Chapter 4

Firm and job dynamics in the United Kingdom before, during and after the global financial crisis: Getting in under the hood

by
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Since the pioneering work of the OECD in the mid-1980s considerable work has been done using job creation accounts to describe job flows. Whilst the conventional approach to job creation accounting focuses on flows, here, by contrast, stocks are centre stage. Using UK firm-level records, the stock of firms and its dynamics are combined with the average number of jobs per firm to track the evolution of the stock of jobs. By separating the stock of firms (and jobs) into start-ups and continuing firms, the relationship between them can be exploited to interpret events. After all, new additions to the stock of continuing firms are just the survivors of previous years' start-ups. Following start-ups into the population of continuing firms reveals an important channel of influence from falling firm births to job losses during the global financial crisis.

Context, motivation and approach

The OECD pioneered the compilation of job creation and destruction accounts from large scale firm-level datasets in the mid-1980s (see OECD, 1987 (Chapter 4, especially Chart 4.1 for a diagrammatic representation). The accounting was further developed by Davis and Haltiwanger in the early 1990s in their detailed study of data from the United States (see Davis and Haltiwanger, 1990; Davis, Haltiwanger and Schuh, 1996).[1] From the outset the focus was on flows, most particularly the magnitude of gross job flows – gross job creation and destruction – and their connection with the operation of labour markets[2] and the parallel accounts for the stock of firms were left implicit. This analysis' focus is rather different. Using the same basic data, it puts the stock of firms centre stage, highlighting its dynamics and combining it with data on the average number of jobs per firm to account for the evolution of the stock of jobs.

Its focus provides a rather different perspective on firm and job dynamics over the period of the global financial crisis (GFC). Viewing the data through this lens highlights the key role of firm dynamics in general, and births in particular, in accounting for the loss of jobs. Firm births dropped about 25% in 2009 which depressed net job creation in that year but, almost as significantly, the fall in births meant that the stock of continuing firms in the following year was also lower by about the same amount and this "missing stock", in turn, was (by its absence) responsible for about half the net job destruction in 2010. Births fell again in 2010 and this fed forward too into 2011. The "collapse" of births directly, and through its subsequent effect on the stock of continuing firms, overshadowed the slowdown in continuing firm job growth, and there was little obvious influence of a rise in business failure. Likewise, a return of firm births towards their pre-GFC level played a key role in the recovery.

There are a few studies taking a broadly similar approach to the United States experience over the GFC period and the subsequent recovery, notably Gourio, Messer and Siemer (2015), Sedláček (2015) and Moreira (2015); and in this (small) literature it is common to refer to the longer term effects of the fall in births as having created a "missing" or "lost" generation of firms.

Of these three the paper by Gourio, Messer and Siemer (2015) is the most similar to this chapter's analysis (and see other related papers by the same authors: Siemer [2014], Gourio, Messer and Siemer [2014] and Gourio, Messer and Siemer [2016]), since it takes the fall in births as "given" (i.e. not trying to explain its cause); and, on the empirical side, they find that there was no post-GFC "overshoot" of births to replace those which were "lost", and that the average size of births remained broadly unchanged. This leads them to a counterfactual calculation: "As of March 2011, we find that there would be 1.7 million more jobs had entry stayed at its historical average." (Gourio, Messer and Siemer, 2015, p.8). Sedláček's argument is slightly different because, in his model, the impact of the fall in births on jobs is "cushioned" by continuing firms which take on more workers. Nonetheless there is still a "missing generation" effect: "in future years the missing entrants generate fewer older firms

(which on average account for the bulk of aggregate employment). This creates a very persistent dent in the employment potential of the economy" (Sedláček, 2015, p. 3).

His argument implies that, while a variation in births might initiate a process of change, the longer term effects on the national jobs total show up in the average size of firms.[3] Finally, the paper by Moreira (2015) presents an argument of a similar character to Sedláček (2015), though her underlying model differs. Here, too, the effects of recessions on entry (her data period extends back before the GFC period) have longer term effects: "I provide new evidence that businesses born in downturns start on a smaller scale and remain smaller over their entire life cycle… My current model simulations indicate that the impact of the crisis on the 2008-09 cohorts reduces aggregate employment by at least one percentage point in the following ten years." Moreira (2015, p.1).

Although each of these three papers relies on differently formulated models (and, indeed, take slightly differing views of the "facts" about average firm size) this study's key conclusion is that the dramatic decline in firm birth associated with the onset of the GFC had significant and long-lasting effects on employment.

The analysis here is tackled in a series of stages, peeling back layers of data. Following a short description of data sources, the first analytical section is brief and is methodological. It draws attention to the rather shadowy role played by "continuing firms" – firms more than a year old – in the conventional job creation and destruction accounts. The next step shows how the accounts can be articulated slightly differently so that the role of continuing firms in the job creation process becomes more transparent. This also allows a clearer picture to emerge of the progress of firms from "start-up" to "continuing" and its implications which, in turn, provides some insight into the inter- relationship between firm and job dynamics. The following section deals with the facts; it starts with the data on firm births.[4] The analytical strategy involves decomposing the stock of start-up jobs into the number of start-up firms and the number of jobs per firm. The rationale here is simple: in the United Kingdom start-up numbers fluctuate, average start-up size rather less, so this decomposition makes it possible to more easily see the differing scale of their contributions to job creation. This study adopts the same approach to investigating the contribution of deaths and continuing firms to job creation, distinguishing the effect of changes in the stock of firms from changes in average size. It completes the data analysis by bringing together start-ups and continuing firms to account for overall net job creation. The final analytical section of the paper reports a simple data-based counter- factual decomposition which illustrates the quantitative importance of start-ups in accounting for the dramatic decline in jobs in the GFC.

Data sources and construction

This analysis uses the United Kingdom *Business Structure Database* (*BSD*) (compiled by the Office for National Statistics)[5] which records annual data on employees for the entire population of firms in the United Kingdom. This data is compiled from a series of annual "snapshots" of the Inter-Departmental Business Register, an administrative database which captures information from a range of sources, among them VAT returns and employer pay as you earn (PAYE) tax and social security records. The unit of analysis is an "employer enterprise" – a business with at least one employee[6] – which is also referred to as a firm. Firms may comprise a number of distinct local units (workplaces, establishments or plants) but this analysis' data refer to firm-level employee numbers.

The annual "snapshots" from the BSD using firm-level identifiers have been linked together to form a longitudinal firm-level database for the United Kingdom and algorithms have been devised to produce firm-level demographic markers for "birth" and "death". The birth of a firm is dated by the first appearance of non-zero employment and its death is treated symmetrically and dated by the disappearance of the last employee. The data do not distinguish between *de novo* births and those which result from the break-up of an existing firm, similarly the data do not distinguish between the closure of a firm and its disappearance due to a merger. Although the data start in 1997, firms alive in 1997 could have been born in any previous year, so the first birth year that can be identified with certainty is 1998.[7]

Firms are classified as either "private" or "public" sectors and this split is made using the classification by industrial sector. All employees in – public administration and defence; education; and health and social work – as public sector (SIC92[8] sections L, M, N) – are classified as public sector. Of course, some firms in these sectors (e.g. in health and education) are private, and some firms in the private sector are government-owned, but this chapter offers a reasonable approximation that ensures that, most typically, longer lived public sector entities (like schools and hospitals) do not distort calculations. In essence, the business population is all employer enterprises in the non-agricultural private sector.

Before proceeding further, there is an important caveat about dating. The data used here are compiled from annual snapshots taken of a "live" register each March. This analysis has adopted the convention of referring to the date of observations by the date of the snapshot, so for example the data labelled 2014 are from the March 2014 snapshot.[9] Those used to working with conventional annual time series may find this labelling potentially misleading for two reasons. First, the data on the register in March are not likely to refer to activity as at March or the period end-March; data entered onto the register in March are very likely to refer to some previous time. Second, the administrative processes underpinning the data collection make it likely that the period to which the data refer varies, at least to some extent, across firms. However, since there are more than 1 million firm-level records, these deficiencies are treated as "noise" when the analysis focuses on trends.[10] Here, though, one particular period is of special interest: the GFC. In practice, as shown below, this period seems clearly visible in the behaviour of the firm and job aggregates: between 2008 – the last pre-GFC year – and 2012 – the first year of the upward move into recovery.

Accounting for continuing firms and their jobs

Firms

This analysis starts with the conventional accounting relationship which connects the closing stock of firms between two periods, where births and deaths are (during period) flows (the superscript *f* denotes firms):

$$\text{closing}_t^f \equiv \text{closing}_{t-1}^f - \text{deaths}_t^f + \text{births}_t^f .$$

This can be re-organised to yield the usual stock/flow relation:

$$\Delta closing_t^f \equiv closing_{t-1}^f - closing_t^f \equiv -deaths_t^f + births_t^f . \quad (1)$$

In its treatment of job creation and destruction this analysis tracks the contribution of continuing firms: firms which were born before the beginning of a year and survive to the end of that year. It follows that the stock of continuing firms at the end of a year can be written as:

- the stock of continuing firms inherited from the previous year
- *plus* the firms born in the previous year, because at the beginning of the current year all last year's births are "re-labelled" continuing firms
- *less* the firms which die in the current year:

$$continuing_t^f \equiv continuing_{t-1}^f - deaths_t^f + births_{t-1}^f,$$

and the corresponding stock/flow relation is:

$$\Delta continuing_t^f \equiv -deaths_t^f + births_{t-1}^f. \quad (2)$$

It is worth emphasising that the current change in the number of continuing firms depends on the previous year's start-ups. As shown later, this dependence has important implications in accounting for job creation dynamics in the GFC period.[11]

The relationship between the overall closing stock of firms and the end-year stock of continuing firms can be written as:

$$closing_t^f \equiv continuing_t^f + births_t^f,$$

and the stock/flow relation (Equation (1)) can be rewritten as:

$$\Delta closing_t^f \equiv \Delta continuing_t^f + \Delta births_t^f. \quad (3)$$

Jobs

This study's creation and destruction accounts for jobs (the j superscript denotes jobs) include one more term than the corresponding firm accounts: the (net) addition to jobs in continuing firms (continuing net). This is a during period flow equal to jobs added by expanding firms less jobs lost by contracting firms – the difference between two terms from the conventional flow accounts:

$$closing_t^j \equiv closing_{t-1}^j - deaths_t^j + births_t^j + continuing\_net_t^j.$$

This term fits quite naturally into the job creation accounts for continuing firms, since job growth during the year has the same effect as start-up jobs:

$$continuing_t^j \equiv continuing_{t-1}^j - deaths_t^j + births_t^j + continuing\_net_t^j, \quad (4)$$

from which follows immediately:

$$\Delta continuing_t^j \equiv -deaths_t^j + births_t^j + continuing\_net_t^j.$$

The relationship between the (overall) closing stock of jobs and the closing stock of jobs in continuing firms parallels the firm relationship, and the stock/flow relation which defines net job creation can then be written as:

$$\Delta closing_t^j \equiv \Delta continuing_t^j + \Delta births_t^j.$$

So overall net job creation can be written as the sum of two components: the change in jobs in continuing firms, and the difference between jobs in the current cohort of start-ups and start-ups in the previous period. As shown below, this alternative presentation provides some rather sharper insights than does the conventional framework into the process of change, particularly over the GFC period.

Jobs per firm

As mentioned earlier, this analysis' primary focus is the stock of firms, and it generates the associated stock of jobs as the product of the stock of firms and the number of jobs per firm. In order to keep track of the evolution of jobs per firm in continuing firms (even though, as will soon become apparent, it shows relatively little variation) a further accounting

relationship is required. The simplest place to start is with an identity which links the current stock of jobs to its constituent components. The first step is to define jobs per firm by dividing the expression for continuing jobs by the current stock of continuing firms:

$$\frac{continuing_t^j}{continuing_t^f} \equiv \frac{continuing_{t-1}^j + births_{t-1}^j + continuing\_net_{t-1}^j - deaths_t^j}{continuing_t^f}. \quad (5)$$

Next the terms on the right hand side are turned into a weighted sum of the separate job-per-firm ratios for each component:

$$\frac{continuing_t^j}{continuing_t^f} \equiv \frac{continuing_{t-1}^j}{continuing_{t-1}^f} \times \frac{continuing_{t-1}^f}{continuing_t^f} + \frac{births_{t-1}^j}{births_{t-1}^f} \times \frac{births_{t-1}^f}{continuing_t^f} + ,$$
$$\frac{continuing\_net_{t-1}^j}{continuing_{t-1}^f} \times \frac{continuing_{t-1}^f}{continuing_t^f} - \frac{deaths_t^j}{deaths_t^f} \times \frac{deaths_t^f}{continuing_t^f},$$

and this can be simplified slightly by expressing the increase in jobs in "inherited" continuing firms (continuing net) as the product of a growth rate (g^i) and the job stock:

$$g_t^i \equiv \frac{continuing\_net_{t-1}^j}{continuing_{t-1}^j}.$$

Now this can be rewritten adding some extra terms which, although adding to the complexity of the expression, ultimately assists in its simplification:

$$\frac{continuing_t^j}{continuing_t^f} \equiv \frac{continuing_{t-1}^j}{continuing_{t-1}^f} \times \frac{continuing_{t-1}^f}{continuing_t^f} \times (1 + g_t^i) + \frac{births_{t-1}^j}{births_{t-1}^f} \times \frac{births_{t-1}^f}{continuing_t^f} \times \frac{continuing_{t-1}^f}{continuing_t^f} + . \quad (6)$$
$$\frac{continuing\_net_{t-1}^j}{continuing_{t-1}^f} \times \frac{continuing_{t-1}^f}{continuing_t^f} - \frac{deaths_t^j}{deaths_t^f} \times \frac{deaths_t^f}{continuing_t^f} \times \frac{continuing_{t-1}^f}{continuing_t^f}.$$

To make the accounting relationship more transparent, additional terms need to be defined: the birth rate (β):

$$\beta_{t-1} \equiv \frac{births_{t-1}^f}{continuing_{t-1}^f}$$

and the death (hazard) rate (δ):

$$\delta_t \equiv \frac{deaths_t^f}{continuing_{t-1}^f}.$$

The denominator is continuing firms from the previous year because that is the population at risk of dying.

Using a *jf* superscript to denote the jobs per firm ratio, Equation (6) can be rewritten as:

$$continuing_t^{jf} \equiv (continuing_{t-1}^{jf} \times \left(1 + g_t^i\right) + \beta_{t-1} \times births_{t-1}^{jf} - \delta_t \times deaths_t^{jf}) \times \frac{continuing_{t-1}^f}{continuing_t^f}.$$

The terms inside the parentheses have a reasonably straightforward interpretation. There is the job-per-firm ratio for "inherited" continuing firms, which is multiplied by their growth rate (i.e. expansions less contractions expressed as a growth rate), and the job-per-firm ratio for start-ups multiplied by the birth rate, less the job-per-firm ratio for firm deaths multiplied by the death rate. The first term captures adjustments at what is called, conventionally, the "intensive" margin – changes involving the continuing firms. The second pair of terms measures the contribution of adjustments at the "extensive" margin – births and deaths – with births making a positive contribution, and deaths a negative contribution to the change in jobs per firm.

Finally, there is the term which multiplies the expression in parentheses. This acts as a "revaluation", or dimensional adjustment: all the terms inside the parentheses are measured relative to the period (t-1) stock of firms. The growth term provides the simplest example. The impact of net jobs in continuing firms on the current period's jobs per firm requires them to be measured in units relative to the current period number of continuing firms (as in Equation (5)), not the continuing firms of the previous period. This ratio term captures that adjustment.

The facts of firm and job dynamics, 1998-2014

First of all the factors driving the evolution of the stocks of firms need to be accounted for, so this study's analysis of the data starts with the components which determine the change in stocks: births and deaths (though, remember, it is the lagged value of births which affects continuing firms).

Births

Figure 4.1 displays the data on firm births (in thousands) and average jobs per firm at birth, with the GFC period highlighted here (and in the later plots) by a shaded region covering the four years between 2008 and 2012.[12] The data has been plotted on a split scale with firm numbers on the left hand axis and jobs per firm (jperf) on the right hand axis. Both series are plotted against a log scale, with the same (log) range on each axis, and with the same tick marks (0.2 log units), so the slopes of the two series – the rates of change over time – are comparable, and visual comparisons of their relative contributions to change are easier to make.[13] The log scale is a particular advantage here, since the stock of jobs is the product of the stock of firms and the number of jobs per firm: so the log of the stock of jobs is the log of the stock of firms plus the log of average jobs per firm. Consequently, the two series can be visually "added" to arrive at the (log) of jobs.

While there does seem to be a "middle" to the distribution of birth numbers over time – the whole period average is 230 000 – there are quite wide swings around that middle. First there is a dramatic 25% "surge" in firm births after 2003, the average 2004-08 is 50 000 larger than from 1998 to 2003. Second, after 2008, there is an equally dramatic "collapse" signalling the start of the GFC period, with the number of births dropping by 74 000, and the lower level persists for the next two years. Third, 2012, the first year of the recovery, recorded a 66 000 increase in births, an increase of roughly the same magnitude as the 2009 "collapse". There was a slight setback in 2013, but in 2014 births exceeded the pre-GFC number.

By contrast, the pattern of change in jobs per firm is considerably less volatile. There is an early (1998 to 2003) period at a relatively stable low level, averaging about 4.5 jobs per firm, and a later relatively stable period (2007-13), averaging a significantly lower three jobs per firm.[14] Overall, though, firms are born relatively small – about one-quarter of the all-firm average size – start-ups simply have not had time to grow. Most significantly for this study's focus here, though, is that over the GFC period average birth size is almost entirely flat. There were many fewer births, but the average size of those firms that were born was the same (pre-GFC) figure.

From what could be seen of the pattern of change in the number of births and their average size, the evolution of jobs in start-ups could be inferred. But Figure 4.2, which records firm births and the numbers of jobs in start-ups, makes the conclusions easier to

see. Again, there is a split log scale with an equal log range and equally spaced (0.2 log units) tick marks and the range on the jobs axis has been chosen to emphasise the similarities between the two series over the GFC period.

Figure 4.1. **Births: firms (thousand) and jobs per firm (jperf)**

Note: The grey shading indicates the period following the global financial crisis.
Source: Authors' calculations.

Notice first, though, that there is little similarity between the path of births and the path of jobs between 2000 and 2006. Specifically, the "surge" in births is almost entirely offset by the drop in jobs per firm noted earlier, keeping the number of jobs relatively unchanged. However, from 2006 onwards the two series move in step, most dramatically during the GFC period and the subsequent recovery. Over the period 2008-14 the birth of firms is clearly driving the number of jobs in start-ups which might, of course, have been anticipated, given the relative constancy of average size noted earlier.

This conclusion, about the driving role of start-ups, is important because births and their associated jobs have two distinct channels of influence. First, in the year in which the birth takes place, the jobs feed into the stock/flow relation for the closing stock of firms and thus overall net job creation. Second, in the period following their birth, new-born firms become part of the stock of continuing firms and their jobs are added (as the stock/flow relation sets out) to the stock of continuing firm jobs. As shall be seen below the incorporation of births into the stock of continuing firms is a potent influence propagating the effects of the collapse in births at the beginning of the GFC period into the stock of jobs for years into the future.

Figure 4.2. **Births: firms and jobs (thousand)**

Note: The grey shading indicates the period following the global financial crisis.
Source: Authors' calculations.

Deaths

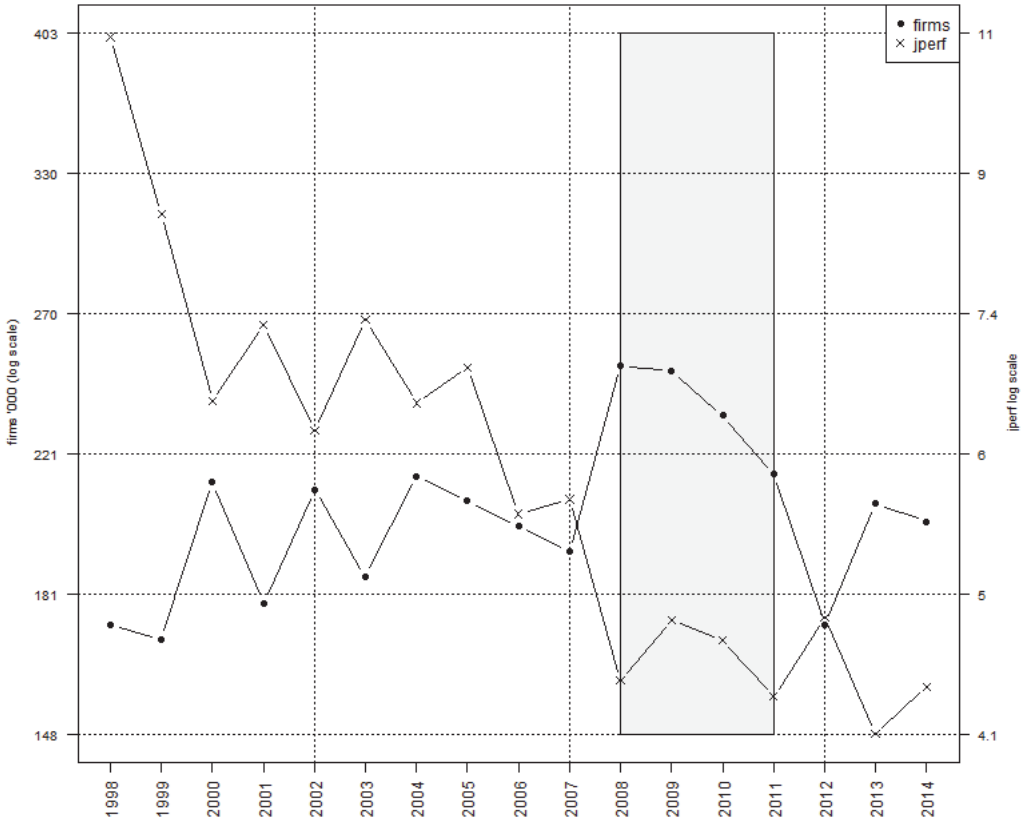
The plot of the number of deaths and the average size of firms at death are recorded on Figure 4.3. The plot has the (usual) split log scale, and the scale (not just the range) on the left hand (number of firms) axis has been chosen to match that of the corresponding births plot (Figure 4.1). However, although the range on the right hand (jobs per firm) axis also matches the comparable births range, the scale does not: dying firms are considerably larger than new-borns (they have had some time to grow).

The annual change in the number of deaths looks rather different to that of births. Specifically, and leaving aside the GFC period, there is rather more year-to-year variation, but within quite narrow bands – around 200 000 ±10%. Although there is, as might have been anticipated, a "surge" in deaths around the GFC period, it appears to have started in 2008, the year before births dropped.[15] By 2011 deaths were back within their pre-GFC range, however, during the three "surge" years deaths were about 250 000, so about 25% above the pre- and post-GFC average.

Like the number of deaths, the jobs per firm series for dying firms shows more year-to-year variation than does the corresponding series jobs per firm in births. However, leaving aside the extreme figure for 1998, and the year-to-year "sawtooth",[16] the pattern of change in jobs per firm displays a familiar pattern – an early period of stability, followed by a drop to a lower level, and a later period of stability. Here the early period average is close

to 7 (between 1998 and 2005), and in the later period (2008-14) the average is about 4.5. Again, as with births, average size seems to have been little affected by the GFC.

Figure 4.3. **Deaths: firms (thousand) and jobs per firm (jperf)**



Note: The grey shading indicates the period following the global financial crisis.
Source: Authors' calculations.

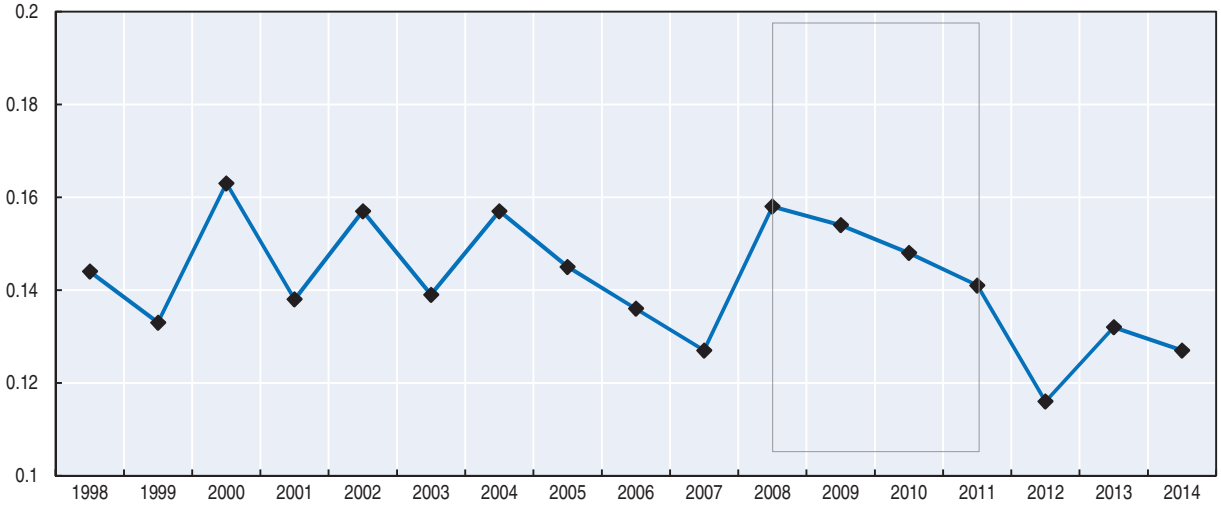
Because there is a noticeable negative correlation between deaths and the average size at death, the pattern of change in jobs lost through death (excluding 1998) is fairly flat up to 2005, as can be seen from Figure 4.4 (again constructed with split log scale and equal log distances between tick marks). From 1999 to 2005 it was around 1.4 million, until the drop in jobs per firm in 2006 when it fell to just over 1 million. Then, over the GFC period, job losses follow the rise, and then fall, in the number of firm deaths. Through the recovery the negative correlation between firms and jobs per firm seems to reassert itself. So with the number of firms in the pre-GFC range, but jobs per firm lower, job losses fell to a new, very much lower level, below 900 000.

An alternative measure for describing firm mortality is the hazard rate – the ratio of the number of firm deaths to the population at risk[17] of dying, where the latter is the stock of continuing firms from the previous year plus last year's births – and the hazard rate has been plotted on Figure 4.5. While this rate also exhibits a sawtooth pattern, typically it fluctuates within quite a narrow band, between 0.13 and 0.16, right up to 2011, the end of the GFC period. There appears to be no evidence of exceptionally high mortality rates during the GFC period.

Figure 4.4. **Deaths: firms and jobs (thousand)**

Note: The grey shading indicates the period following the global financial crisis.
Source: Authors' calculations.

Figure 4.5. **Death ratio**

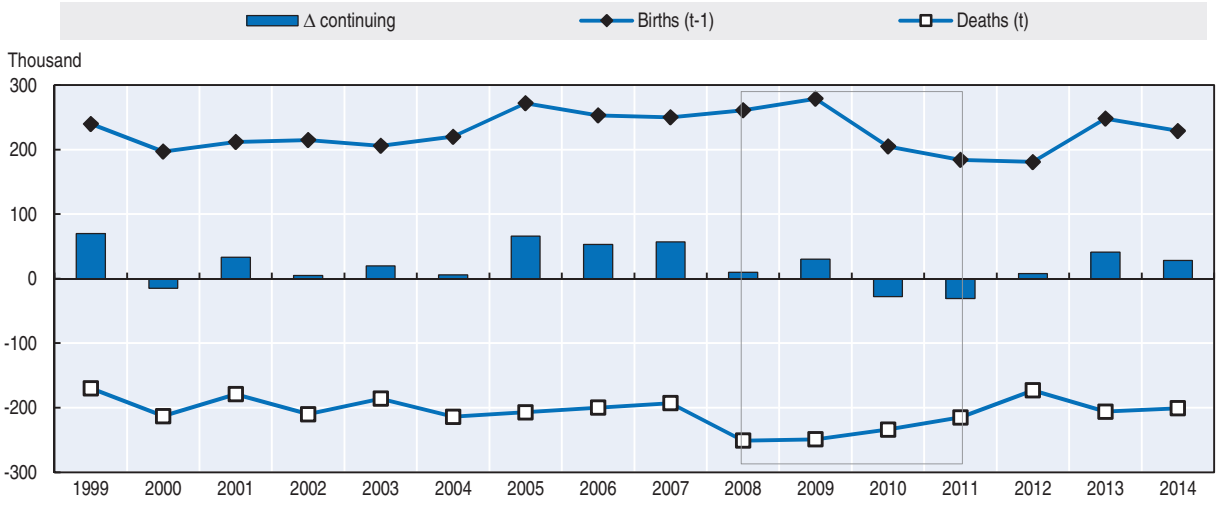


Note: The rectangle indicates the period following the global financial crisis.
Source: Authors' calculations.

Continuing firms

To fix ideas, this discussion of the stock of continuing firms starts with year-to-year changes. As Equation (2) has shown, the change in the number of continuing firms can be written as the sum of births in the previous period and deaths in the current period. Figure 4.6 displays the data: (previous period) births are at the top; deaths are plotted with a negative sign; and the bars in the middle are the sum of the two components – the change in the stock of continuing firms. As the discussion of births and deaths has yielded, both these series fluctuate between 150 000 and 250 000, while their difference is always in the range ± 50 000. The exceptional nature of the GFC period, at least of 2010 and 2011, is clear, with deaths exceeding (previous year) births and continuing firm numbers contracting by about 30 000 in each year (even though the hazard rate was not exceptionally high over this period).

Figure 4.6. **Contributions to change in continuing firm numbers**

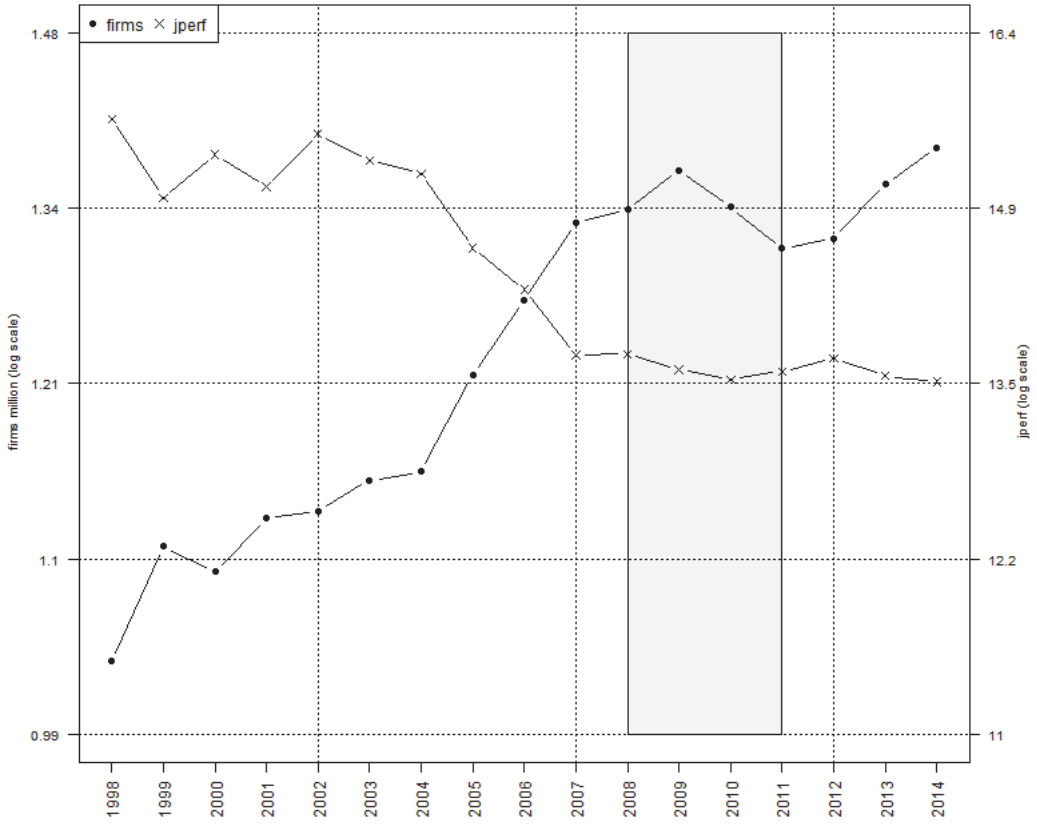


Note: The rectangle indicates the period following the global financial crisis.
Source: Authors' calculations.

Figure 4.7 displays the data on the stock of continuing firms together with the average number of jobs per firm. Again, the data has been plotted on split log scales with firm numbers on the left hand axis and jobs per firm on the right hand axis with the same (log) range on each axis and with the same tick marks (0.1 log units).[18] From a starting point at around 1 million in 1998 the stock of firms rises steadily up to 2004, but at a relatively modest rate, after which it rises rather more steeply up to 1.35 million in 2009. Then it drops, a year after the onset of the GFC period. Although the log scale affects perception a little, the pattern of change depicted by the bars in Figure 4.6 can be seen here over the GFC period. Growth resumes after 2012, and by 2014 the stock of firms exceeded the 2009 level.

The other curve on the plot, average jobs per firm, shows (as it did for births), rather less year-to-year variation over most of the period than the numbers of firms (and remember the slopes of two series are in comparable units). Indeed, jobs per firm exhibits two periods of relative constancy: up to 2004 it averaged 15.3 jobs per firm, while in the second period of relative stability, between 2007 and 2014, it averaged 13.6 jobs per firm (in the intervening period of adjustment it declined quite smoothly). As with births, jobs per firm declined very little during the GFC period (a more precise account is given below).

Figure 4.7. **Continuing firms (million) and jobs per firm (jperf)**



Note: The grey shading indicates the period following the global financial crisis.
Source: Authors' calculations.

Because the stock of firms has a rather striking time path, and jobs per firm varies relatively little, it is possible to "see" the trajectory of job numbers in the trajectory of firm numbers (remember the log of jobs is equal to the log of firms plus the log of jobs per firm). Figure 4.8 records data on jobs together with the number of firms and, to make the connection between firms and jobs easier to see, a split log scale has been used again (firms on the left, jobs on the right) with the same log range (but not scale) on each axis and tick marks 0.1 log units apart. The firms curve is simply reproduced from Figure 4.7, and this repetition serves to reinforce the clear difference in trajectory between firms and jobs. This follows, of course, from the downward slide in average jobs per firm between 2004 and 2007. The jobs curve has been placed on the plot so that it coincides as closely as possible with the firms curve during the GFC period. Clearly through the GFC "dip" and the subsequent recovery, job numbers follow the number of firms extraordinarily closely.

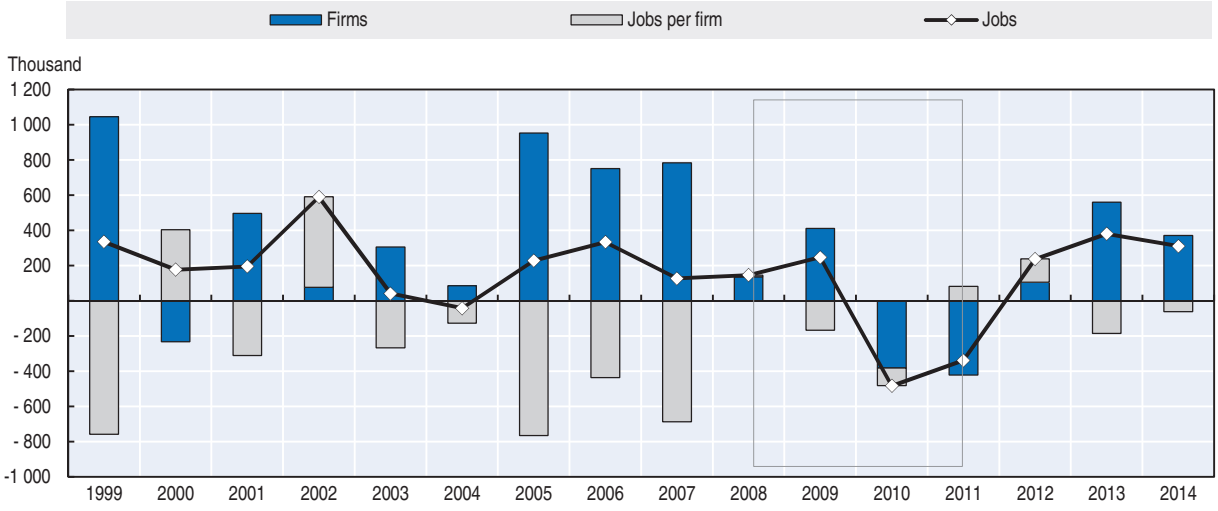
In fact it is possible to be quite precise about the relative importance of the contributions of changes in the stock of firms and in jobs per firm to (net) job creation. The bars on Figure 4.9 are the annual (weighted) change in the stock of continuing firms (dark) and the annual (weighted) change in jobs per firm (light).[19] The sum of these two series is the change in the stock of jobs[20] which is recorded by the line which fluctuates around the middle of the plot.

The broad pattern of change in jobs per firm is known – fairly constant but with a major decline 2004-07 – while the stock of firms typically grew, particularly in 2004-07

Figure 4.8. **Continuing firms and jobs (million)**

Note: The grey shading indicates the period following the global financial crisis.
Source: Authors' calculations.

Figure 4.9. **Contributions to change in continuing firm jobs**



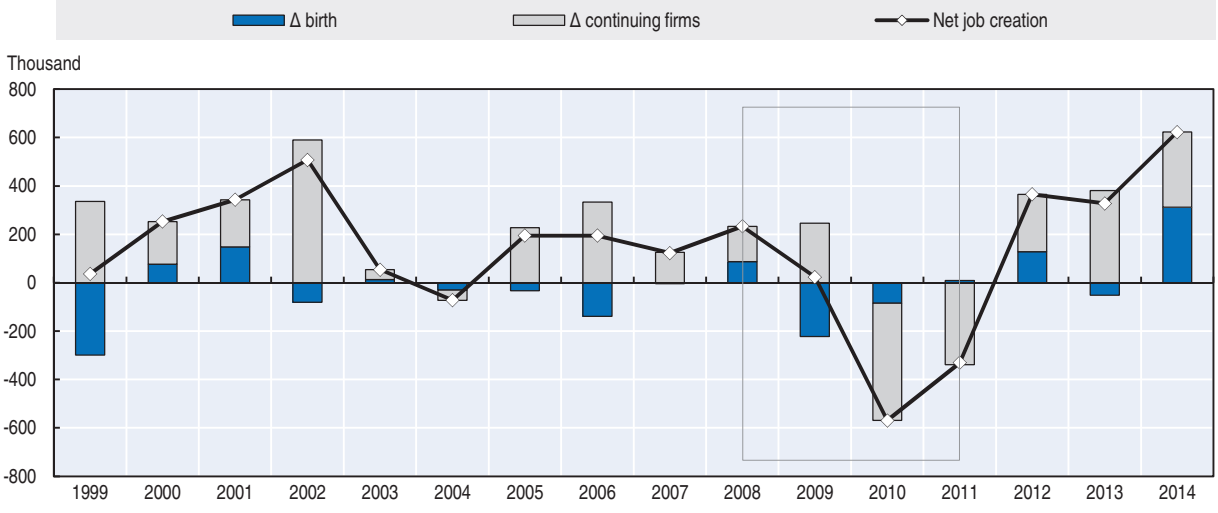
Note: The rectangle indicates the period following the global financial crisis.
Source: Authors' calculations.

(when jobs per firm were in decline). It is also equally clear that the GFC period was quite exceptional, with an extraordinary decline in jobs driven almost entirely by an exceptional drop in firm numbers. So this plot confirms what had been inferred from Figure 4.8, that the "bite" out of jobs in 2010 and 2011 which stands out so clearly is driven by the corresponding "bite" out of the number of firms. Equally, it is the turnaround in firm numbers after 2011 (from negative to marginally positive) which drives the recovery in jobs. It becomes apparent that the contraction in the stock of firms contributed a job loss of around half a million a year in the GFC period and in the recovery phase the turnaround in firm numbers is proximately responsible for the 1 million new jobs.

Drawing the threads together

Figure 4.10 brings the analysis to a close with a display of the contributions to change in the overall stock of jobs (net jcr), which Equation (3) had shown to be the sum of the change in jobs in continuing firms plus the change in jobs in start-ups. Of course, many of the features of this plot are well-known from the earlier discussion of births and continuing firms. So, for example, the 2002 peak in net job creation, accounted for by a change in continuing firms, can be tracked back to a large change in average size in that year, as plotted on Figure 4.9 (going one step further back it is equally visible on Figure 4.7, where it appears as an uptick in the level of jobs per firm).

Figure 4.10. **Contributions of births and continuing firms to net job creation**



Note: The rectangle indicates the period following the global financial crisis.
Source: Authors' calculations.

Focusing on the GFC period, it can first be seen that net job creation in 2009 was shielded from the impact of the fall in births by the contribution of increased jobs in continuing firms. This increase, as Figure 4.6 (and indeed Figure 4.1) clearly show, was generated by a peak in births recorded in 2008. So job growth was slow in 2009 (but not negative) because of a "bulge" in newly minted continuing firms born in 2008. In 2010 the 2009 collapse in births fed into the stock of continuing firms and, with the average size unchanged, it translated into very largely negative net job creation. Again, in 2011, there is the delayed impact of a fall in births in the previous year (2011 births themselves were essentially unchanged from 2010). Although births did increase substantially in 2012, and this had some impact, the

improvement of continuing firms was more important and the effect here, as Figure 4.6 shows, is due to the 2012 slump in deaths. Once the recovery was under way, though, the increased numbers of births began to play an important role. Indeed in 2014, the increase in births, and the feedthrough of improved births in 2013 into continuing firms, were of roughly equal importance as contributors to net job creation.

Butcher and Bursnall (2013) seems to be the only other detailed recent study of job creation and destruction in the United Kingdom over the GFC period (they have little to say about the recovery, though, since their last data point is taken from the 2012 BSD). Comparison between this chapter's analysis and their work is complicated for a number of reasons. First of all there is a simple matter of dating, as noted earlier, they adopt the convention of referring to data from the BSD as using the BSD date less one year (so, for example, BSD 2009 data is labelled 2008). More substantially, their analysis uses workplace-level data rather than firm-level data (where a workplace is a production location, and firms may consist of a number of workplaces). Consequently, their approach – an application of the conventional "gross flows" framework – might be regarded as somewhat removed from this analysis. Nonetheless (and perhaps because most firms are in fact single workplace firms) this analysis does reach similar conclusions on one matter:

> "The loss of employment in a downturn is sometimes seen to be due to closure of workplaces or lay-offs. In the current case, in two of the three years of low or no net job growth (2008, 2009 and 2010 [2009, 2010 and 2011 in this study's terms]) the main effect is a reduction in job creation through reduction in entry of workplaces." Butcher and Bursnall (2013, p. F9) [dates added by this chapter's authors].

Even though this analysis approaches the issue rather differently – Butcher and Bursnall work directly with the fall in jobs generated by entry, whereas this study focuses on the fall in firm births – both approaches agree on the key role of births at the onset of the recession.

Some counterfactual calculations for the GFC period

A simple model

This section sets out the results of a very simple "what if" exercise. It works through the implications for jobs of a "counterfactual" where firm births did not collapse in 2009, but instead remained at their 2008 level. The effect of setting firm births in 2009, the first year of the GFC period, at their previous year's value, and thereafter at their actual historic values, is to simply postpone the onset of the GFC by one year and shorten the length of the GFC period by one year. Computing the difference between this analysis' counterfactual and the historical record yields a clearer view of the importance of start-ups in the GFC period.

To undertake this "what if" exercise this study's accounting framework is turned into a simple "model" by making some assumptions about which quantities might be treated as "given", these take on their actual values or are subject to counterfactual manipulation, while the other variables are then endogenous and determined by the system of equations. Since, as shown above, the job-per-firm ratios for births, deaths and continuing firms ratios varied relatively little between 2008 and 2013, it seems plausible (as a first approximation) to assume that they appear unlikely to have made any "active" contribution to the contraction and the recovery which followed. Accordingly, to keep matters simple, average jobs per firm ratios are also taken as given, as well as the proportion of the stock of firms which dies during a year (δ). The number of births in 2009 is treated which, as seen, collapsed with the

onset of the GFC, as exogenous, setting it at its 2008 value in this study's counterfactual calculation. Clearly this is a very simple model. As can be seen it is only a handful of assumptions away from being a collection of accounting identities. Nevertheless, it does shed some interesting light on firm and job dynamics during the GFC period.

There are seven endogenous variables. Three are firm aggregates (superscript *f*): deaths, continuing firms and closing firms and these are determined by the relationships below,[21] where a bar over a variable name indicates that it is either exogenous or given (and set at its observed value):

$$deaths_t^f = \bar{\delta}_t \times \left(continuing_{t-1}^f + births_{t-1}^f\right) \tag{7}$$

$$continuing_t^f = continuing_{t-1}^f - deaths_t^f + births_{t-1}^f \tag{8}$$

$$closing_t^f = continuing_t^f + \overline{births}_t^f. \tag{9}$$

There are four job aggregates (superscript j): births, deaths, continuing and closing:

$$births_t^j = \overline{births}_t^f \times \overline{births}_t^{jf} \tag{10}$$

$$deaths_t^j = deaths_t^f \times \overline{deaths}_t^{jf} \tag{11}$$

$$continuing_t^j = continuing^f \times \overline{continuing}_t^{jf} \tag{12}$$

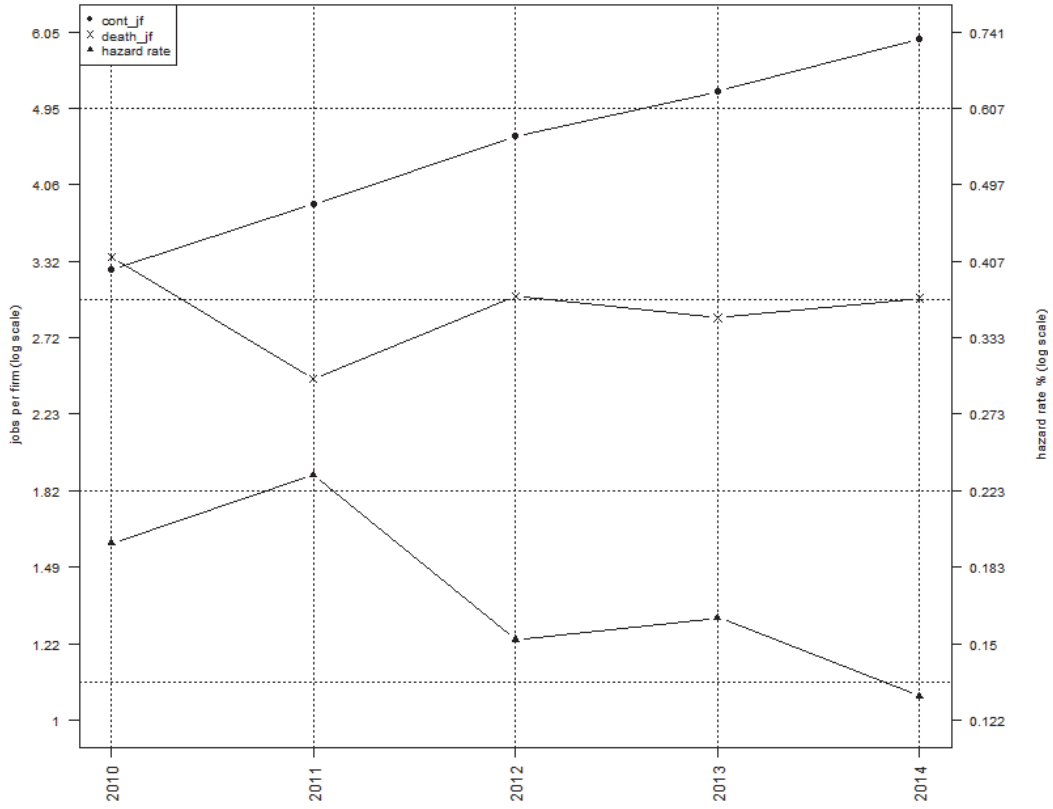
$$closing_t^j = continuing_t^{fj} + births_t^j. \tag{13}$$

Setting 2009 births to its 2008 value is equivalent to adding 74 000 to births in 2009, the number by which 2009 fell short of 2008. This analysis proposes to treat these firms (from a jobs-per-firm viewpoint) as if they were like the 205 000 firms actually born in 2009. Figure 4.1 showed that the average size of firms born in 2009 was about 3, so that is the figure that is fed into Equation (9) to generate the jobs associated with the extra births.

Moreover, Figure 4.3 showed that the average size of continuing firms in 2010 is around 13.5. However, firms born in 2009 do not "jump" from an average birth size of three to the average all-firm size around 13.5 in just one year. The actual path of average jobs per firm for firms born in 2009 is plotted on Figure 4.11 for the period 2010 to 2014.[22] It can be seen that in 2010 the average size has grown a little larger than it was at birth. From 2010 it moves up slowly in succeeding years. Since the data has (again) been plotted against a log scale, the smooth curve can be interpreted as steady growth, and by 2014 average size has doubled.

This analysis applies the same logic in assigning "given" values to the average size of firms at death, and this series is also plotted on Figure 4.11. Although average size at death starts at about the same size as the firms that survive, the size at death series does not grow. This confirms a well-known characteristic of firm performance: firm deaths, particularly among relatively young firms, are concentrated among smaller firms.[23] The remaining curve on Figure 4.11 is also connected with firm death – it is a plot of the final "given": the hazard (of death) rate. It is difficult to get a clear picture of the shape of this curve from just five observations, however there are two features it shares with the same curve for other cohorts. First, it rises from age 1 to age 2, and second, it falls thereafter, although the downward path can sometimes be a little "bumpy". Needless to say, the presence of these age effects – here in average jobs per firm and the hazard rate – illustrate the need for cohort data in studies of firm performance, but that is an argument beyond this chapter's scope.

Figure 4.11. **Exogenous variables for counterfactual**



Source: Authors' calculations.

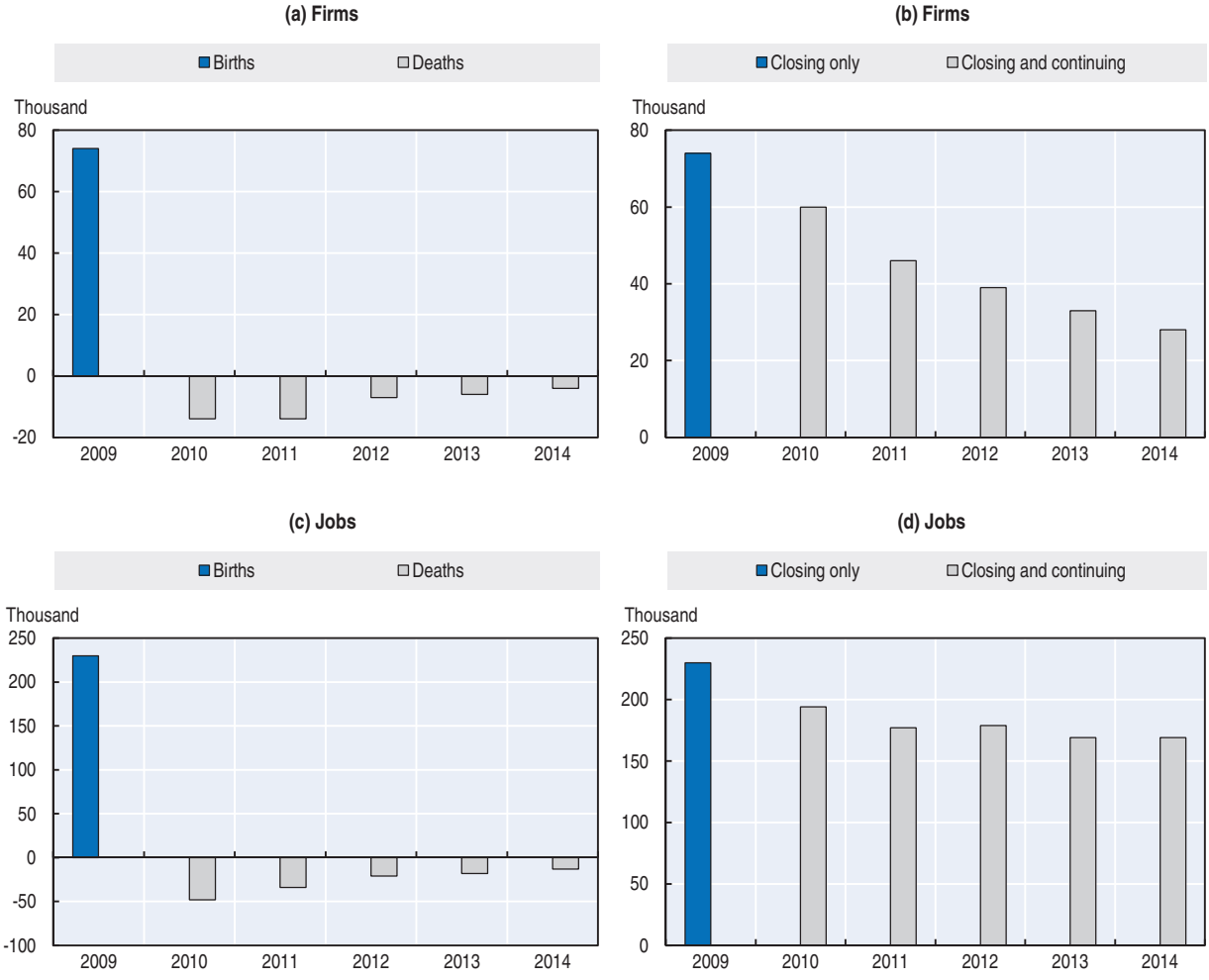
The results of the counterfactual

The results of this study's counterfactual calculations are summarised in Figure 4.12. The two panels in the top row refer to firms, the two panels in the bottom row to jobs. All the numbers are plotted as differences from their historical values: calculated less observed. The first bar in Panel (a) records births, and simply serves as a reminder of the size of the exogenous change that have been assumed: in 2008 births were 279 000, in 2009 they fell by about 25% to 205 000, a reduction of 74 000. So the 74 000 "extra" counterfactual births for 2009 appear on the plot. The "excess" births in 2009 produce (by definition) a matching increase in closing firm numbers in 2009, which are recorded on Panel (b). But of course there is no effect (again by definition) on continuing firm numbers in 2009, which depend on births in 2008. By assumption births in 2010 return to their observed value and so the birth plot records excess births of zero for all following years. Now the "excess" births of 2009 feed through to increase continuing firm numbers in 2010 (as those births are "re-labelled") but the increase falls slightly short of 74 000 because, as shown, and can be seen from Panel (a), some deaths have occurred and these are recorded as negative numbers. In fact, 14 000 firms have died, so the "excess" continuing firm figure is 60 000 (= 74 000-14 000). And, of course, with "excess" births now equal to zero, the "excess" closing firms figure is also 60 000.

Moving backward and forward between Panel (a) and Panel (b), the process of change in subsequent years can be traced. With no new "excess" births, it can be seen that the numbers of continuing (and closing) firms continue to decline as deaths reduce the "excess" from 2009, year by year. However, because deaths are a proportion (albeit declining after 2011) of

the previous year's closing firms, "excess" deaths decline too. The process of adjustment is quite slow, and by 2014 there are still 28 000 "excess" firms: about one-third of the "excess" births are still alive. Evidently a fall in births like that observed in 2009 has not just a large immediate impact on the stock of firms, but it has an impact which persists for many years.

Figure 4.12. **Counterfactual results, jobs and firms**



Source: Authors' calculations.

This analysis takes a very simple approach to translating firm numbers into job numbers. Using the observed average size at birth of 3.11, the "excess" births produce 230 000 "excess" jobs in that year. For obvious reasons then, there is a very close relationship between the plots of firm numbers in the first row of Figure 4.12 and the corresponding plots of job numbers in the second row. Although continuing firms are marginally larger in 2010 than they were at birth, the number of continuing firms is slightly smaller because 14 000 firms have died. So 230 000 jobs at birth become 194 000 jobs at age 1 in 2010. This study showed that the stock of continuing firms will continue to shrink but, the effect of death on the number of jobs depends on the balance between the growth in the average size of survivors and the (essentially constant) size of the firms which die. As a consequence, the path of "excess" jobs in continuing (and closing) firms can be a little bumpy. This analysis showed that in 2014 there were still 28 000 "excess" firms and between them these firms account for 169 000 jobs.

It is important to emphasise that this study's counterfactual calculations are not intended to imply that there was an alternative path available to the United Kingdom which would have mitigated the effect of the collapse of firm births. This study has presented no evidence to suggest that firm births are manipulable by policy makers. While it may be reasonable to assume that firm births are endogenous at the macroeconomic level, it seems equally reasonable to suppose that they are determined by all the factors – international and national, policy choices and random shocks – which determine macroeconomic performance more generally. However, unless there is some particular reason to believe that some unrecognised feedback loop is operating (at the aggregate level) during the GFC period which connected the stock of continuing firms in year t to births in year $t + 1$, then this study's calculations can provide a rough guide to the implications of the extraordinary fall in births which occurred in 2009 (and was sustained until 2011).

What have we learned?

This chapter has shown how a shift in perspective – focusing on firm stocks rather than job flows – provides a more coherent, and slightly different, account of firm and job dynamics in the United Kingdom over the period since 1998. This change of perspective does have a cost, annual gross flows – expansions and contractions of continuing firms – disappear from view, to be replaced by a summary statistic: jobs per firm. Of course the value of this approach depends on its usefulness, which depends in turn on the questions to be answered: in this case a narrative account of recession and recovery. So this discussion of the United Kingdom data was organised around the simple idea that the stock of jobs can be written as the stock of firms multiplied by average jobs per firm. This analysis applied this simple idea to births, deaths and to the stock of continuing firms and found, in each case, that average jobs per firm varied relatively slowly (and in much the same way in all three cases). By implication then, at least over the last decade and a half in the United Kingdom, variation in the number of firms (being born, dying or continuing) appeared to play a more active role in driving variation in job creation than did variations in the average size of continuing firms.

A narrow focus on the GFC period yields that its onset was signalled by the collapse in firm births in 2009 (the number of firm deaths had moved up sharply the year before, but had been offset by record births). Births stayed at this depressed level (indeed, they fell a little further) in 2010 but the principal depressing effect on firm numbers had by then become the decline in the number of continuing firm. The previous year's drop in births had fed through, and deaths remained roughly unchanged. Continuing firm numbers fell again in 2011: the previous year's births were low and deaths unchanged. In 2012 the turnaround began. First of all deaths fell substantially and consequently continuing firm numbers stabilised; second, birth numbers recovered sharply, almost back to pre-GFC levels. In 2013 the recovery of continuing firm numbers got under way as 2012 births fed through. By 2014 births, deaths and the stock of continuing firms had recovered to pre-GFC values. The time path of jobs over the recession and recovery followed the time path of firms quite closely because in neither the recession nor the recovery phases were there very large adjustments in the average number of jobs per firm. To be sure, the rate of growth of jobs per firm in continuing firms was relatively depressed during the downswing (it even turned negative in 2010) and recovered during the upswing, but compared to fluctuations in firm numbers these swings were of relatively little importance.

This chapter stipulates that policy makers can learn something from the analysis presented here, but not because it has immediate implications for the choice of policy instruments. Rather it provides a framework of ideas within which policies can be designed, understood and, subsequently, evaluated. Even though this study does not argue that the overall number of start-ups is manipulable (or should be manipulated), it does contend that a firm grasp of the message that "today's start-ups are tomorrow's continuing firms" may suggest that there may be a case for considering interventions which improve firms' chances of survival and their prospects for growth.[24]

Notes

1. There is an earlier tradition using a similar framework, referred to as the "components of change analysis", a sub-field of industrial geography. The work of Birch (1979) (and the work he inspired) provides a bridge between the older and newer literatures.
2. There are two inter-related strands: one concerned mainly with labour market fluctuations (see Davis et al. [2006] for a summary); the other with the effect of regulation on labour market flexibility and the links with productivity (see Haltiwanger, Stefano and Schweiger [2014] for a recent, widely cited, example).
3. A related paper investigates the argument using an extended model applied to a longer run of data, see Sedláček and Sterk (2016).
4. The terms "start-up" and "firm births" are used interchangeably.
5. For a full, official, account of the Business Structure Database and its compilation, see Evans and Welpton (2009).
6. Since an employee can work for more than one firm, summing over firms produces an estimate of jobs rather than employment. This distinction is ignored here and the terms "employment" and "jobs" are used interchangeably.
7. The database which underpins this study – the Longitudinal Business Structure Database – can be accessed by approved researchers through the ONS Virtual Microdata Laboratory or the United Kingdom Data Service Secure Lab.
8. The United Kingdom version of the EU NACE rev.1.
9. Others have made different choices: Butcher and Bursnall for example, use the year prior to the snapshot, so they refer to the March 2014 snapshot as 2013 data.
10. It is a by-product of using a data collected for administrative purposes as a resource for research.
11. Since some of these start-ups might die in their birth year, strictly speaking, it is net start-ups from the previous period.
12. It is worth remembering, though, that there is an important caveat attached to these dates, see the second section above.
13. There is an arithmetic relationship between the change in the logarithm of a pair of numbers and the rate of growth. If g is the rate of growth of *X* between *t* and *t-1*,

$$\frac{X_t}{X_{t-1}} \equiv (1+g)$$

$$\Delta ln(X_t) \equiv ln(1+g),$$

then using the first term in a Taylor's series expansion for $ln(1+g)$,

$$\Delta ln(X_t) \approx g.$$

14. The change in jobs per firm is associated with a shift at the "small" end of the firm size distribution: between 2003 and 2004, the share of firms born with less than five employees increased by two percentage points, and that increase, in turn, largely reflected an increase in single job firms.
15. Again, it is worth emphasising that this study's data has its origins in a live register and so the precise dates assigned to births and deaths may depend, to some extent, on the organisation and timing of administrative procedures recording births and deaths.

16. The 1998 figure may be an artefact. The first year of data is 1997 and 1998 is the first year for which deaths can be identified, so it is possible that amongst the 1.2 million firms recorded in 1997 there were in fact a proportion – possibly as many as 200 000 – which were, in fact, already dead. Equally, the "sawtooth" may also be an artefact. Since this study's data derives from an administrative source and (e.g. for revenue-related reasons) there may be more concern with capturing newborns than with "killing off" firms which are no longer alive. Indeed, current practice allows firms to remain on the business register for a number of years after which they have become "inactive", an administrative practice for which this analysis has tried to adjust.

17. The term "population at risk" is used as an alternative, but equivalent term, to the term "risk set": "The set of individuals for which the event of interest has not happened before a given time t, and who have not been censored before time t, is termed the risk set at time t." (Aalen, Ornulf and Gjessing, 2008, p. 4).

18. The log range is half that for births because continuing firms and their average size show relatively less variation.

19. This "contributions" plot in log points could have been constructed directly from the slopes of Figures 4.7 and 4.8, but it seemed preferable to report the changes in natural numbers.

20. There is in fact a third "interaction" term – the product of the change in the stock of firms and the change in jobs per firm. This is a second order term and typically small, and although it is not plotted separately, it is included in the change in jobs. The computation underpinning the plot involves the expression for the first difference of a product:

$$jobs_t \equiv firms_t \times jperf_t,$$

taking first differences:

$$\Delta jobs_t \equiv \Delta firms_t \times jperf_t + firms_t \times \Delta jperf_t - \Delta firms_t \times \Delta jperf_t.$$

The "double Δ" term does not appear on the plot.

21. There also two "auxiliary" equations which feed the current values of births and continuing firms from one period to their lagged values in the following period.

22. Since only births differ from "history" in 2009, this study's other "given" variables only affect the outcome from 2010 onwards.

23. For a discussion of size effects on survival in a cohort of UK firms, see Anyadike-Danes and Hart (2015).

24. For an illustration of how evidence on the age and size dependence of firm performance might inform policy design see Anyadike-Danes (2015).

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