller firms in the 1 – 4 size-band which die, signalled by a ratio greater than unity for that size-band. This produces an average size of firm which is 12% larger in the 1 – 4 size-band ('rsr$_w$', (a) (5)) and survivors have 1.72 jobs per firm ('avjob^{bs}', (a) (6)) by comparison with the 1.53 average for all size-band 1 – 4 firms at birth. For larger firms, in Austria at least, it has little impact: the effect is visually undetectable on Figure 1.

We can now combine the average size of survivors by size-band using the size-band shares from the survivors birth size distribution as weights. The result is recorded as 'wavjob^{bs}' ((b) (3)). The sum of these weighted contributions, 4.58, is the overall average number of jobs at birth in survivors. This figure is larger by about one third than the cohort at birth, but it is important to emphasise that this is *not* a growth-related phenomenon. It reflects the fact that, looking back at the birth cohort from 2008, we find that a disproportionate number of small firms have died.[19] It is this number, the average size of survivors at birth, from which we will measure job growth. Finally, notice that the combined effect of these changes ('share^{bs}', (b) (4)) is to shift the distribution towards the 20+ size-band.

[18] Cabral and Mata [2003, p. 1075], amongst others, refers to this as the "selection effect", because we have used grouped sizes we distinguish within' and 'between' components.

[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.

The final step along the path from birth to 2008 is to incorporate size-band specific growth. As we can see from Figure 1 and the table ((a) (7)), the growth ratio varies substantially with size: at the small end, survivors in the 1 – 4 size-band expand by a factor of 2.34 – equivalent to growth of around 9% per annum. By contrast, the expansion factor for 20+ survivors is just 1.19 – an annual average rate of about 1.8%. Applying the growth ratio to the average size of survivors at birth yields the average jobs per firm in 2008 ('avjob^t', (a) (8)) and we see that firms in the 1 – 4 size-band now have 4.02 jobs (up from 1.53), an average which lies, albeit only very slightly, outside their size-band at birth. The proportionate increase at the 20+ end is much more modest, but it implies a significant absolute increase of 22 jobs, up to 80.38 jobs from 67.57.

To arrive at the overall average jobs per firm figure for 2008 we proceed as before. The firm size distribution of survivors at birth is used to weight average jobs per firm in 2008, to produce a final set of weighted components which are recorded as 'wavjob^t' ((b) (5)). Summing the column produces an average number of jobs per firm in Austria in 2008 of 7.79 (familiar from Table 2, (c) (3)), implying a growth ratio for survivors of 1.7, equivalent to annual average job growth of 5.5%. What we can now see from the share column ('share^t', (b) (6)) is that the pattern of contributions looks quite different to either the survivors at birth or the whole cohort 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, accounting for more than 40%, whilst 20+ firms account for less than one third. Remember, jobs are being recorded here against birth size-bands and, 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.

5.2 Cross-country variation and the decomposition: a counter-factual 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, and Sweden 50% slower.

Using Austrian data as the baseline we have constructed Table 4, it measures 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. So for each country we replace each of the elements of the Austrian decomposition, one at a time, and record the difference from the Austrian growth ratio. These elements are: average number of jobs per firm at birth ($avjob^b$); the firm size distribution at birth (fsd^b); the two components of the selection effect, the 'between' relative survival ratio (rsr_b) and the 'within' relative survival ratio (rsr_w); and the growth ratio (growth).

If all the components of the decomposition were additively related the the sum of these individual difference for a country would eactly 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 4 and the (other) analytical tables is provided as Appendix Table 1.

As noted earlier, three of our four size-bands are bounded[20] and the pattern of contributions in column (1) reflects, almost entirely, the negative association

[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.

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 smaller and the growth rate contribution is, consequently, positive (see Appendix Table 1 column (1)).

We see straight away from column (2) of Table 4 that the (admittedly small) differences between Germany and Austria's firm share distribution (see Appendix Table 1 column (2) for details) has no impact on the difference between their growth ratios. The two countries lower down the growth rate distribution than Austria – Norway and Sweden – record more sizeable negative differences, whilst for the two countries higher up the growth rate distribution the differences are positive. What differentiates these two pairs is the pattern of shares at either end of the size distribution. 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.

Differences in 'between' relative survival ratios (column (3)) make little contribution to differences in growth ratios. The only substantial figure is for Finland where the survival rate of firms in the 1 – 4 size-band is very low (again, possibly another by-product of the 'full-time equivalent effect') and this makes the 'slope' of the ratio across size-bands rather steeper (see Appendix Table 1, column (3)). The (relatively) better prospects for larger firms produces a negative contribution to relative growth. By contrast, the ratio for Sweden has less 'slope' than that for Austria; that is, the survival prospects of larger firms are not much better than smaller firms, and this generates a positive contribution to growth.

The largest contribution of 'within' relative survival ratios to growth (column (4)) is in Finland at the small end of the size distribution where the average size of the smallest firms increased by 50% (the 'full time equivalent effect'

again) and, at the other end of the size distribution, the average size of 20+ firms contracted by about one fifth (see Appendix Table 1, column (4)). In Sweden the negative contribution to growth was a by-product of a 40% increase in the average size of 20+ firms.

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 decomposition 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 5. 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.[21] 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 3 (column (7)) 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[22] and others which are now in a larger size-band. The first row of Table 6 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)

[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.
[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 Table 2 for details.

- 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,

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

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 6. 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 can now perform a further 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 7 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. 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.[23] 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,

[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.

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

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. y 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. 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.

There are three obvious limitations of this study – 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.[1] 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.

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

(a) 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

(b) 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

Table 2: Austria, Finland, Germany, Norway, Sweden & UK cohort98 firms, jobs & jobs per firm: birth & 2008

(a) firms		survivors		survival	bus/pop
	birth	birth	2008	ratio (%)	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) jobs '000		survivors		differences	
	birth	birth	2008	(2)-(1)	(3)-(2)
	(1)	(2)	(3)	(4)	(5)
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	7.2	-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		survivors		growth	
	birth	birth	2008	ratio	rate(%)
	(1)	(2)	(3)	(4)	(5)
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 person	8.24	10.62	16.07	1.514	4.3

Definitions: 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 annual average rate

Note: the 'Memo' item records jobs/firm figures for Norway calculated from 'person count' data

Table 3: Austria, cohort98 job growth decomposition by size-band: birth to 2008

panel(a)	fsd^b	rsr_b	fsd^{bs}	$avjob^b$	rsr_w	$avjob^{bs}$	growth	$avjob^t$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1--4	0.89	0.945	0.84	1.53	1.122	1.72	2.341	4.02
5--9	0.06	1.432	0.09	6.27	1.002	6.28	1.903	11.96
10--19	0.02	1.475	0.03	13.50	1.012	13.66	1.751	23.92
20+	0.02	1.541	0.03	67.57	0.998	67.43	1.192	80.38

panel(b)	$wavjob^b$	$share^b$	$share^{bs}$ $wavjob^{bs}$		$wavjob^t$	$share^t$
		%		%		%
	(1)	(2)	(3)	(4)	(5)	(6)
1--4	1.37	39.8	1.45	31.7	3.39	43.5
5--9	0.40	11.7	0.58	12.6	1.10	14.1
10--19	0.31	9.1	0.46	10.1	0.81	10.4
20+	1.35	39.4	2.09	45.6	2.49	32.0
overall	3.43	100.0	4.58	100.0	7.79	100.0

Notes:
1. in panel (a): (3) = (1) × (2); (6) = (4) × (5); (8) = (6) × (7)
2. $wavjob^b = fsd^b \times avjob^b$; $wavjob^{bs} = fsd^{bs} \times avjob^{bs}$; $wavjob^t = fsd^{bs} \times avjob^t$
3. overall average jobs per firm ('overall', the sum over 'wavjob') may differ from the corresponding figures in Table 1 panel (c) columns (1), (2) and (3) due to rounding

Table 4: Counterfactual decomposition by country of contributions to job growth ratio birth to 2008, Austria baseline

^{b}	$avjob_b$	fsd^b	rsr_b	rsr_w	growth	inter	total
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
UK	-0.19	0.05	0.00	0.04	0.55	-0.03	0.42
FI	-0.21	0.11	-0.08	0.12	0.58	-0.19	0.33
GE	0.20	0.00	0.00	-0.02	-0.12	0.08	0.14
NO	-0.09	-0.17	0.00	0.02	0.12	-0.05	-0.17
SW	0.03	-0.17	0.04	-0.09	-0.29	0.12	-0.36

Key: $avjob_b$, average number of jobs per firm at birth; fsd_b, the firm size distribution at birth; rsr_b , the between relative survival ratio; rsr_w , the within relative survival ratio; growth, the growth ratio; inter, interaction effect; total, overall difference in growth ratio.
Note: for construction see text.

Table 5: Counterfactual decomposition of effect of size-band specific growth ratios by country, contribution to job growth ratio, birth to 2008, Austria baseline

	1 – 4 (1)	5 – 9 (2)	10 – 19 (3)	20+ (4)	inter (5)	total (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 6: Contributions of 1 – 4 size-band at birth to job growth ratio by destination (2008) size-band, Austria

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

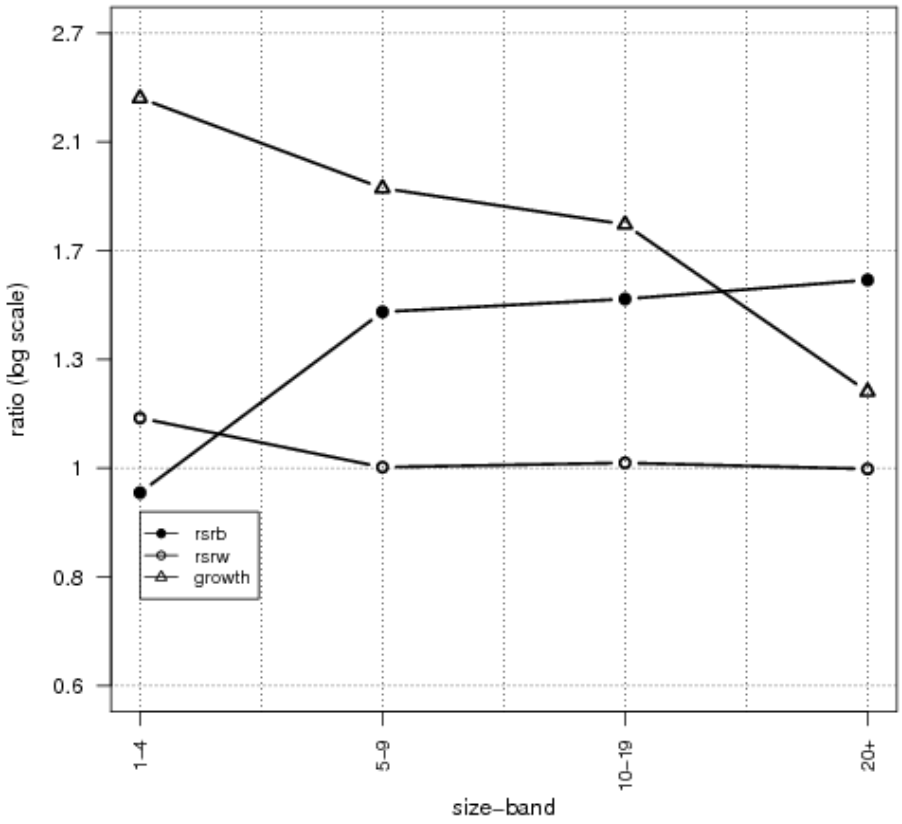
Memo: sum of contributions is 2.332, the growth ratio for Austrian firms born in size-band 1 – 4, see Appendix Table 1, column (5); differences due to rounding.
Note: for construction see text.

Table 7: 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

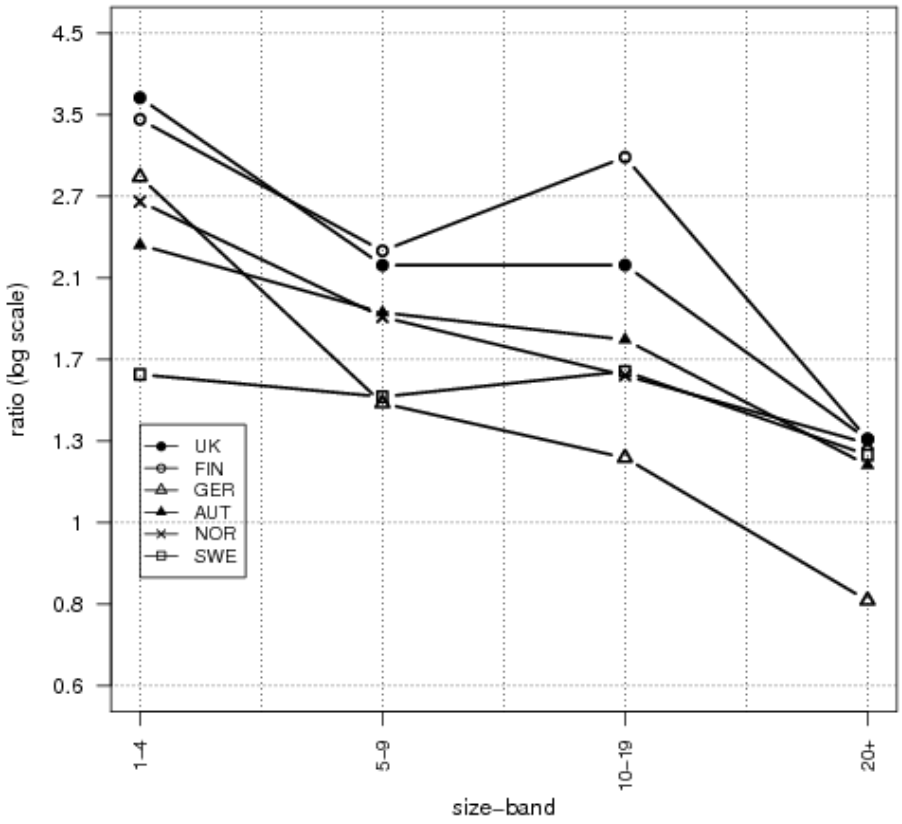
Note: This is a counterfactual calculation of the difference between Austria's 1–4 size-band growth rate decomposition from Table 6 and the other countries. Column (5) of this table is overall 1–4 growth rate for Austria less each country's 1–4 growth rate from Appendix Table 1 column (5); for construction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

Figure 1: Austria, the 'three ratios' 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

Appendix – A framework for the decomposition of survivor job growth

A.1 The principal decomposition

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,

$$avjob^b = \frac{job^b}{firm^b} \qquad (3)$$

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,

$$firmsh_i^b = \frac{firm_i^b}{firm^b} \qquad (4)$$

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

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

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

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,

$$firm^{bs} = \delta \times firm^b \qquad (6)$$

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,

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

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

$$avjob^{bs} = \sum_{i=1}^{4}(firmsh_i^b \times rsr_{bi} \times avjob_i^{bs}) \quad (8)$$

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

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 (rsr_{wi}) – 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,

$$rsr_{wi} = \frac{avjob_i^{bs}}{avjob_i^b} \quad (9)$$

Combining these two expressions we can write,

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

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,

$$avjob_i^t = avjob_i^{bs} \times growth_i \quad (11)$$

So we can now write,

$$avjob^t = \sum_{i=1}^{4}(avjob_i^b \times firmsh_i^b \times rsr_{bi} \times rsr_{bi} \times growth_i) \quad (12)$$

by definition,

$$growth = \frac{avjob^t}{avjob^{bs}} \quad (13)$$

so finally,

$$growth = \frac{\sum_{i=1}^{4}(avjob_i^b \times firmsh_i^b \times rsr_{bi} \times rsr_{bi} \times growth_i)}{\sum_{i=1}^{4}(avjob_i^b \times firmsh_i^b \times rsr_{bi} \times rsr_{bi})} \quad (14)$$

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

A.2 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,

$$mob_i = \frac{firm_i^t}{firm^t} \qquad (15)$$

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

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

$$avjob^t = \sum_{i=1}^{4} (mob_i \times avjob_i^t) \qquad (16)$$

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

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

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

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

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 interpredted 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,

$$gr_i = \frac{avjob_i^t}{avjob_i^b} \quad (19)$$

and,

$$sel_i = \frac{avjob_i^b}{avjob^b} \quad (20)$$

Now re-writing the expression,

$$\frac{avjob^t}{avjob^b} = \sum_{i=1}^{4}(mob_i \times gr_i \times sel_i) \quad (21)$$

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

Appendix Table 1: Austria, Finland, Germany, Norway, Sweden & UK cohort98, job growth decomposition: birth to 2008

		birth size (1)	firmsh ratio (2)	relsurv ratio (3)	select ratio (4)	growth ratio (5)	2008 size (6)
Austria	1-4	1.53	0.893	0.945	1.122	2.341	4.02
	5-9	6.27	0.064	1.432	1.002	1.903	11.95
	10-19	13.50	0.023	1.475	1.012	1.751	23.92
	20+	67.57	0.020	1.541	0.998	1.192	80.36
Finland	1-4	0.81	0.944	0.942	1.526	3.440	4.25
	5-9	6.62	0.030	1.875	1.016	2.299	15.47
	10-19	13.60	0.012	1.910	0.990	3.064	41.28
	20+	112.72	0.013	2.306	0.789	1.291	114.73
Germany	1-4	1.88	0.877	0.949	1.013	2.884	5.49
	5-9	6.19	0.077	1.297	1.013	1.441	9.03
	10-19	13.71	0.026	1.398	1.009	1.219	16.86
	20+	32.68	0.020	1.564	1.023	0.787	26.30
Norway	1-4	1.82	0.740	0.907	1.101	2.674	5.36
	5-9	6.40	0.144	1.216	1.006	1.877	12.09
	10-19	13.20	0.066	1.234	0.983	1.569	20.35
	20+	117.71	0.049	1.457	0.925	1.274	138.67
Sweden	1-4	1.82	0.704	0.958	1.032	1.574	2.96
	5-9	6.54	0.167	1.046	0.999	1.470	9.61
	10-19	13.15	0.078	1.090	1.006	1.589	21.02
	20+	71.41	0.052	1.292	1.383	1.230	121.41
UK	1-4	1.54	0.886	0.969	1.053	3.676	5.96
	5-9	6.32	0.072	1.148	1.007	2.200	14.00
	10-19	13.07	0.026	1.340	0.995	2.201	28.64
	20+	157.59	0.016	1.526	0.803	1.290	163.14

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

Appendix Table 2: 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

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

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