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Te Kōmihana Whai Hua o Aotearoa

Firm dynamics and job creation

Revisiting the perpetual motion machine

Research Note

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Firm dynamics and job creation: revisiting the perpetual motion machine

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[1] The Commission that pursues abundance for New Zealand.

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1 Purpose and scope

This note presents analyses of firm dynamics in New Zealand. The purpose of the analysis is to revisit the findings of Meehan and Zheng (2015), to see if firm dynamics have changed since that study.

Meehan and Zheng (2015) analysed firm mortality and employment growth in New Zealand in the decade from 2001 to 2011 using Statistics New Zealand's Longitudinal Business Database (LBD). The analysis focussed on the cohort of firms born in 2001. The main findings were:

- most firms are born small and die young;
- firms that are born small have higher death rates; and
- job creation and destruction are both highly concentrated in a relatively small number of firms.

This note revisits the dynamics of the 2001 cohort of firms, between 2011 and 2016 and finds:

- much lower rates of growth, in numbers of employees, amongst firms in the period 2011 to 2016, compared to the period 2001-2011;
- persistently high rates of mortality amongst firms that are born very small, but less distinct or persistent differences in mortality rates amongst firms of other birth sizes; and
- continued significant job creation by a small number of firms that started out very small.

All of these findings are consistent with comparable analyses of firm dynamics in OECD countries.

Analysis of the 2001 cohort, for the first 10 years of life, has been extended to investigate variations in firm dynamics between different cohorts. This shows that:

- firm dynamics vary significantly across different cohorts, questioning the extent to which findings for any year-specific cohort can be generalised
- job creation is concentrated in the early stages of firms lives and that, overall, creation of new firms is a key driver of job growth.

This paper also investigates the dynamics of "digital" firms – firms in industries that produce digital and communications technologies or support their use by other firms and consumers, or produce and sell digital content and media. Collectively these are referred to as the "digital sector". These "digital" firms are compared to firms in a comparator group of industries. The differences are not profound, in the sense that patterns of firm entry, growth and death are similar across all industries. But "digital" firms tend to be smaller, are more likely to die young, and surviving firms grow faster, than firms in the comparator group (for a break-down of industries in the digital sector and the comparator group see Table 7).

2 Why firm dynamics matter

Firms are constantly being born, growing and dying. Meehan and Zheng (2015) refer to these dynamics as a "perpetual motion machine". When firms shrink and die, jobs are destroyed but they also give way to new firms and new jobs.

In normal circumstances there is a considerable amount of churn in the economy and, on balance, additions outweigh subtractions. This is summarised in Figure 1 which shows a steady decline in the number of ageing firms and replacement with new firms (in the top panel) and new firms contributing the lion's share of job creation (in the bottom panel).

Studying the dynamics underlying these macro-trends can provide insights into the functioning of the economy and causes of, or barriers to, productivity growth. If firms 'refuse' to die, but stagnate instead, this may reflect insufficient competitive pressure that should cause these firms to fail. When firms stagnate, but do not die, they can also impede reallocation of resources and workers to higher valued uses – and as such they can impede productivity growth.

Empirical analyses show that reallocation from low productivity to high productivity industries is an important aspect of economic development (Rodrik and McMillan, 2011). Meehan (2016) found that productivity growth would have been higher in New Zealand in the 2000s if resources had been allocated to higher productivity firms or industries. Resources have been allocated most inefficiently within, rather than between, industries.

One implication of this is that firms are larger than they ought to be, given their productivity. These findings are consistent with findings overseas (Hsieh & Klenow, 2009; Bartlesman et al 2013).

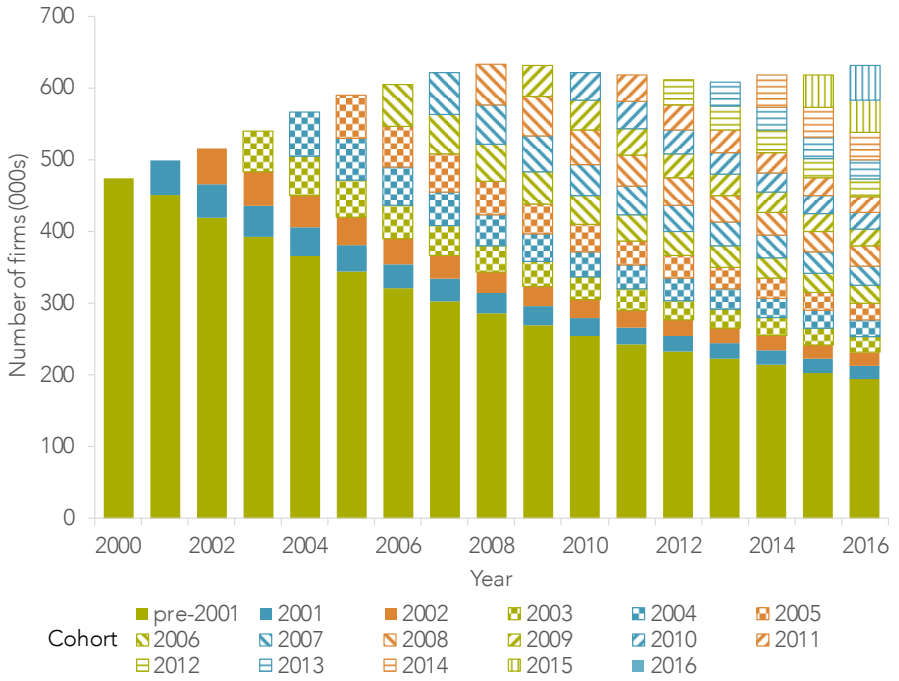
Firm dynamics have also attracted attention of policy makers seeking to support productivity growth by investigating policies that can support firms exhibiting rapid employment growth – so-called "high-growth firms".[2] The pursuit of policies to support "high-growth firms" is based on presumptions that high-growth firms are more likely to be high productivity firms, innovative, and disruptive in terms of the increasing competitive pressure when they enter new markets (MBIE, 2013).

Firm birth and growth rates also affect adjustments to economic shocks or structural changes in the economy. If employment growth begins to decline or firms begin to shrink, employees can only find work elsewhere if the perpetual motion machine is working well – with new firms being born and new jobs being created. If new job opportunities are not being created, such as often occurs following a negative economy-wide external demand shock, then the effects on workers can be significant and long-lived (see e.g. Farber, 2017).

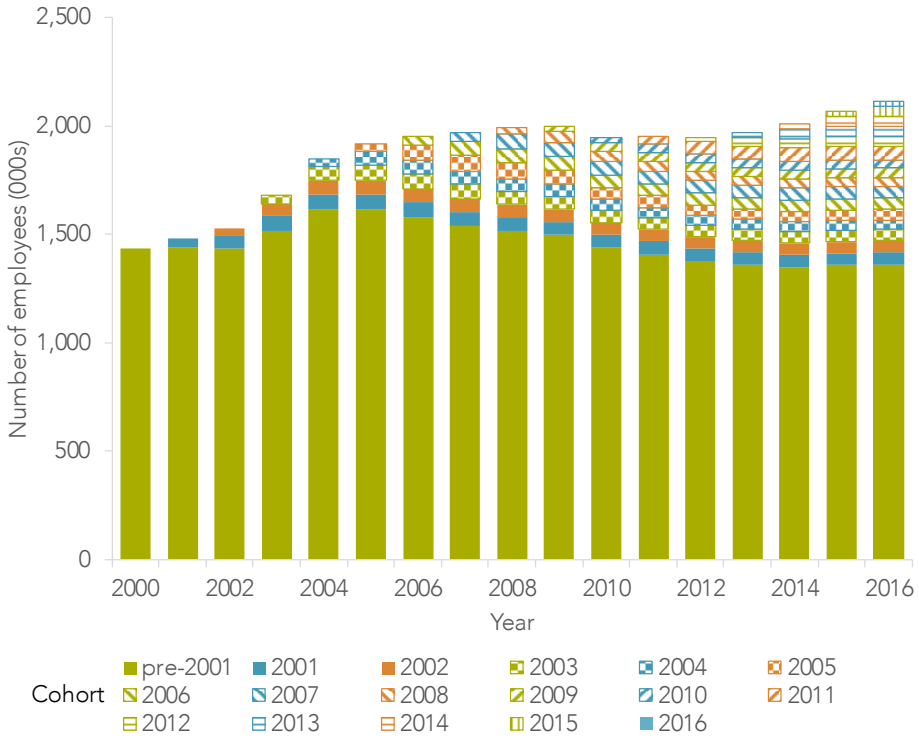
[2] One commonly-used definition of high-growth firms is firms with at least 10 employees in the start year and annualised employment growth exceeding 20% during a three-year period (Eurostat-OECD, 2007).

Figure 1 Firm and employee counts by cohort

A. Firm count



B. Employee count



3 Stylised facts and theory

Empirical analyses of firm dynamics, from around the OECD, typically find that[3]:

- most firms are small, including new firms (Bartlesman et al, 2005);
- most firms die young with, e.g. half of all firms "dying" in the first 5 years of life (Anyadike-Danes & Hart, 2018);
- small firms die younger (Evans, 1987) and grow faster than larger firms (Hall, 1987);
- most jobs are created by young firms (Criscuolo et al, 2014);
- a significant majority of firm growth, measured by changes in numbers of employees, can be attributed to a very small proportion of firms (Anyadike-Danes et al, 2014); and
- the size distribution of firms is right skewed – a consequence of the other stylised facts (Cabral & Mata, 2003).

The size distribution of firms have been studied extensively for decades, but it is only in the last decade or so that analyses of firm dynamics using micro-economic data has been able to flesh out the stylised facts listed above.

Prior to that, researchers relied heavily on cross-sectional analyses that revealed stylised laws about the size distribution of firms – such as Gibrat's (1931) famous observation that firm growth is independent of firm size – but did not shed light on the underlying processes that created these distributions.

Although empirical studies consistently find the same stylised facts about firm behaviour, theory about the fundamental drivers of these dynamics is not so concordant. There are many theories – some partially competing – on what drives the firm dynamics that we observe in the data.

The fact that firms seem to fail at high rates, could be down to firm owners failing to understand their own capabilities and failing to match these abilities to the market (Jovanovic, 1982). Over time, firms can learn more about their capabilities (or relative efficiency) and about the market or industry they compete in. This learning increases their likelihood of growth or survival. Firms that discover they are inefficient, will exit.

Theories that involve firms learning about their own capabilities and the demands of the market can also explain why young firms grow more quickly than older firms. If, early in their life, owners of firms know little about their likelihood of success or about the resources they need to acquire to be successful, they will benefit from learning (as long as they do not fail) and are less likely to fail as their firm ages and they accumulate experience. But, after a time, the rate at which their knowledge improves reduces and as a consequence growth rates decline.

Rossi-Hansberg and Wright (2007) developed a theory that can explain why small firms grow faster than large firms. Firms need to acquire industry-specific human-capital, through learning-by-doing. If there are diminishing returns to human capital, small firms will provide higher returns and will grow faster, as long as they do not fail. This theory can explain differences in firm size distributions across different industries. Industries that rely on industry-specific physical capital provide lower returns to industry-specific human capital and consequently have a greater number of larger firms with higher growth rates.

The number and size of firms in an industry is also likely to depend on the life-cycle of an industry and industry-specific technologies. For example, industries that are relatively new and offer considerable scope for innovation, have: (i) high returns, (ii) large numbers of smaller firms, (iii) high growth rates and

[3] References provided typically confirm all of these stylised facts. Here the references are provided alongside facts that are emphasised by each of these studies. Other studies find similar stylised facts. See, for example, Haltiwanger et al (2012).

(iv) high failure rates. As the industry matures, innovation becomes more difficult and returns decline and the industry consolidates with a smaller number of larger firms (Jovanovic & MacDonald, 1994).

So different theories (and the above are just a sample) provide insights into different phenomena that relate to firm dynamics. They do not coalesce on a single grand theory. Instead, they all provide useful insights into and justifications for empirical observations regarding the birth, death and growth of firms.

4 Revisiting the 2001 cohort

The literature suggests that analysing a cohort of firms, over a decade since it was born, would show significantly less dynamism and lower growth rates compared to analysis of growth during the early years of firms' lives. This is precisely what we find when we analyse rates of growth for the 2001 cohort of firms in New Zealand between 2011 and 2016.

Data sources and definitions

Data sources and definitions used in this analysis are the same as in Meehan & Zheng (2015), with a few exceptions that are noted in this report.

Data on firm births and deaths are taken from the Longitudinal Business Database (LBD). The population of interest is economically active firms operating in the private sector. Data is firm level rather than plant-level. Changes in firms' legal status, which can confound analysis of firms over time, has been addressed using "permanent" enterprise identifiers that are based on Fabling (2011).

An entering firm, or firm birth, is a firm that has administrative data in year *t* but not in year *t-1*. It is possible that some entering firms identified in this way are short-lived firms that enter at time t and exit again in the same year.

Firms are assumed to have exited if they have zero sales or zero employees in all future periods, for which we have data.

Meehan and Zheng also distinguish between permanent and temporary firm exits. A firm that has zero employment or sales in a given period but positive employees or sales in some future period is a temporary exit or "inactivity" rather than exit.

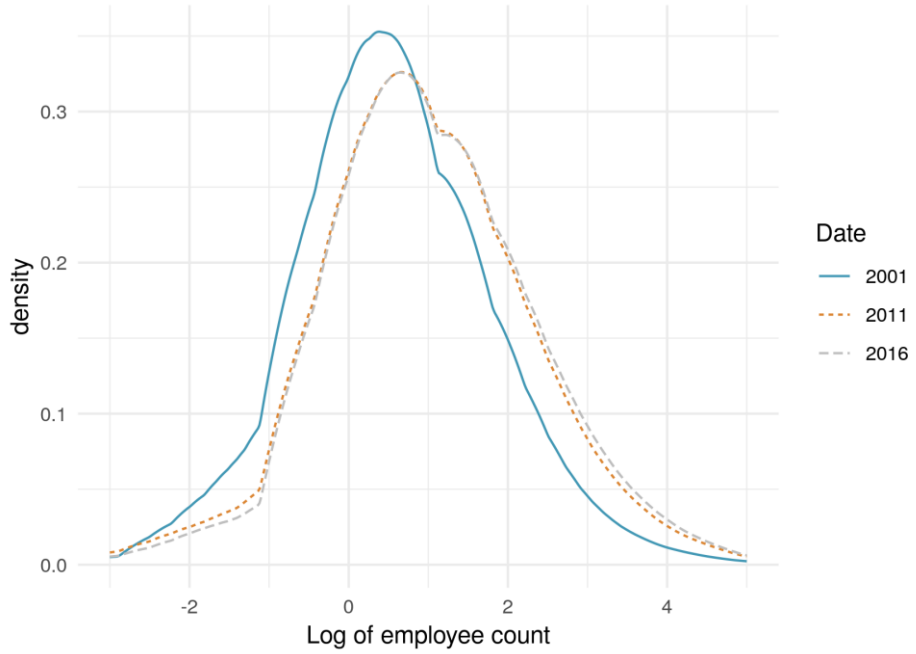
Firm size and growth rates are measured using firm employment: Firm employment is measured using rolling-mean-employee (RME) counts from the Linked Employer-Employee dataset (LEED), which is derived from IRD's Employer's Monthly Schedule tax form. The RME count is a 12-month average of employee counts for the year ending March. This employment measure simply uses employee head counts, with no distinction between full-time and part-time employment. Non-employing firms (i.e. working proprietor) firms are included in the analysis, but working proprietors are not included in the employment counts.

Firm activity is not adjusted for part-years. If, for example, a firm is born in July with 1 employee the data will present the firm as being born with half an employee. Future research could usefully address this aggregation problem by analysing firm dynamics by age measured in months rather than calendar years.

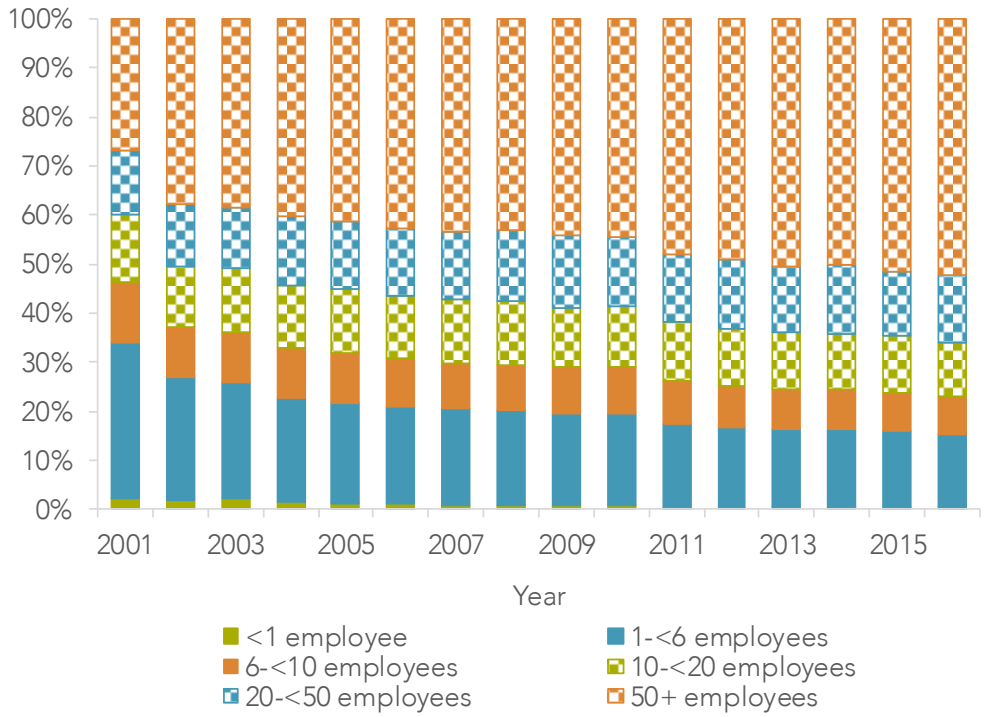
The biggest changes in the firm size distribution occur early in the life of a cohort of firms. This can be seen in Figure 2 which charts the distribution of employee numbers for the 2001 cohort in its birth year and again in 2011 and 2016.

The significant change in firm size distribution between 2001 and 2011 – with the entire distribution shifting out to the right – was an effect that occurred very early in the life of the cohort. The change in the distribution between 2011 and 2016 is more representative of how the distribution of firm sizes evolves over time, with comparatively minor contractions in the number of small firms and comparatively minor expansions of the number of larger firms.

Figure 2 Firm size distribution for the 2001 cohort in 2001, 2011 and 2016[4]



In the first two years of life there is significant growth in the number of employees in firms that are born small – with less than 1 employee initially (see



B. Employment share

[4] Firms with no employees have been removed from the data, for this example, before transforming the data using natural logarithms. The bandwidth used to construct these kernel densities has been chosen to produce a relatively smooth distribution to assist with visual inspection of changes in the distribution. Default parameters for density estimation in statistical software would usually produce smaller bandwidths and less smooth densities for this data.

Figure 16 in the Chart and data Appendix). This is as much a matter of arithmetic as it is a meaningful dynamic. When small firms grow they cannot help but grow by large amounts, in terms of percentage changes.

As shown in Meehan and Zheng (2015), the first year or two of establishment is also associated with acquiring capital. Capital stocks per employee jump significantly after the first year of activity.

At the same time, a substantial number (20%) of very small firms are inactive one year after birth. Figure 3 shows the share of firms that are active in each year, defined by a firm having non-zero rolling mean annual employee count or non-zero sales in that year.[5]

Taken together, high mortality rates and high growth rates create significant changes in the distribution of firm sizes early in the life of the cohort.

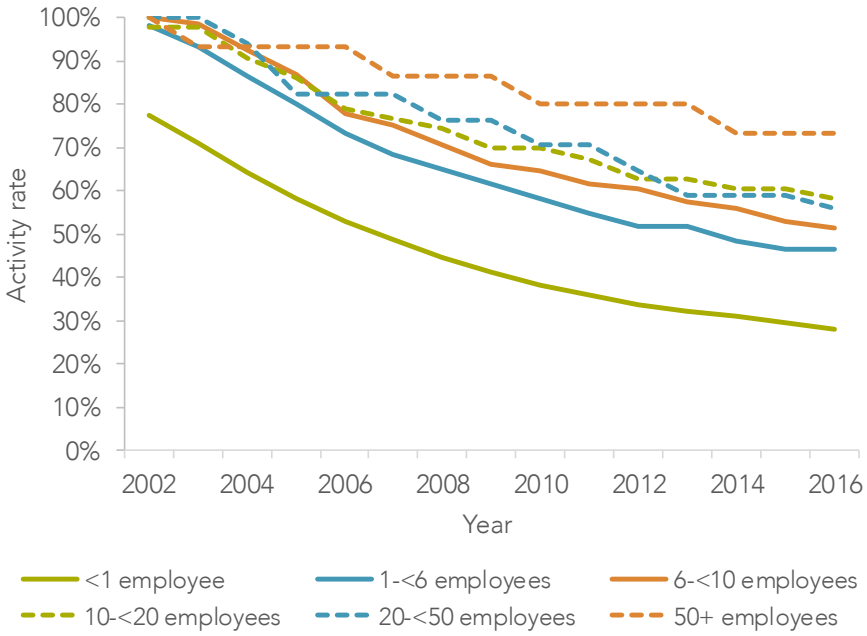
Very small firms – with less than 1 employee – make up a significant proportion of the number of firms (85% in 2001 – see Figure 15 in the Chart and data Appendix). As such, they can significantly affect measurements of firm dynamics even though their shares of employment are very small (less than 3% in 2001).[6]

[5] This is the definition used in Meehan and Zheng (2015) for calculating firm survival rates. Here, this definition is referred to as 'activity rates'. This note differs in the definition of survival with survival rates defined by the firm never again being active – within the data available for this analysis. Classifying temporarily inactive firms as having exited is troublesome because survival rates can increase – if enough firms return to activity. This is counterintuitive. The definition of survival used here is more intuitive, but suffers from bias due to the limited sample length – a bias that is increasing later in more recent years.

[6] These numbers differ from those in Meehan and Zheng (2015). The data used here has approximately 4,700 (10%) more firms in it than were in the previous analysis. This does affect comparability of some data points but turns out not to affect the qualitative conclusions.

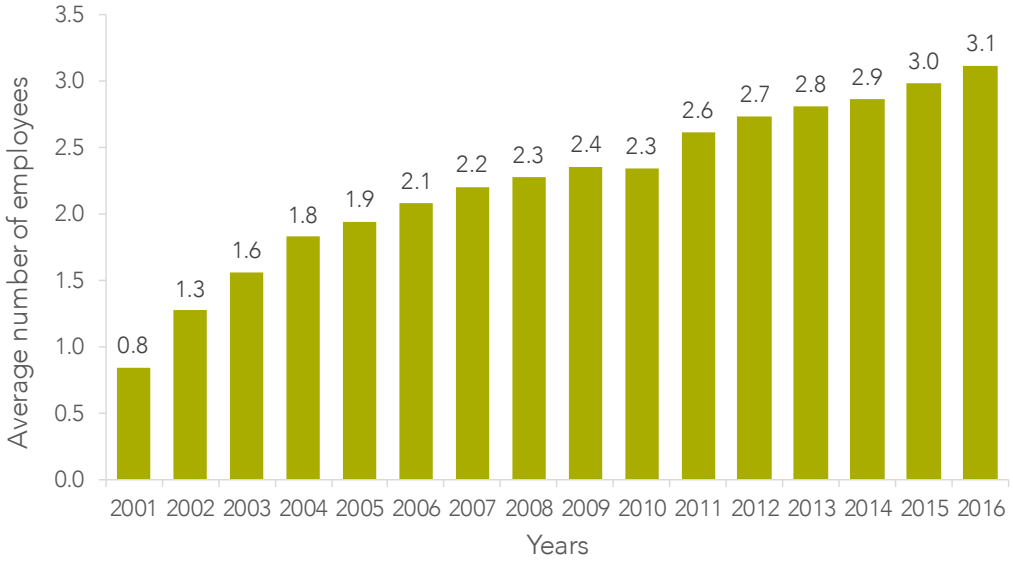
Figure 3 Activity rates by birth size, 2001 cohort

Share of firms active in the current year, by birth size



Firms in the 2001 cohort have continued to grow reasonably quickly, on average, between 2011 and 2016 (despite the impression given by Figure 2, where the use of natural logarithms means that significant changes are emphasised and more modest changes are harder to perceive). As shown in Figure 4, average number of employees per firm grew from 2.6 to 3.1 between 2011 and 2016 – an average growth rate of 3.6% per year.

Figure 4 Average firm size for the 2001 cohort, 2001-2016



The 2001 cohort exhibits substantial variation in the longevity and growth of firms born small. Firms that are born very small (with less than 1 employee) have the lowest survival rates by a considerable margin – only 32% of such firms survive to age 10 (in 2011) and 27% survive to age 14 (see Table 1). This compares to survival rates that are approximately 20 percentage points higher than for firms in the next birth size group, with at least 1 but less than 6 employees at birth.

Survival rates shown here are the proportion of firms in a cohort that are still alive (still active) at a given date (e.g. a 33% survival rate indicates that 2 out of 3 firms in a cohort are no longer active).

The probability of surviving one more year, for firms born very small, is also comparatively low (hazard rates of 32% in 2011 and 26% in 2015).[7] This means that low survival rates are not simply a matter of many very small firms exiting early in their life cycle. Rather, firms that are born very small tend to have higher rates of mortality throughout their lifecycle. This also suggests there is something peculiar about the nature of firms that are born very small.

It may be that firms born very small are firms that are primarily working-proprietor firms, with owners that do not aspire to, or do not have the capacity to, hire staff and to grow.[8] Or this group of firms may include a substantial number of first-time entrepreneurs who attempt to grow but tend to fail at a higher rate than other firms. In the latter case, high fail rates by small firms may include a substantial amount of learning. Future research is needed to analyse such dynamics and to assess the effectiveness of this kind of learning-by-doing.

Such research could also analyse the extent to which owners of very small firms, that exit, subsequently become owners of businesses that are larger at birth. One hypothesis is differences in survival rates by firm size reflects learning that effects the growth or success of larger firms (rather than simply size at birth).

Note that the survival rates in Table 1 are shown for the year 2015, rather than 2016. This is because the calculation of hazard rates requires knowledge of survival beyond the current year. The LBD is currently limited to observations up to the year ended December 2016. So, with a single cohort, survival for firms beyond 2016 cannot be estimated.

Table 1 Firm size transitions and survival

Number of continuing firms, by number of employees, in 2011 and 2015.[9]

Year	Birth size	Firm size (employees)					Total	Survival rate	Hazard rate[10]	Born[11]
		<1	1-<6	6-<10	10-<20	20+				
2001 cohort in 2011	<1	10,236	2,340	255	126	90	13,047	32%	32%	41,085
	1-<6	780	1,779	279	192	78	3,108	52%	9%	5,982
	6-<10	45	102	120	78	54	399	59%	6%	678
	10-<20	12	27	54	111	69	273	64%	6%	426
	20+	6	12	3	15	129	165	65%	8%	252
2001 cohort in 2015	<1	8,484	1,944	210	141	96	10,875	26%	29%	41,085
	1-<6	648	1,596	222	165	84	2,715	45%	8%	5,982
	6-<10	45	87	108	57	45	342	50%	7%	678
	10-<20	9	27	54	102	54	246	58%	6%	426
	20+	6	9	6	18	111	150	60%	2%	252

Even as very small firms exit at much higher rates than all other firms, there are a small number of firms that grow significantly. In 2011, 90 firms had grown to have 20 or more employees from less than 1 employee in 2001. Furthermore, this cohort of very small firms continued to grow, with an additional 6 firms entering the size group of 20 or more employees between 2011 and 2015. This indicates that growth of very small firms can be persistent and is not solely a feature of early stage growth.

In the 2001 cohort, for firms born with one or more employees, hazard rates do not vary much in relation to birth size. The range of hazard rates is generally between 6% and 9%. One minor exception to this observation is for firms born with 20 or more employees, where hazard rates were only 2% in

[7] Hazard rates are the difference between survival rates in the current year and survival rates in the next year, as a proportion of survival rates in the current year.
[8] Fabling (2018) suggests a substantial proportion of firms are working-proprietor firms. The number of these firms increases during periods of negative labour market conditions. So, some individuals choose to be working proprietors out of necessity and therefore may not be intending to grow their businesses but rather re-enter an employment relationship when conditions allow.
[9] This data is restricted to firms that are still active in the next year, so that firms that exit in 2011 or 2015 have been excluded from the counts in the table.
[10] See definition in footnote 6.
[11] Number of firms born in 2001.

2015 compared to hazard rates of 6%-8% for other firms born with one or more employees. This observation should not be overemphasised, as the number of firms involved is relatively small (150 firms) so modest changes in the number of surviving firms can have large effects on observed hazard rates.[12]

Table 1 shows that a number of firms decline in size quite gradually. In 2011, at age 10, only 51% of firms born with 20 or more employees still had 20 or more employees while 14% of these firms were still operating but were smaller than they were at birth. In 2015, 15% of the 2001 cohort, born with 20 more employees, had employment levels that were lower than in 2001. More broadly, amongst firms born with 6 employees or more, 20% had fewer employees in 2015 than in 2001.

Of the jobs created between 2001 and 2016, by the 2001 cohort, almost half (45%) were created by small firms that grew from less than 1 employee in 2001 to 20 or more employees in 2016 (see Table 2). This mirrors the results of Meehan and Zheng's (2015) analysis for job creation between 2001 and 2011 (see Table 6 in the Chart and data appendix for updated results for 2011).[13]

In contrast, job destruction is concentrated amongst both small firms with at least 1 but less than 6 employees and large firms of 20 or more employees in 2001. In 2016 these groups accounted for 29% and 47% of jobs destroyed, respectively.

In a departure from Meehan and Zheng, the revised firm data for this study indicates that firms of all birth sizes had positive job creation rates between 2001 and 2011.[14] The previous study found that firms with 20 or more employees in 2001 had negative net job creation rates, where[15]:

- creation rates are the sum of jobs created divided by the average of the number of employees in these firms in the base year (or birth year) and the number of employees in these firms in the year at the end of the evaluation period;
- destruction rates are the sum of jobs destroyed divided by the average of the number of employees in these firms in the base year (or birth year) and the number of employees in these firms in the year at the end of the evaluation period; and
- net job creation rates are the difference between creation rates and destruction rates.

During the 5 years between 2011 and 2016 firms that were born small were also the ones to contribute the most to net job creation. As shown in Table 3, firms that began with less than one employee and grew to 20 or more employees by 2016, created an additional net 1,900 jobs between 2011 and 2016.

In contrast, the largest source of net job destruction was firms born with 10 to 19 employees in 2001 and who had grown to have 20 or more employees in 2011, but then shed workers by 2016. Amongst these firms a net 1,400 jobs were destroyed between 2011 and 2016.

[12] High survival rates (low hazard rates) for larger firms raises questions about whether these firms take "too long" to exit the market. If a large firm's performance is lagging but the firm remains rather than exit the market, this could mean efficient resource reallocation is restricted, potentially impeding productivity growth. This analysis, being descriptive, cannot pronounce on whether firms are too slow to exit the market. It can observe that firms that are born large, with 20 or more employees, are less likely to exit (die) than other firms even as they decline in size (with negative growth in numbers of employees).
[13] As in Meehan and Zheng (2015, p17) "…job creation (destruction) is the number of jobs the 2001 cohort of firm creates (destroys) through firm expansion (contraction) between 2001 and 2011" or between 2001 and 2016.
[14] This feature also holds for the extended sample from 2001 to 2016 (see Figure 18 in the Chart and data appendix).
[15] For an algebraic representation of the calculation of these rates see Meehan and Zheng (2015) p.17.

Table 2 Job creation and destruction between 2001 and 2016

A. Creation 2016

Year	Firm size (no. of employees)	<1	1-<6	6-<10	10-<20	20+	Total
2001	<1	190	4,000	1,700	1,800	10,600	18,290
	1-<6	0	920	1,000	1,700	4,600	8,220
	6-<10	0	0	45	330	1,700	2,075
	10-<20	0	0	0	90	3,200	3,290
	20+	0	0	0	0	8,500	8,500
	Total	190	4,920	2,745	3,920	28,600	40,375

B. Destruction 2016

Year	Firm size (no. of employees)	<1	1-<6	6-<10	10-<20	20+	Total
2001	<1	140	0	0	0	0	140
	1-<6	1,700	570	0	0	0	2,270
	6-<10	370	340	45	0	0	755
	10-<20	260	260	260	130	0	910
	20+	360	450	340	330	2,200	3,680
	Total	2,830	1,620	645	460	2,200	7,755

C. Net job creation 2016

Year	Firm size (no. of employees)	<1	1-<6	6-<10	10-<20	20+	Total
2001	<1	50	4,000	1,700	1,800	10,600	18,150
	1-<6	-1,700	350	1,000	1,700	4,600	5,950
	6-<10	-370	-340	0	330	1,700	1,320
	10-<20	-260	-260	-260	-40	3,200	2,380
	20+	-360	-450	-340	-330	6,300	4,820
	Total	-2,640	3,300	2,100	3,460	26,400	32,620

Table 3 Net job creation, between 2011 and 2016

Year	Firm size (no. of employees)	2016					Total
		<1	1-<6	6-<10	10-<20	20+	
2001	<1	-40	-1,200	-200	0	1,900	460
	1-<6	300	-260	-400	-400	1,000	240
	6-<10	90	70	-20	-170	-300	-330
	10-<20	100	40	10	-60	-1,400	-1,310
	20+	510	220	-200	-90	-300	140
	Total	960	-1,130	-810	-720	900	-800

5 Variations across cohorts

Comparisons of survival rates and job creation across cohorts show conclusions about firm dynamics should not be generalised from a single cohort of firms.

Analysis of the 2001 cohort suggested that firms that are larger at birth have higher survival rates than firms that are smaller at birth. This relationship appeared to be persistent across all firm sizes (monotonic). However, replicating the analysis for other birth years shows that in some years the largest firms are not the ones with highest survival rates (see Figure 5).

For firms born in 2004, the firms that started with 10 to 20 employees have the highest survival rates. But for firms born in 2006, those that started with 20 to 50 employees have the same or higher survival rates than firms with 50 or more employees.

These observations are likely to be influenced by the fact that few firms are born with 50 or more employees (~0.1%). As a result, measurements of the survival rates of large firms will be sensitive to the failure of a small numbers of firms.

A stronger result from comparing growth rates across cohorts is that differences in survival rates, across birth sizes, appear to have narrowed over the time period being analysed. Differences in survival rates, across different birth sizes, were much wider in the 2001 and 2002 cohorts than in the 2004, 2005 and 2006 cohorts. The 2001 and 2002 cohorts show clear differences in survival rates between firms born very small (less than 1 employee) and other firms born small, with less than 10 employees. For later cohorts the survival rates of these smaller firms are almost indistinguishable from each other.

In terms of job creation, the smallest firms in the cohort, at birth, create the most jobs. This effect can be split into a small number of jobs being created by a large number of firms and large numbers of jobs being created by a small number of firms. This is shown in Figure 6 where job creation by firms born with less than 1 employee are large for those that grow to have 1-6 employees and those that grow to have 20 or more employees.

Firms that start out very small are often, but not always, the ones that go on to create the most jobs amongst firms that reach larger sizes. This can be seen in Figure 6 where firms that started with less than one employee went on to contribute the largest increases in employment (creation less destruction) amongst firms with 20+ employees in the 2001, 2002 and 2003 cohorts. In 2004, firms that started with 20+ employees were the ones that created the most jobs. For the 2006 cohort, it was firms that started with 1-6 employees that contributed the most to increased employment.

Figure 5 Survival rates by birth year and size at birth

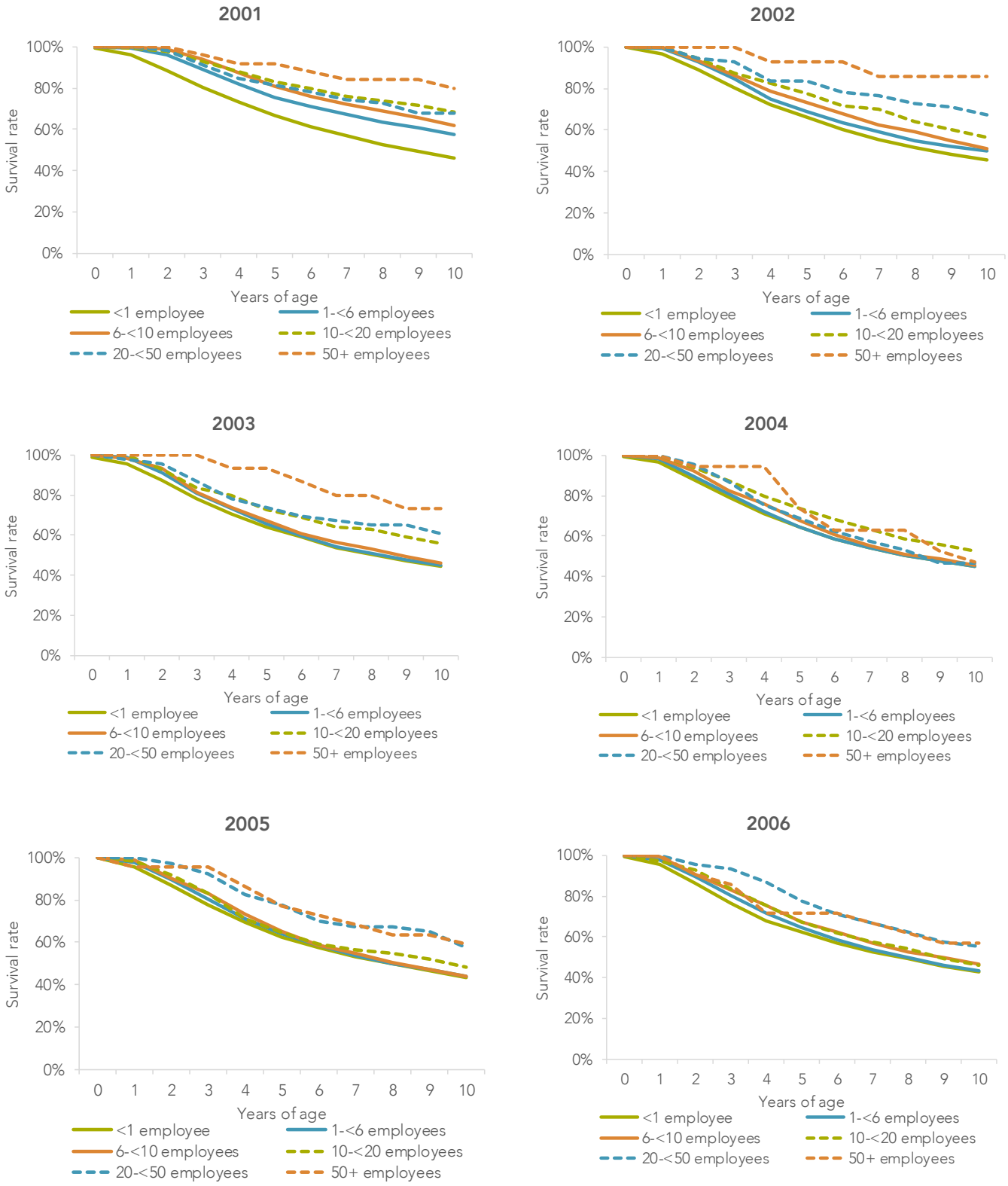
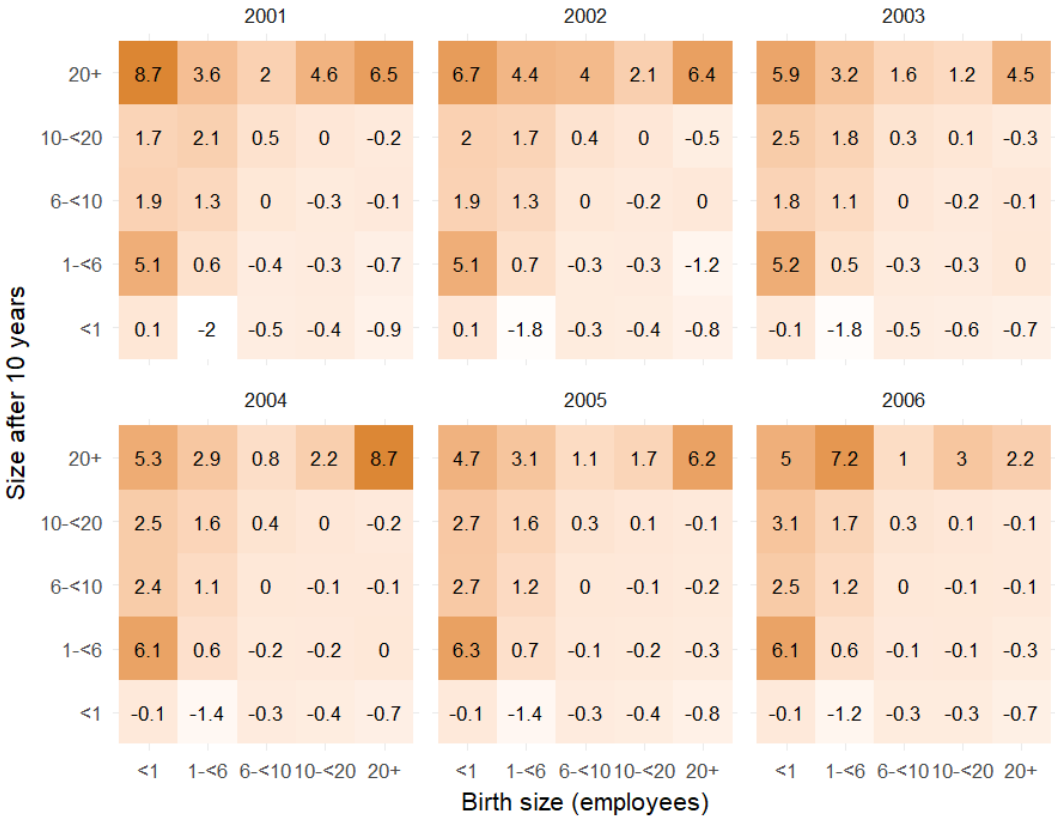


Figure 6 Net job creation by birth year and size

Cell values are net thousands of jobs created 10 years after birth[16]



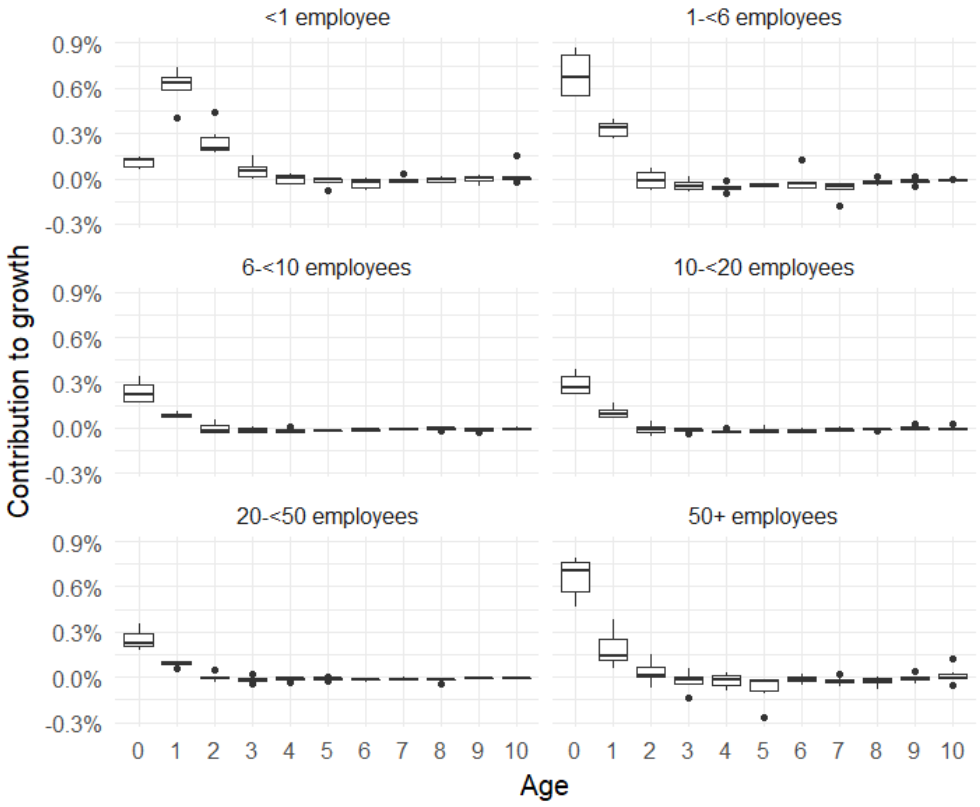
For all firms, contributions to national employment growth are dominated by birth effects and early stage growth. That is, firms have their largest effects on overall growth early in their life cycle.[17] This can be seen in Figure 7, which charts contributions to national growth in employee counts by firm year of age and birth size. For each age, the Figure plots the range of contributions of the different cohorts (2001-2006), using 'box plots', to summarise the distribution of these contributions to growth. Each of the firm size groupings have their largest effects on overall growth in national employee counts during the first 2 or 3 years of life. Very small firms make their largest contributions during the second and third years of life. For other firms, their effects on growth are largest in the first and second years of life.

The effects shown in Figure 7 are significant relative to typical annual growth in employee counts. From 2001 to 2016, employee growth averaged 2.5% per year nationally. Firms starting with less than one employee contributed around a quarter of this growth, in their second year of existence. Firms that began with 1-6 employees and 50 or more employees each contributed around a quarter of this growth in their first year of life. All told, new firms contributed an average of 2.2% of the average 2.5% increase on employees in private firms – based on contributions to growth in the first year of life. This suggests creation of new firms is a crucially important engine of growth and more important to job creation overall than growth of firms as they age.[18] This result has been observed in studies of firm dynamics in the United States (Haltiwanger et al. 2012) and United Kingdom (Anyadike-Danes & Hart, M., 2018).

[16] Note that values have been suppressed, for confidentiality reasons, for firms born in 2003 and 2004 with 20+ employees that have 1 to 6 or 6 to 10 employees 10 years later. The Figure presents these as zeros because suppressed values create jarring changes in colour hues that hinder interpretation of the Figure.
[17] At least when growth is measured according to changes in national rolling mean employee counts in the private sector.
[18] This result was also suggested in prior studies for New Zealand, and it has been noted that this result depends on regulation with firm births and deaths a much less important driver of business and employment growth in New Zealand prior to substantial deregulation of the economy in the 1980s (Malcolm, 1993).

Figure 7 Contributions to employment growth by age and birth size

Cohorts born in 2001 to 2006[19]



[19] The box plots, for each age, include a horizontal line indicating the median contribution, boxes showing the inter-quartile range (IQR), a line or "whisker" showing values that are 50% larger (smaller) than the upper (lower) quartile (as long as the maximum (minimum) values are 50% larger (smaller) than the upper (lower) quartiles), and dots that are outliers (values that are more than 50% larger (smaller) than the top (bottom) of the IQR).

6 The digital sector displays different firm dynamics

Firm dynamics differ across industries for numerous reasons, such as industry maturity, the characteristics of output markets that they operate in, and the input markets upon which they rely. Differences are also likely to reflect differences in production technologies and the rate of change in these technologies. For example, industries with low capital intensity or high rates of innovation, whether technological or organisational, might be expected to exhibit higher rates of growth and higher rates of firm failure.

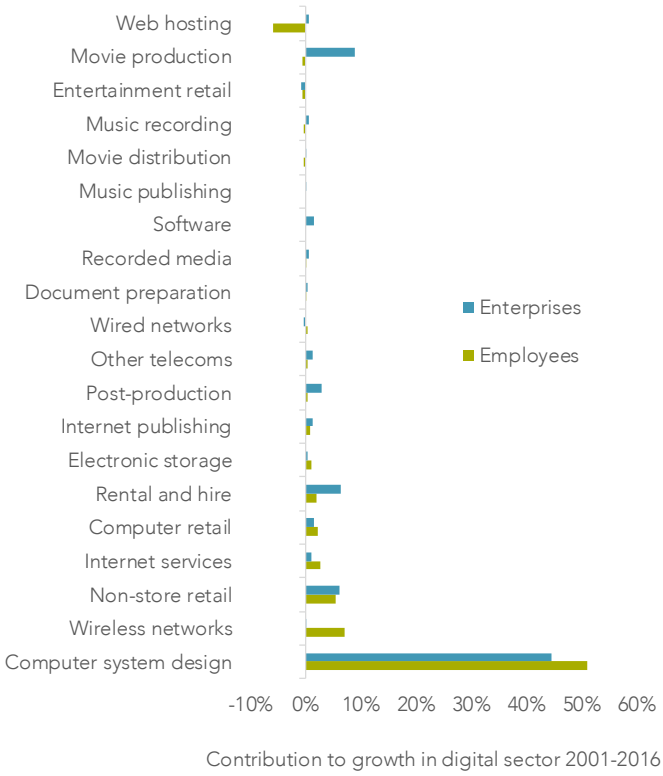
Growth in the digital economy provides a case study for exploring differences in industry growth rates and firm dynamics. In recent years, policy makers and researchers have been paying increasing attention to the intensity of data use and digital technology by firms and consumers and the increasing importance of data and digital technologies in production and productivity growth. Yet measuring the impact of digital diffusion has proven difficult. Statistical classification codes such as ISIC and ANZSIC delineate industries based on the goods and services produced – such as ICT services – but the classification will not tell you about the use of digital technologies as an input into production; the classification system is not designed for this.

This paper takes a very simple approach, splitting the ANZSIC industry classification into a "digital sector" – those firms in industries that produce digital and communications technologies or support their use by other firms and consumers, or produce and sell digital content and media – with a comparator group of industries.[20] A list of industries in the digital sector and the comparator is set out in Table 7 in the chart and data appendix.[21] Although these industries include a wide range of different types of businesses, the digital sector has been dominated by the computer system design industry (see Figure 8), in terms of growth and share of employment. The next largest growth area is in the wired and wireless telecommunications network industries, which collectively have about one-third of the employees of the computer system design industry.

Firms that are associated with public and social services and agriculture and forestry were excluded from the comparator group as they are likely to have very different life cycle dynamics. Forestry and agriculture are industries with long-lived capital (e.g. land) and slow production cycles. Firms in these industries would be expected to have different dynamics than those with shorter production cycles and more fungible assets. Public services – such as schools, tertiary institutions and hospitals – are effectively "immortal" (Dunleavy & Carrera, 2013).

[20] To define the digital sector this paper followed the approach of the Office for National Statistics (2015) in the United Kingdom but tailored to better reflect the New Zealand business environment.
[21] OECD (2018) presents a framework for classifying digital activity based on supply and use of products. This framework is not yet complete but promises a much improved method for defining the "digital sector".

Figure 8 Computer system design dominates digital sector growth[22]



Data on dynamics of these New Zealand "digital" firms suggests dynamics that differ from firms in the comparator group of industries. These differences are not profound, in the sense that patterns of firm entry, growth and death are like other industries. But "digital" firms tend to be smaller, were more likely to die young, and surviving firms grew faster than firms in the comparator group. Employment in the digital sector grew by 3.9% per year, on average, between 2000 and 2018. This is more than twice the growth rate of industries in the comparator group (see Figure 8). In 2000 the digital sector comprised 1.9% of employment and by 2018 this share had grown to 2.8%.[23] Firms in the digital sector tend to be born smaller and have higher death rates than other firms, in comparator industries.[24] An example, for firms born in 2001, is provided in

Year	Birth size	Current firm size (employees)					Total	Survival rate	Hazard rate	Born
		<1	1-<6	6-<10	10-<20	20+				
2001	<1	573	126	9	15	6	729	26%	36%	2,766
	1-<6	33	54	15	6	6	114	43%	16%	264
	6-<10	--	--	6	--	3	9	50%	0%	18
	10-<20	--	--	--	--	--	--	--	--	18
	20+	--	--	--	--	--	--	--	--	6
2015	<1	519	81	9	9	9	627	23%	25%	2,766
	1-<6	24	51	9	3	6	93	35%	11%	264
	6-<10	--	--	6	--	3	9	50%	0%	18
	10-<20	--	--	--	--	--	--	--	--	18
	20+	--	--	--	--	--	--	--	--	6

Table 5 and Table 6.

[22] Industry names in this chart are abbreviated. See Table 7 in the chart and data appendix for a detailed list of industry names and ANZSIC06 codes.
[23] Based on counts of employees.
[24] See Table 8 in the chart and data appendix for details of distributions of births by size group, cohort and industry.

Figure 9 Industries in the digital sector have grown faster than other industries

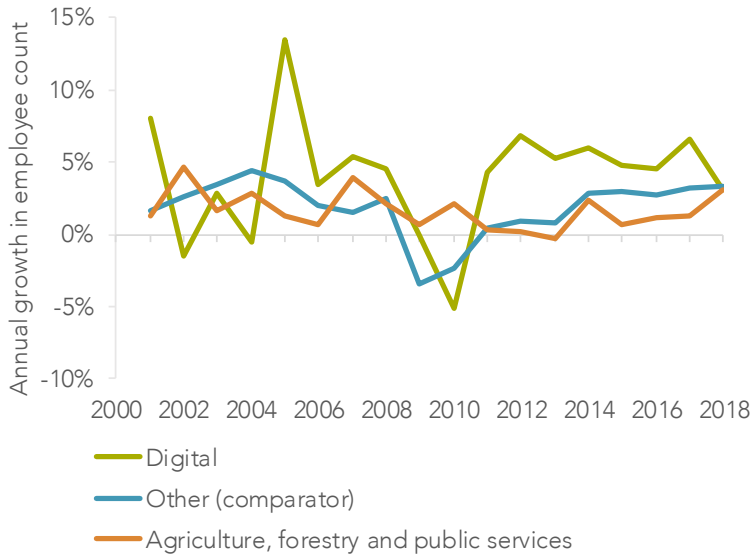


Table 4 "Digital" firms size transitions and survival, 2001 Cohort of firms

Number of continuing firms, by number of employees, in 2011 and 2015. Suppressed data = --.[25]

Year	Birth size	Current firm size (employees)					Total	Survival rate	Hazard rate	Born
		<1	1-<6	6-<10	10-<20	20+				
2001	<1	573	126	9	15	6	729	26%	36%	2,766
	1-<6	33	54	15	6	6	114	43%	16%	264
	6-<10	--	--	6	--	3	9	50%	0%	18
	10-<20	--	--	--	--	--	--	--	--	18
	20+	--	--	--	--	--	--	--	--	6
2015	<1	519	81	9	9	9	627	23%	25%	2,766
	1-<6	24	51	9	3	6	93	35%	11%	264
	6-<10	--	--	6	--	3	9	50%	0%	18
	10-<20	--	--	--	--	--	--	--	--	18
	20+	--	--	--	--	--	--	--	--	6

Table 5 Comparator firms size transitions and survival, 2001 cohort of firms

Number of continuing firms, by number of employees, in 2011 and 2015. Suppressed data = --.

Year	Birth size	Current firm size (employees)					Total	Survival rate	Hazard rate	Born
		<1	1-<6	6-<10	10-<20	20+				
2011	<1	8,250	1,806	198	96	72	10,422	31%	33%	34,068
	1-<6	567	1,506	243	162	69	2,547	51%	9%	5,001
	6-<10	36	93	111	72	45	357	58%	4%	615
	10-<20	9	24	48	108	66	255	65%	7%	390
	20+	6	12	--	15	117	150	65%	9%	231
2015	<1	6,771	1,476	165	117	72	8,601	25%	27%	34,068
	1-<6	453	1,353	192	141	72	2,211	44%	5%	5,001
	6-<10	33	84	99	54	39	309	50%	2%	615
	10-<20	6	24	48	96	51	225	58%	4%	390
	20+	3	9	6	18	105	141	61%	0%	231

[25] Data suppressed for confidentiality.

Year	Birth size	Current firm size (employees)					Total	Survival rate	Hazard rate	Born
		<1	1-<6	6-<10	10-<20	20+				
2001	<1	573	126	9	15	6	729	26%	36%	2,766
	1-<6	33	54	15	6	6	114	43%	16%	264
	6-<10	--	--	6	--	3	9	50%	0%	18
	10-<20	--	--	--	--	--	--	--	--	18
	20+	--	--	--	--	--	--	--	--	6
2015	<1	519	81	9	9	9	627	23%	25%	2,766
	1-<6	24	51	9	3	6	93	35%	11%	264
	6-<10	--	--	6	--	3	9	50%	0%	18
	10-<20	--	--	--	--	--	--	--	--	18
	20+	--	--	--	--	--	--	--	--	6

Table 5 and Table 6 show that "digital" firms that are born very small (less than 1 employee, 90% of births) had 10 year survival rates (in 2011) that were 5 percentage points lower than for other firms born in the same size group (85% of births). For larger firms (born with between 1 and 10 employees), "digital" firms had 10 year survival rates that were 8 percentage points lower than for comparator firms. At larger birth sizes, there are insufficient numbers of firms to be able to make comparisons of death rates between "digital" and comparator firms.

Given that "digital" firms, in aggregate, have grown more rapidly than comparator firms, the existence of higher death rates (lower survival rates) for small "digital" firms suggests higher rates of creative destruction in the digital sector. This is consistent with theories linking firm dynamics to the maturity of an industry (mentioned in section 3) predicting that less mature industries or industries with rapid technological change, such as digital industries, should be characterised by: (i) high returns, (ii) large numbers of smaller firms, (iii) high growth rates and (iv) high failure rates.

The observation that "digital" firms have lower survival rates than comparator firms is generally persistent across firm sizes, for which there is data, and across different cohorts of firms. However there have been exceptions. "Digital" firms born in 2005 and 2006 with 1 to 6 employees had higher survival rates than comparator firms born in the same years and size group. This is shown in Figure 10, which charts the ratio of "digital" firm survival rates to survival rates of firms in comparator industries. Values less than 1 indicate that firms in the digital sector had lower survival rates than their counterparts in comparator industries. For "digital" firms born with less than 1 employee, survival rates are persistently lower than for comparator firms – across all cohorts. While for firms born with 1 to 6 employees, survival rates of "digital" firms are lower than for comparator firms between 2001 and 2004 but higher in 2005 and 2006.

Figure 10 Relative survival rates, "digital" relative to comparator firms

Changes in relative rates of survival, for firms with 1 to 6 employees, may reflect a differential effect of the global financial crisis on these firms relative to firms in comparator industries and relative to "digital" firms born into other size groups.

Indeed, "digital" firms experienced slightly smaller percentage increases in mortality, around the time of the financial crisis, than comparator firms. On average, the probability of firms dying within the next year (the hazard rate) increased by 16 percent in 2009 for "digital" firms and 19 percent for comparator firms.[26]

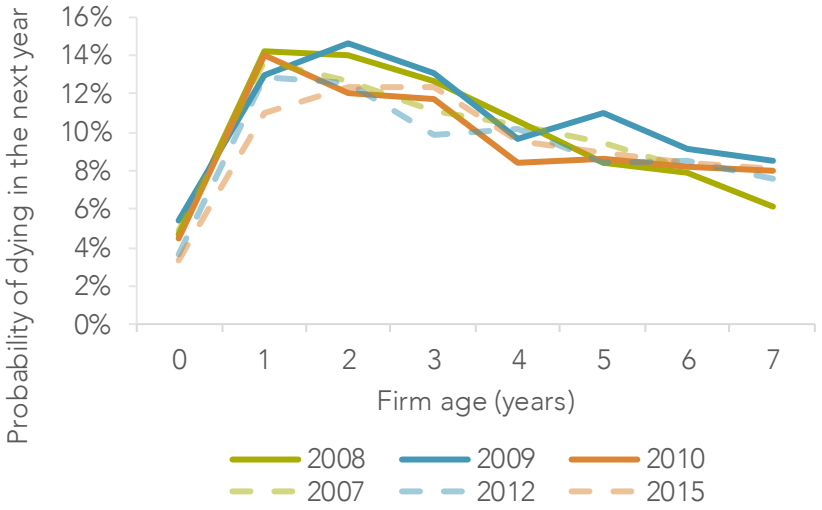
The financial crisis did, however, have a larger impact on "digital" firm death rates, in terms of percentage point increases, because "digital" firms have higher death rates. This is illustrated in

[26] Based on an ex-post analysis of hazard rates of firms in the first four years of life. The analysis is restricted to firms in the first four years of life because our data sample only distinguishes the birth year and age of firms born after the year 2000. Observed changes in hazard rates are based on mean hazard rates in 2008 relative to the mean hazard rate between 2001 and 2016 for newly born firms, 2002 and 2016 for 1 year old firms, 2003 and 2016 for 2 year old firms, and 2004 and 2016 for 3 year old firms.

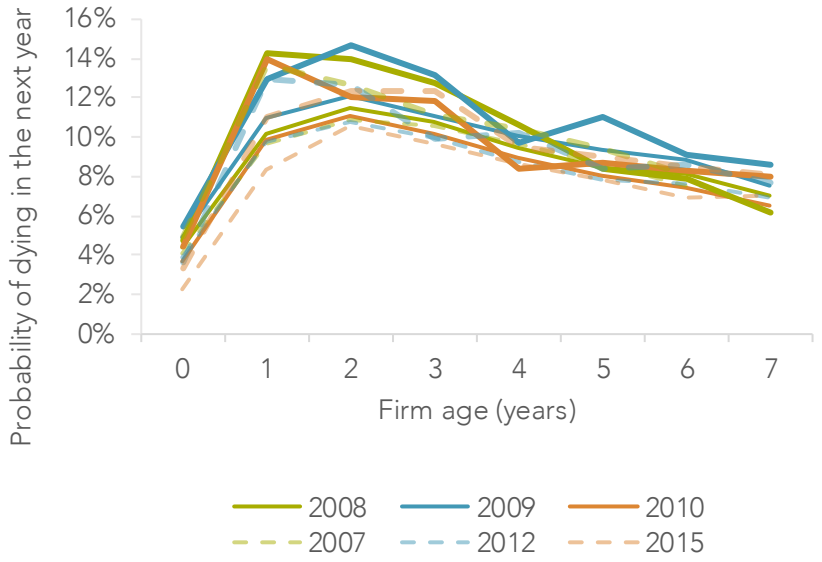
Figure 11, which charts hazard rates for "digital" and comparator firms by year and year of age. Hazard rates were highest in 2008 and 2009 and for firms of 1 and 2 years of age. Hazard rates for these young firms are around 2 percentage points higher for "digital" firms than for comparator firms, regardless of the year in which the hazard rates are observed. Although there is some reversion to the mean, with hazard rates at older ages being roughly the same for "digital" firms as for comparator firms.

Figure 11 "Digital" and comparator (other) firm hazard rates, by age and year

A. Digital

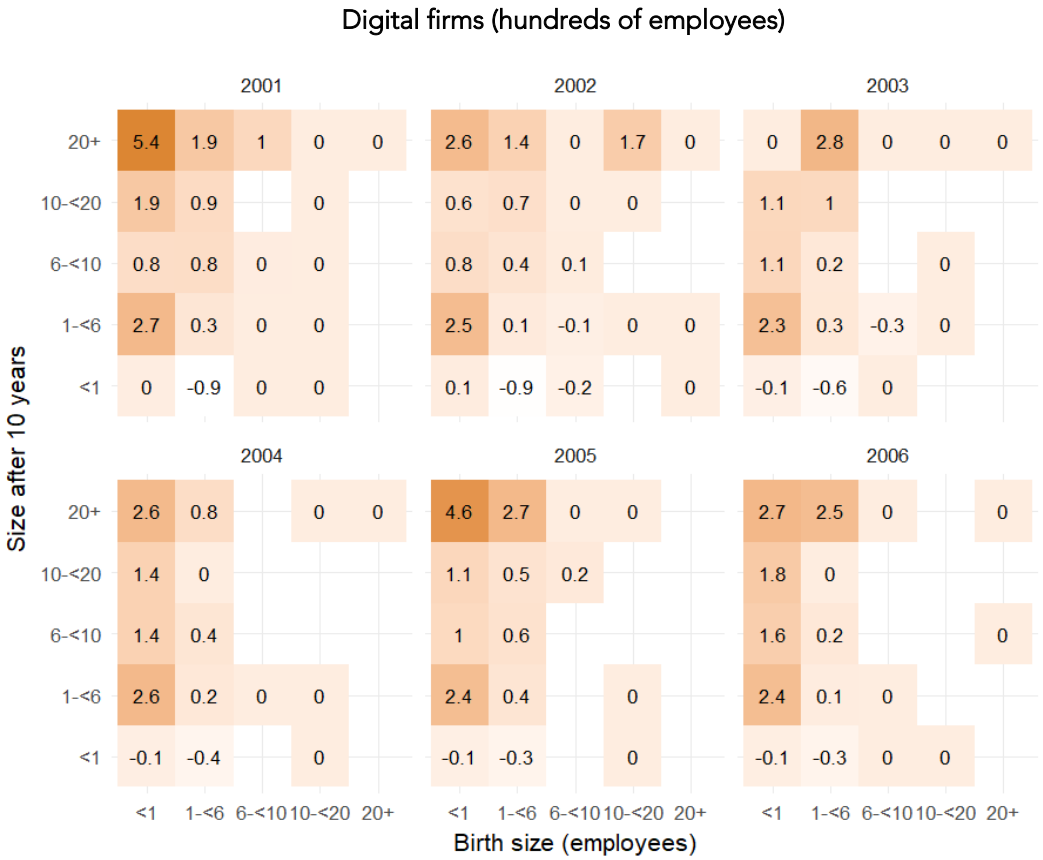


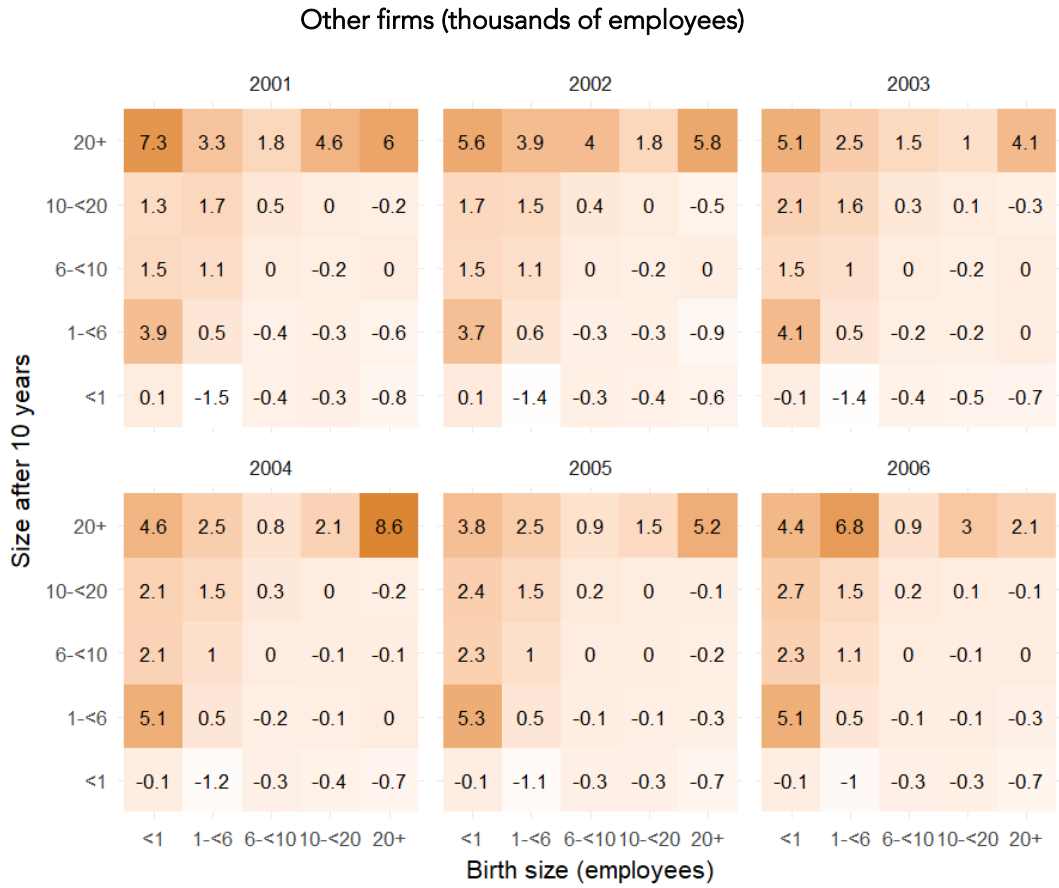
B. Other



In line with the relatively small birth sizes of "digital" firms, the majority of job creation and sales growth is concentrated in "digital" firms that are born small. As shown in Figure 12, job creation is concentrated in firms that are born with less than 1 employee but go on to grow to have more than 20 employees after 10 years. A substantial amount of job creation also occurs amongst numerous firms that grow relatively modestly, transitioning from less than one employee to between 1 and 6 employees over 10 years. This contrasts with firms in comparator industries where firms born with 20 or more employees are also significant contributors to job creation.

Figure 12 Net job creation by "digital" firms and comparator (other) firms, by birth size by cohort (year of birth)

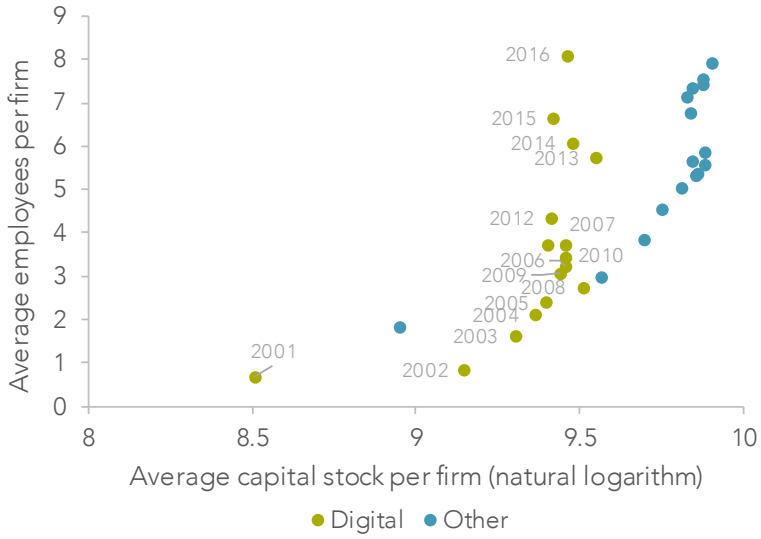




Differences in capital intensity may be a factor in the smaller scale of "digital" firms compared to other firms.[27] Lower firm- and industry-specific capital is likely to lower the costs of entry and exit into and out of an industry. Although some "digital" firms are capital intensive – such as communications network providers – most "digital" firms are less capital intensive than comparator (other) firms. This is illustrated in Figure 13, which charts average capital stock (in natural logarithms) against average employees per firm.

Figure 13 Digital firms have lower capital intensity

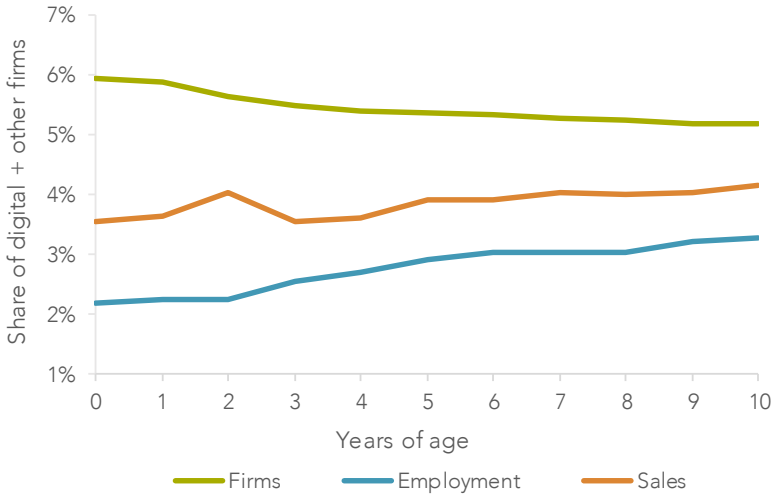
2001 cohort, average employees and average capital stock per firm



Both "digital" firms and comparator firms follow a similar pattern of development, with substantial capital investment occurring in the first 1-2 years of life and gradual but accelerating growth in number of employees (see Figure 13).[28] However, capital stocks of "digital" firms are substantially smaller than for comparator firms, even as firms age and grow. "Digital" firms have performed most strongly in employment growth, relative to comparator firms. Though the share of "digital" firms declines as firms age, "digital" firms increase their shares of sales (by firm age) and increase their shares of employment over time (see Figure 14).

Figure 14 Digital firms, increasing shares of sales and employment

Averages of firms born in 2001 to 2006



[27] Some of this difference in firm capital intensity, between the digital sector and comparator ("other") firms, may be due to greater importance of intangible assets (software, copyrights, brands, knowledge) to "digital" firms and the higher degree of difficulty that firms are likely to have in measuring the value of their intangible assets. This would lead to an underestimate of the capital intensity of firms in the digital sector.

[28] Note that the data sample used for this chart is smaller than the one used for analysis elsewhere in this report. Financial data needed for calculating capital stocks is less reliable and less abundant than data on firm counts, sales, and employee counts.

7 Concluding remarks

Key findings of this note are.

- firms that are born very small, tend to die young;
- a small number of firms that start out very small are a source of significant job creation; and
- job creation is concentrated in the early stages of firms lives, whatever their size, and creation of new firms is a key driver of job growth.

Analysis of "digital" firm dynamics emphasises that these patterns are important for growth and structural change in the economy.

"Digital" firms have higher death rates (low survival rates) than other firms but higher contributions to overall growth, measured by growth in employment or sales of surviving firms. And, in this comparatively new sector, growth is more highly concentrated in firms that are born small compared to non-digital (comparator) firms.

These findings are consistent with the view that firm birth, death and growth involves a considerable degree of trial and error and searching for a match between firm capabilities, business ideas and market demand.

That said, these observations are not definitive. They are only suggested by the analysis in this note, which is descriptive.

The data in this note only distinguishes firms by when they are born, by broad industry group and by birth size groupings. Numerous other factors are likely to affect decisions to start, grow or close a business.

Future research could usefully investigate the characteristics of surviving and high growth firms and individuals that are employed by or own these firms to determine, for example, the extent to which early stage firm survival and growth reflects trial and error and creative destruction – with the old giving way to the new – versus people shifting periodically between employment and self-employment for reasons of necessity or in response to changes in labour market norms or regulation.

The findings in this note also suggest that future research also differentiate between firm dynamics in different industries.

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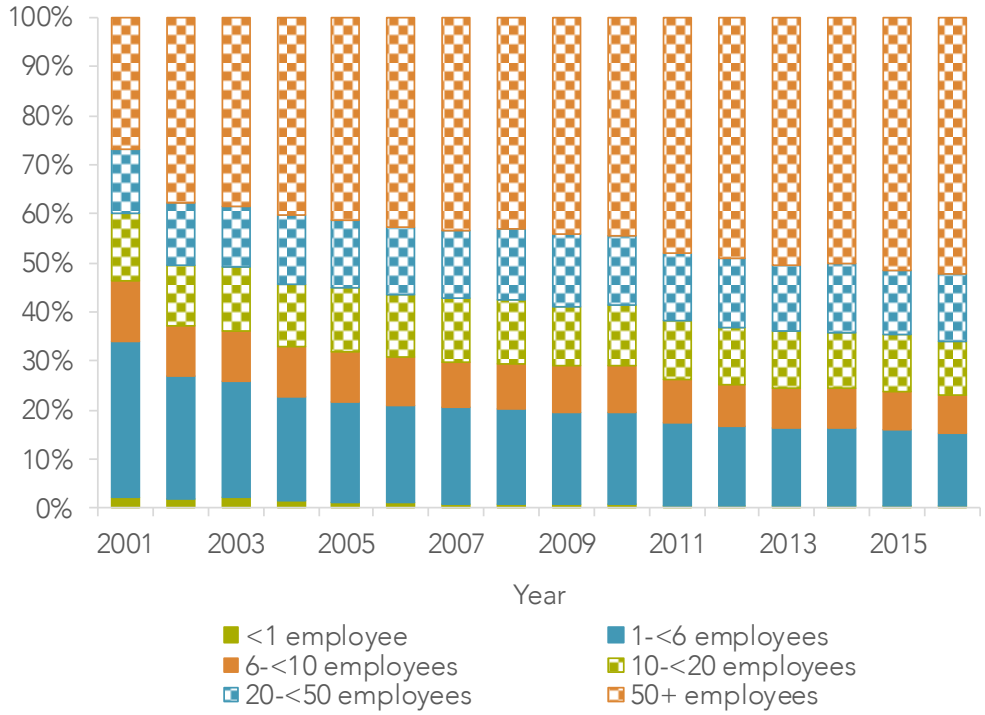
Appendix: additional charts and data

Figure 15 Firm and employment share by firm size for the 2001 cohort, 2001-2016

A. Firm share



B. Employment share

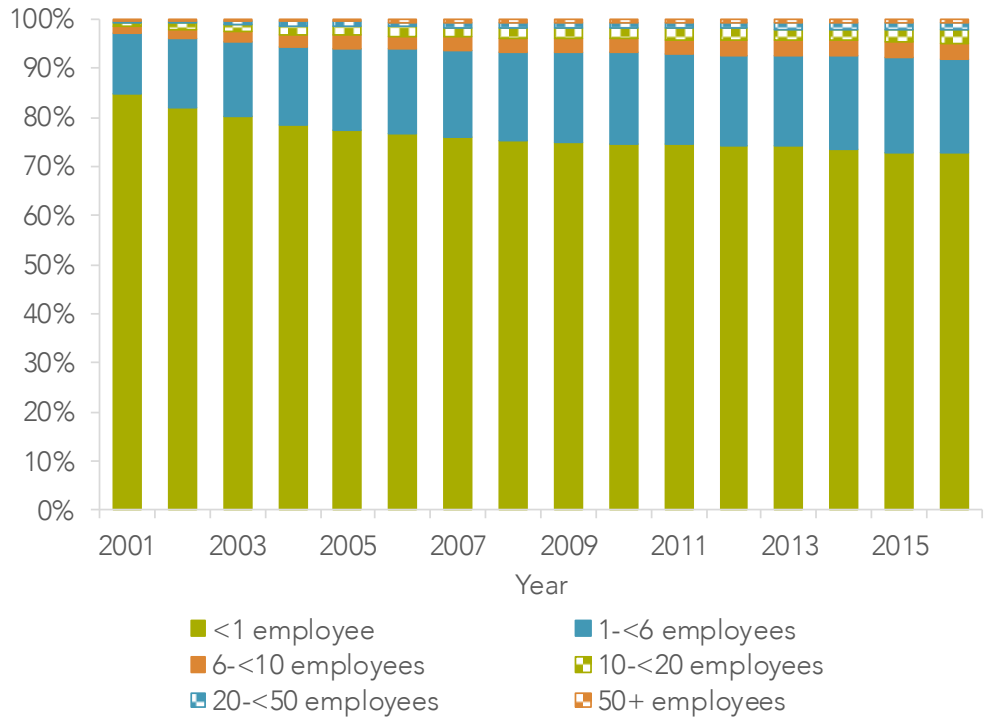


Figure 16 Average annual growth in employees by firm size at birth, 2001 cohort

Figure 17 Average growth rate by firm size, 2001-2016

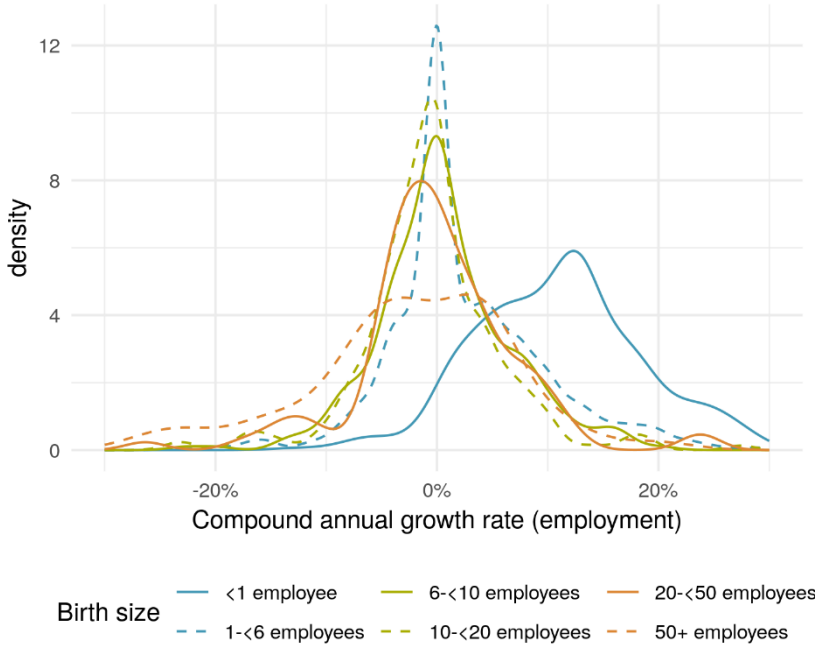
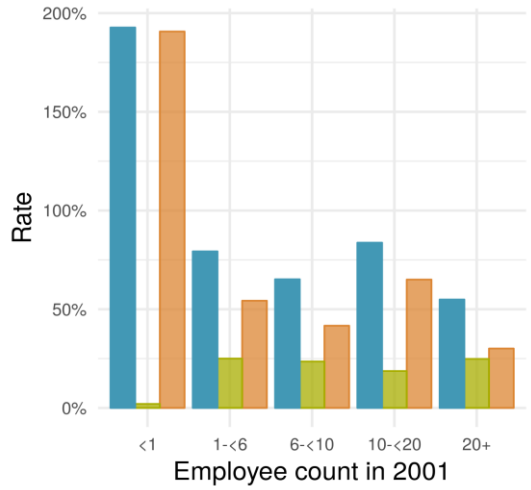


Figure 18 Job creation, job destruction and net job creation rates by firm size at birth between 2001 and 2011 and 2001 and 2016

A 2001-2011



B 2001-2016

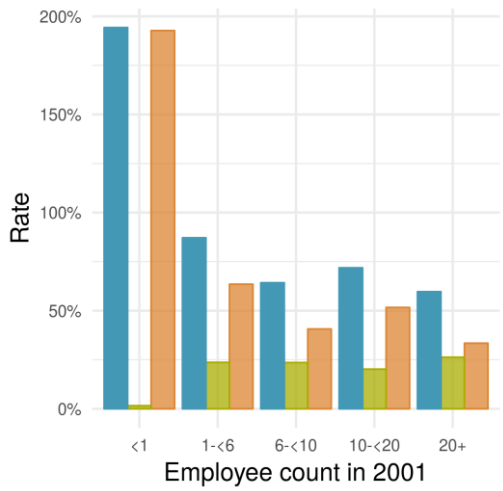


Table 6 Job creation and destruction between 2001 and 2011

A. Creation 2011

Year	Firm size (no. of employees)	<1	1-<6	6-<10	10-<20	20+	Total
2001	<1	280	5,200	1,900	1,800	8,700	17,880
	1-<6	0	1,200	1,400	2,100	3,600	8,300
	6-<10	0	0	65	500	2,000	2,565
	10-<20	0	0	0	160	4,600	4,760
	20+	0	0	0	0	8,500	8,500
	Total	280	6,400	3,365	4,560	27,400	42,005

B. Destruction 2011

Year	Firm size (no. of employees)	<1	1-<6	6-<10	10-<20	20+	Total
2001	<1	190	0	0	0	0	190
	1-<6	2,000	590	0	0	0	2,590
	6-<10	460	410	45	0	0	915
	10-<20	360	300	270	140	0	1,070
	20+	870	670	140	240	1,900	3,820
	Total	3,880	1,970	455	380	1,900	8,585

C. Net job creation 2011

Year	Firm size (no. of employees)	<1	1-<6	6-<10	10-<20	20+	Total
2001	<1	90	5,200	1,900	1,800	8,700	17,690
	1-<6	-2,000	610	1,400	2,100	3,600	5,710
	6-<10	-460	-410	20	500	2,000	1,650
	10-<20	-360	-300	-270	20	4,600	3,690
	20+	-870	-670	-140	-240	6,600	4,680
	Total	-3,600	4,430	2,910	4,180	25,500	33,420

Table 7 Industries defined as digital and industries excluded from comparison (ANZSIC06)

Digital – chart labels, abbreviated ANZSIC descriptions	Digital - ANZSIC codes and descriptions	Firms excluded from comparison with digital
Recorded media	C1620 Reproduction of recorded media	A01 - Agriculture
Computer retail	G4222 Computer and Computer Peripheral Retailing	A0301 - Forestry
Entertainment retail	G4242 Entertainment Media Retailing	O - Public administration and safety
Software	J542 Software publishing	P802 - School education
Movie production	J5511 Motion picture and video production	P810 - Tertiary education
Movie distribution	J5512 Motion Picture and Video Distribution	Q84 - Hospitals
Post-production	J5514 Post-production Services	
Music publishing	J552 Sound recording and music publishing	
Internet publishing	J5700 Internet publishing and broadcasting	
Wired networks	J580100 Wired Telecommunications Network Operation	
Wireless networks	J580200 Other Telecommunications Network Operation	
Other telecoms	J580900 Other Telecommunications Services	
Internet services	J591000 Internet Service Providers and Web Search Portals	
Web hosting	J592100 Data Processing and Web Hosting Services	
Electronic storage	J592200 Electronic Information Storage Services	
Non-store retail	G431 Non-store retailing	
Rental and hire	L6639 Other Goods and Equipment Rental and Hiring n.e.c.	
System design	M70 Computer system design	
Document preparation	N7292 Document Preparation Services	

Table 8 Distribution of birth sizes by industry and cohort

Industry	Cohort	Employees					
		<1	1-<6	6-<10	10-<20	20-<50	50+
All	2001	84.8%	12.4%	1.4%	0.9%	0.4%	0.2%
	2002	85.8%	11.8%	1.2%	0.8%	0.3%	0.1%
	2003	88.1%	9.9%	1.0%	0.7%	0.2%	0.1%
	2004	90.9%	7.5%	0.8%	0.5%	0.2%	0.1%
	2005	90.7%	7.7%	0.7%	0.5%	0.2%	0.1%
	2006	90.5%	7.9%	0.7%	0.6%	0.2%	0.1%
Digital	2001	90.0%	8.6%	0.6%	0.6%	0.0%	0.2%
	2002	89.4%	9.0%	0.9%	0.5%	0.2%	0.0%
	2003	92.1%	7.0%	0.8%	0.2%	0.0%	0.0%
	2004	95.2%	4.4%	0.2%	0.2%	0.0%	0.0%
	2005	95.5%	4.1%	0.2%	0.2%	0.0%	0.0%
	2006	95.0%	4.4%	0.2%	0.2%	0.2%	0.0%
Other	2001	84.5%	12.4%	1.5%	1.0%	0.4%	0.2%
	2002	85.5%	11.9%	1.3%	0.9%	0.4%	0.1%
	2003	87.9%	10.0%	1.1%	0.7%	0.2%	0.1%
	2004	90.7%	7.5%	0.8%	0.6%	0.2%	0.1%
	2005	90.6%	7.8%	0.8%	0.6%	0.2%	0.1%
	2006	90.3%	7.9%	0.8%	0.6%	0.2%	0.1%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