MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
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RESEARCH, EVALUATION & ANALYTICS

Business Information and Communication Technology (ICT) use and productivity growth in New Zealand

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New Zealand Government

Increasing labour productivity is one of MBIE's strategic objectives, as part of an effort to improve business competitiveness. High-intensity Information and Communication Technology (ICT) use has been linked to greater productivity among New Zealand firms, but detail is lacking with regards to how ICT use contributes to productivity gains over time. A greater understanding of the relationship between ICT use and productivity growth would provide insight into the interventions most likely to have the greatest impact on labour productivity.

New Zealand firms appear to be underutilizing the full potential of ICTs to boost productivity. The Digital Economy team has commissioned a study to better understand the relationship between ICT use and productivity growth as part of an evidence base to inform interventions.

What is the relationship between ICT use and productivity growth among New Zealand firms, and what does that mean for how the Digital Economy team directs its interventions?

Firms with high-intensity ICT use are more likely to improve their productivity than other firms

Firms demonstrate one of three general patterns of ICT use: low-intensity (uses ICT to achieve few business outcomes), mid-intensity (uses ICT to achieve some business outcomes and has a web presence) or high-intensity (uses ICT to achieve numerous outcomes, has a web presence and receives internet sales).

From 2006 to 2012, firms with high- or mid-intensity ICT use were consistently more productive (>$12,000 median difference in value-add per full-time equivalent) than low-intensity firms.

Firms with high-intensity ICT use were 6% more likely to increase their productivity over two-year intervals than other firms; however, mid-intensity ICT-use firms were no more likely to improve their productivity than low-intensity firms.

Small to medium-sized firms (6-49 employees) that increased ICT use were more likely to see productivity improvement the following two years.

In all industries, firms with a greater intensity of ICT use were either more productive or more likely to increase their productivity, or both.

This research supports policy aimed at a broad-based increase in ICT use among New Zealand firms, for the purposes of boosting labour productivity

In 2014, approximately one-third of New Zealand firms were low-intensity ICT users and only one-fifth were high-intensity users, indicating considerable scope for improvement.

Confidence in assessment (Low/Moderate/High): Moderate

Patterns were derived from a large sample of businesses over six years. Minimal effort was made to isolate the effect of ICT use on productivity from other related business practices; therefore, effect sizes should be taken as indicative only. Growth patterns were highly variable from one end of the time series (2006) to the other (2012); a longer time series may provide greater confidence in the trend.

Policy implications

This report supports policy aimed at a broad-based increase in ICT use among New Zealand firms, for the purposes of boosting labour productivity

The Digital Economy Team is engaged in a programme of work aimed at increasing digital use among small businesses for the purposes of increasing nation-wide productivity. Overall, this research was supportive of the planned programme of work, on the basis that:

- Firms with a moderate level of ICT use were more productive than firms with a low level of ICT use
- Firms with a high level of ICT use were more likely to improve their productivity than firms with a moderate level of ICT use
- These patterns were reasonably robust over time and across sectors
- Potential gains are of sufficient scale to warrant intervention

The research strengthens the evidence base on which the programme is based by providing a more comprehensive New Zealand context.

The evidence does not suggest a significant difference in benefit from transitioning firms from low to medium use versus medium to high use

Firms with a low intensity of ICT use were:

- Less productive (>$12,000 median difference in value-add per full time equivalent) than firms with a moderate or high level of ICT use
- Less likely (6%) to increase their productivity than firms with a high level of ICT use

Firms with a mid-level intensity of ICT use were:

- Less likely (6%) to increase their productivity than firms with a high level of ICT use

Firms with low-intensity ICT use were clearly in the worst productivity position and high-intensity ICT-use firms were in the best. However, the research was ambiguous as to whether a programme targeted at raising ICT use from low to medium, or from medium to high, would likely have the greater effect; the former is supported by differences in productivity levels and the latter is supported by differences in productivity growth.

A conservative approach would be to encourage greater ICT use across all sectors, with an emphasis on low-use sectors or sectors with a proven productivity advantage for firms using more ICT

There were some industries, such as the Distributive Industries (Transport, Postal and Warehousing, Wholesale and Retail Trade), with greater productivity differences between firms using more or less ICT. This may seem to suggest that these industries are more appropriate as targets for intervention; however, it is important to note that these differences are fairly fluid (as demonstrated in Appendix: Sector case studies) and, given a five year time lag from the analytical window to the present there is likely to have been some re-positioning of industries with stronger or weaker anticipated

benefits. This fluidity would be expected as firms develop industry-specific ICT uses and these uses spread across the industry.

The productivity benefits of the pilot programme may only be observable with a certain scale and intensity of implementation and with an extended timeframe for monitoring effects

The research was designed in part to examine what productivity effects a firm might expect to achieve by participating in the Digital Economy pilot programme.

- Small businesses that increased their ICT use were no more likely to improve their productivity than other small businesses concurrent with their upgrade, but they were more likely in the two years thereafter.
- High-intensity ICT-use firms were 6% more likely to improve their productivity over two-year intervals than other firms

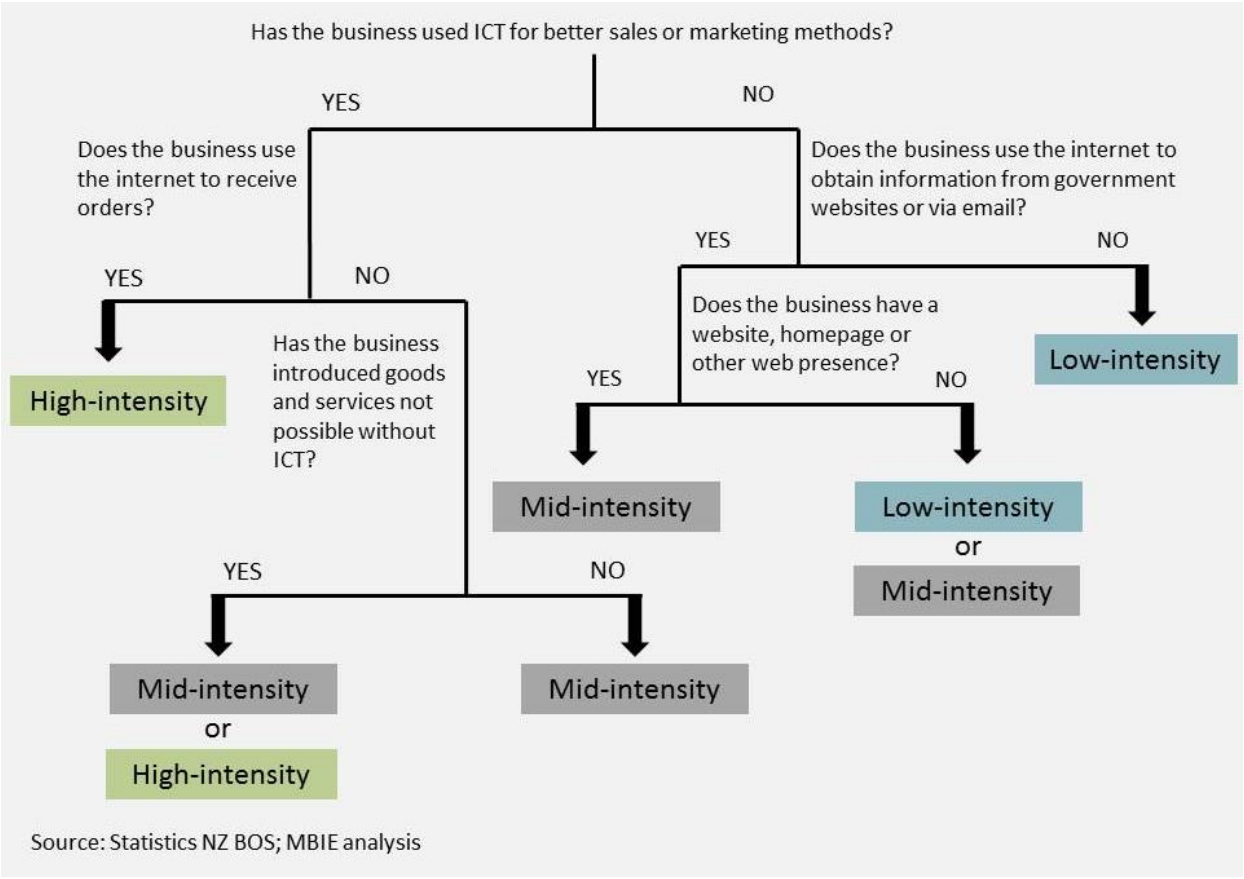
The productivity growth difference was modest, only associated with high-intensity ICT use, and on a delay from implementation.

The overall intensity of ICT use by a firm can be inferred from a few key questions

ICT uses among firms are highly inter-correlated, but there are a few that can serve as indicators of a firms' overall intensity of ICT use.

- Does the business use the internet to receive orders?
- Does the business have a website, homepage or other web presence?
- Does the business use the internet to obtain information from government websites or via email?
- Has the business used ICT for better sales or marketing methods?
- Has the business introduced goods or services not possible without ICT?

Ideally, these would be used in combination to identify the overall intensity of use within a firm as follows:



Source: Statistics NZ BOS; MBIE analysis

There are benefits to expanding the research to future years

There was some indication that the association between greater ICT use and productivity growth was strengthening towards the end of the time series. Extending the time series would give an indication as to whether this trend continued, and provide a greater sense of the overall consistency of the patterns.

The analysis did not focus on establishing the causal impact of ICT use on productivity growth, in part because there were relatively few multi-year windows available to test growth patterns. Adding more years to the time series may allow a deeper exploration of causality and investigation of effects on a longer time horizon (i.e. four to six years).

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Part I: Background

Previous studies suggest greater use of ICT by New Zealand firms may lead to productivity gains

One of MBIE's strategic objectives is to double nation-wide labour productivity growth, as part of an effort to improve business competitiveness.[1] A key mechanism by which this may be achieved is increasing the use of information and communication technology (ICT) by New Zealand businesses. ICT — namely electronic software, hardware and supporting infrastructure — has been shown to have a positive and significant effect on productivity in nearly all studies on the subject from the mid-1990s to the present.[2] The effect is achieved through gains in capital efficiency (i.e. more output per capital cost), complementarities to other processes, and knowledge spillovers. The cumulative impact of ICT on productivity can be profound, with essentially all labour productivity growth from 1995 to 2002 in the United States attributable to increased use of ICT.[3] Because the ICT sector comprises a relatively small component of the New Zealand economy (6.2% of GDP in 2015), the greatest opportunity for productivity gains comes from increasing ICT use by firms outside of the ICT sector.

Several points of evidence suggest that New Zealand businesses are underutilising the full potential of ICT to boost productivity. A study by the Sapere Research Group found that New Zealand firms that make more extensive use of the internet are 6% more productive than their industry average.[4] Firms across four sectors (tourism, retail, agriculture and professional services) noted that increased internet use was driving productivity improvement in their industries. A follow-up study by Sapere identified the sectors most likely to benefit from increased ICT use, based on productivity differentials between high ICT-use firms and their industry average.[5] Construction; transport, postal and warehousing; and agriculture, forestry and fishing were identified as the sectors with the greatest potential for productivity gains, with modelled benefits in the $3-10 billion range for each sector. Productivity differences between New Zealand and Australia in these industries and others may reflect differential uptake of ICT, although notably New Zealand is more productive in some industries and overall uptake of ICT is fairly comparable between the two countries.[6,7]

Informed by the Sapere studies, the Digital Economy Programme aims to improve the productivity of small businesses by encouraging better use of digital technologies, starting with a pilot programme targeting firms in tourism, arable farming, and construction trades.[8] As an evidence base to inform conversations with small

[1] MBIE 2015. Statement of Intent: 2015-2019.
[2] For a list of literature reviews see Miller and Atkinson 2014. Raising European productivity growth through ICT.
[3] OECD 2004. The economic impact of ICT: Measurement, evidence and implications.
[4] Glass et al. 2014. The value of internet services to New Zealand businesses.
[5] Blick et al. 2015. Identifying sectors of the economy for more effective use of ICT.
[6] Mason 2013. Investigating New Zealand-Australia productivity differences: New comparisons at industry level.
[7] Baller et al. (eds.) 2016. The Global Information Technology Report 2016: Innovating in the Digital Economy.
[8] The Business Growth Agenda 2016. Building a Digital Nation: A BGA Building Innovation Occasional Paper.

businesses about the benefits of increased ICT use, the Sapere studies have several limitations which this research aims to address.

1. The Sapere studies were conducted at two points in time (2012 and 2014, respectively). Examining a longer time series would provide a sense of how consistent the benefits of ICT use are, and whether they appear to be increasing or decreasing.

2. The Sapere studies used a highly simplified characterization of ICT use (high or low) based on five aspects of use. A more nuanced characterization of ICT use would provide greater insight regarding the types of uses that are likely to result in the greatest productivity gains for firms with varying degrees of digital sophistication.

3. The Sapere studies found that, on average, high ICT-using firms were more productive, but did not speak to the consistency with which high ICT-use firms realize a productivity advantage. A likelihood-based approach to productivity growth (i.e. how much more likely is a firm to grow if it uses more ICT?) may be more in line with the thinking of a business owner deciding whether or not to increase their ICT use (i.e. how much more likely am I to grow if I use more ICT?).

4. The Sapere studies are descriptive rather than causal; firms that use more ICT are more productive, but it is not clear to what extent ICT use drives the pattern.[9] One could move a step towards causality by examining the impact of increased ICT use on productivity growth. Observing productivity growth coincident with (or soon after) ICT upgrades would provide a stronger sense that the two are related.

In addressing the above limitations, the current study should help the Digital Economy team tailor interventions to greater effect and provide a sense of what might be expected from programmes in terms of scale and timeliness.

[9] High ICT-use firms may have other properties, like being innovative or investing in capital, that also contribute to higher productivity.

The Longitudinal Business Database provides an opportunity to investigate the relationship between ICT use and productivity growth

In even-numbered years since 2006, the Business Operations Survey (BOS) has contained a module on ICT.[10] The questions in this section investigate how and why businesses use ICT. The BOS is sent to a sample of several thousand businesses each year and the responses are available in the Statistics NZ Datalab environment as part of the Longitudinal Business Database (LBD).[11]

Broadly speaking, the questions in the BOS ICT module focus on either the ICT components a firm has (e.g. type of internet connection, percentage of staff with cell phones) or what ICT is used for by the business (e.g. staff training, percentage of online sales). In terms of elucidating a productivity effect of ICT, the ***way*** that ICT is used is likely to have a more direct bearing than ***what*** is used, assuming that the primary benefit of having more or better ICT is that it permits more or better use for business purposes. For this reason, a subset of 39 questions was selected from the BOS that collectively represent the way that an individual firm uses ICT (see Appendix: BOS ICT use).

The housing of the BOS in the LBD provides the opportunity to link responses by individual firms to productivity information that is also housed in the LBD. Fabling and Maré used tax records and survey data from the Annual Enterprise Survey to generate the components required to calculate labour productivity (i.e. firm output, intermediate consumption, and labour[12]). For various reasons, the productivity components are not available for each firm in every year, but coverage is reasonably comprehensive and the data have undergone some manipulations (e.g. price deflation) to facilitate longitudinal research. A limitation of using this dataset is that it currently extends only to 2012 due to changes to one of the forms from which the productivity numbers are derived.

[10] The target population for the Business Operations Survey is private, live enterprises that are economically significant, have six or more employees, and have been operating for one year or more.
[11] Sampling was stratified random and responses are weighted to be nationally representative.
[12] Fabling and Maré 2015. Production function estimation using New Zealand's Longitudinal Business Database.

Defining labour productivity and productivity growth

Productivity is a measure of the efficiency with which inputs (e.g. labour and capital) are converted into outputs (i.e. goods and services). Labour productivity is focused on the efficiency with which units of labour (such as full-time equivalents or hours worked) are converted into a volume of outputs. There is no universal agreement as to how to calculate labour productivity; for consistency with the Sapere studies, value-added (output minus intermediate consumption) per worker was used.[13] An increase in labour productivity can indicate that some change has made production more efficient and/or that the worker has access to greater resources to support production (capital deepening).[14]

Productivity changes were measured as the percentage change in labour productivity over a given time interval (e.g. +3% over two years). This change could be negative, indicating declining productivity, or positive, indicating productivity growth.

The general approach was to look at how much more likely firms were to improve their productivity with greater use of ICT. This likelihood-based approach is in contrast to studies that look at aggregate benefits by industry or other high-level grouping. The latter may be disproportionately affected by a few highly successful firms, which could provide a misleading sense of what can typically be expected from an increase in ICT use. Productivity outcomes (up to four years) were compared between firms with differing initial levels of ICT use, and between firms at a given level of use that either upgraded their ICT or did not. The overarching goal was to quantify the productivity advantage of higher levels of ICT use.

Key caveats and limitations

- The analysis was limited to the time period between 2006 and 2012. The patterns uncovered may be more or less relevant to the modern day, in particular because the nature or consequences of ICT use may have changed.
- Productivity growth over a given interval (e.g. 2 years) was related to firm ICT use at the start of the interval, thus effectively ignoring any subsequent changes that may have occurred.[15]
- The capital contribution to changing productivity levels was not examined, nor the effect of changing skill levels among employees.
- Minimal effort was made to isolate the effect of ICT use on productivity growth from other related business practices. Firms may need to implement other changes in order to realise potential benefits from ICT, and these changes may themselves have a direct effect on productivity.

[13] Including working proprietors

[14] Because the output measure is revenue-based, an increase in measured productivity could also indicate a rise in prices without an increase in the production of goods or services.

[15] Aside from analyses explicitly looking at ICT use changes

Part II: Findings

Firms demonstrate one of three general patterns of ICT use: low-intensity, mid-intensity, or high-intensity

The BOS asks questions about 39 different aspects of ICT use.[16] In practice, the ways in which firms use ICT are likely to be highly inter-related. For example, a firm with online sales is likely to use the internet for other functions like purchases and training. Conversely, a firm with no web presence is unlikely to have used ICT to improve their sales or marketing methods. Where multiple uses are more tightly linked, it is more difficult to determine the effect of each use, in isolation, on productivity; more realistically, one can investigate the effect of adoption of a collection of related ICT uses on productivity.

Cluster analysis was used to identify patterns of ICT use that co-occur within firms.[17] These clusters represent a profile of uses that, when collectively employed, contribute to certain productivity outcomes. Clusters were formed according to aggregate 2014 results, providing a common reference point for changes that occur over time and between industries and firms of different sizes. Firms clustered into three groups that could broadly be described as low-, mid-, and high-intensity ICT use, with around one-third (36%) in the low-intensity group, 44% mid-intensity and just 20% in the high-intensity group.

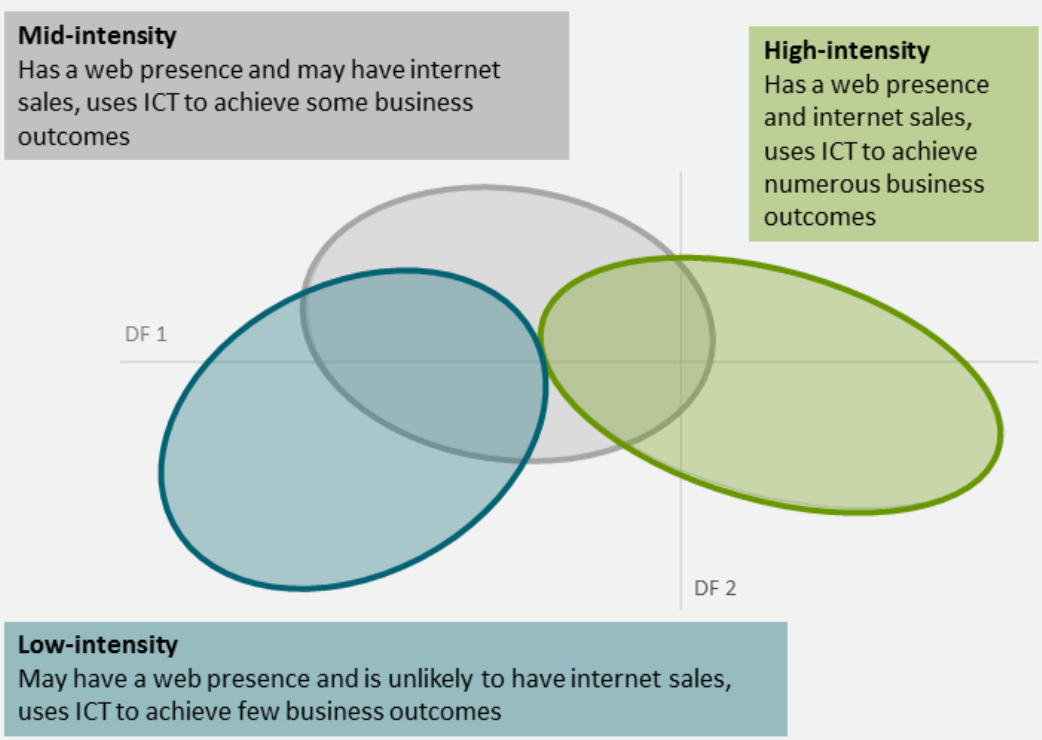
[16] See Appendix: BOS ICT use for the full list.

[17] Details of the cluster analysis are provided in Appendix: Additional notes.

How meaningful are the ICT clusters?

There are no hard and fast rules for determining the 'correct' number of clusters for a given dataset; rather, there are various heuristics to help guide the decision depending on how completely the clusters separate. Based on 2014 ICT use, firms cluster most distinctly into only two groups, but show some degree of separation in up to seven groups. Three clusters were chosen as a reasonable number to interpret, based on clear differences between groups and policy implications that are not overly vague or granular. Analyses indicate that these clusters were no worse or better at predicting productivity growth than the individual ICT uses, and thus work as useful shorthand for a collection of uses.

ICT clusters represent a continuum of use



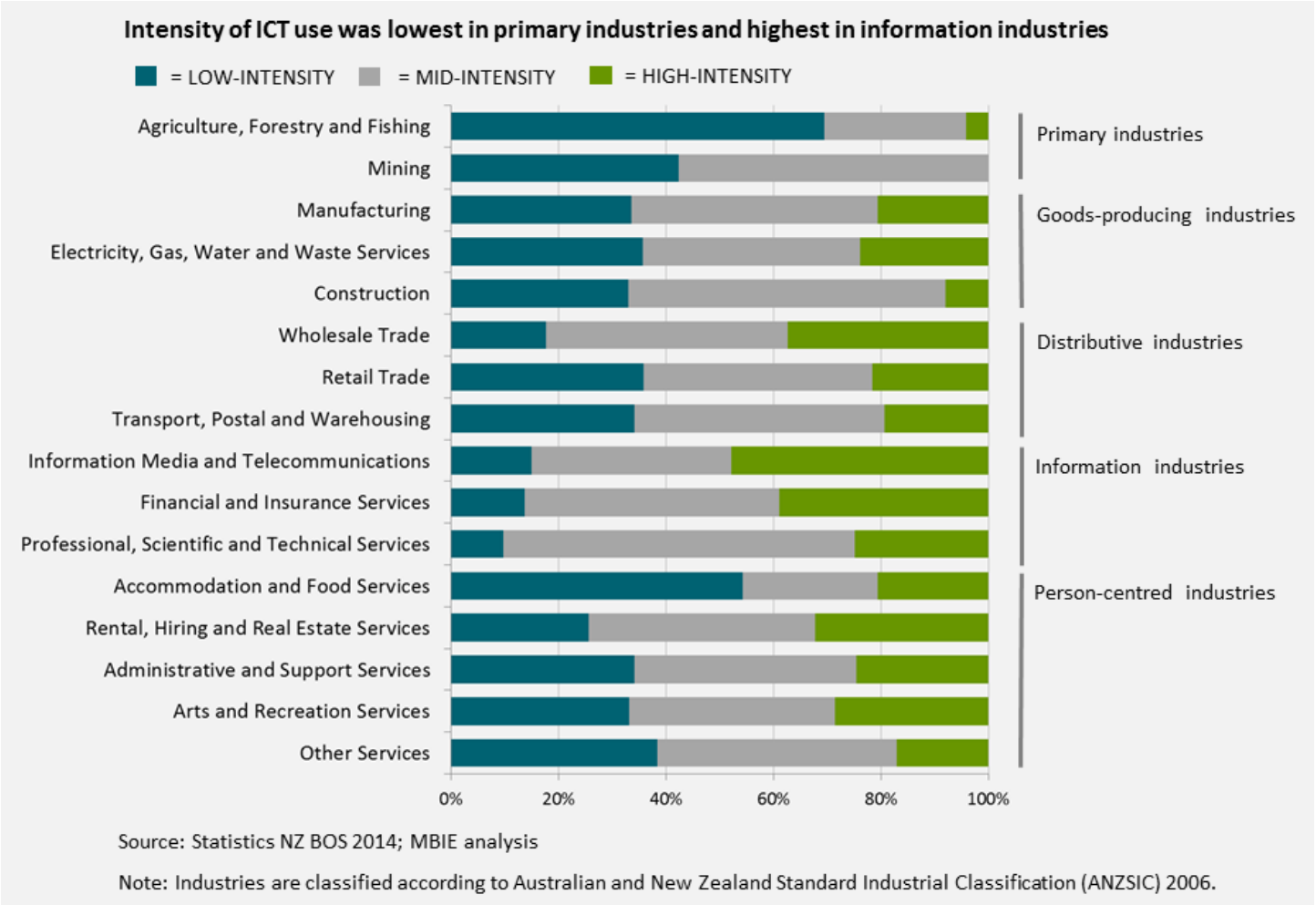
Source: Statistics NZ BOS 2014; MBIE analysis

Note: Axes are discriminant functions (DF) that represent where firms rank on a spectrum of 39 ICT uses. Key differences between low, medium and high use groups are noted. Ellipsoids represent 95% confidence intervals around firms scores.

High-intensity ICT-use firms were more likely to have internet sales and supporting processes (i.e. taking orders by email or online, collecting customer information online, provision of after-sales online support) than other firms.[18] Also, they were more likely to report a wider range of business outcomes with the assistance of ICT use, including a better understanding of markets, better sales or marketing methods, introduction of new goods or services, improved production efficiency, and improved management of quality. On average, high use firms used ICT to achieve eight of thirteen outcomes listed in the BOS, in comparison to four outcomes by medium-use firms and one outcome for low-use firms.

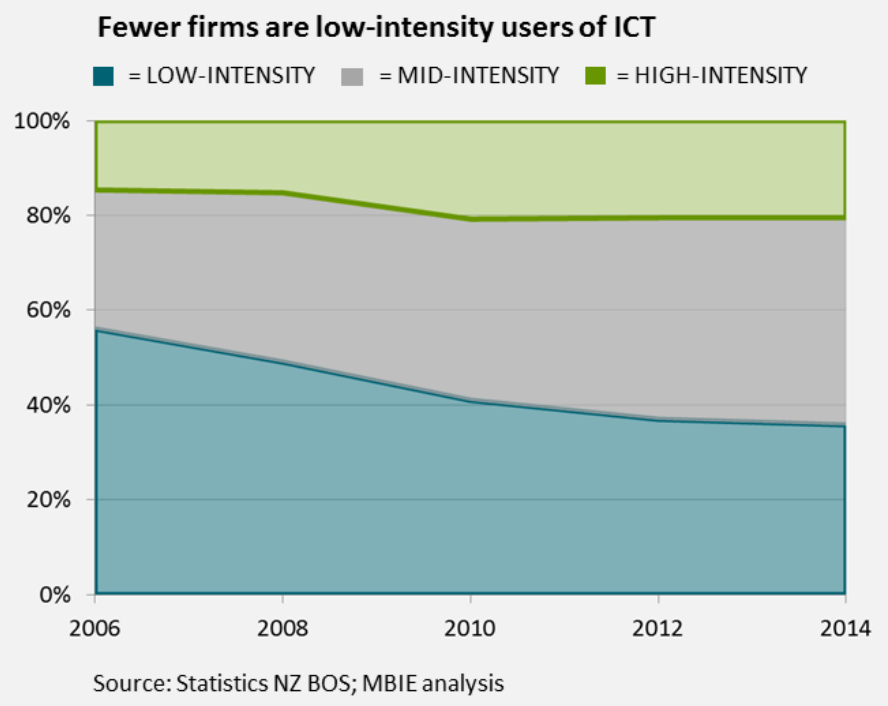
[18] Further detail on cluster properties is provided in Appendix: Sector case studies.

By volume, high-intensity firms were most common in the Wholesale Trade and Manufacturing industries, whereas proportionally they made up the largest percentage of firms in the Information Media and Telecommunications and Financial and Insurance Services industries. Not surprisingly, larger firms (20+ employees) were more likely to be high-intensity ICT users than smaller firms.



Low-intensity ICT-use firms were usually connected to the internet, used ICT for their finances, and may have used ICT for purchases or interactions with government, but little else. Notably, low-use firms were somewhat unlikely to have a website (~40% of firms had a website), whereas websites were common among medium-use firms (83%) and near universal among high-use firms (97%). By volume and by proportion, low-intensity firms were most common in the Accommodation and Food Services and Agriculture, Forestry and Fishing industries.

The trend over time is towards increasing ICT use, with a greater number of firms transitioning from low to medium use than from medium to high use. The rate of transition appears to have slowed towards 2014.



Firms with high- or mid-intensity ICT use were consistently more productive than low-intensity firms

Productivity estimates were available annually, whereas ICT use was measured biennially. Rather than simply use productivity estimates that align with the years of the BOS ICT module, an average was taken of productivity in the year of and year prior to the BOS ICT module. This was done for two reasons: to decrease volatility in year-over-year estimates, and to increase overall sample size.[19] All productivity values used in the analyses were derived in this manner.

The simplest way to delineate productivity growth would be to identify firms that have increased their productivity over a given interval. However, very small increments might be better interpreted as neutral growth. Setting a higher bar for what constitutes productivity growth should differentiate firms that have achieved a meaningful level of growth from the rest. A moving threshold (above-average growth, relative to the time period under consideration) was used to identify firms that achieved substantial productivity growth relative to other firms.

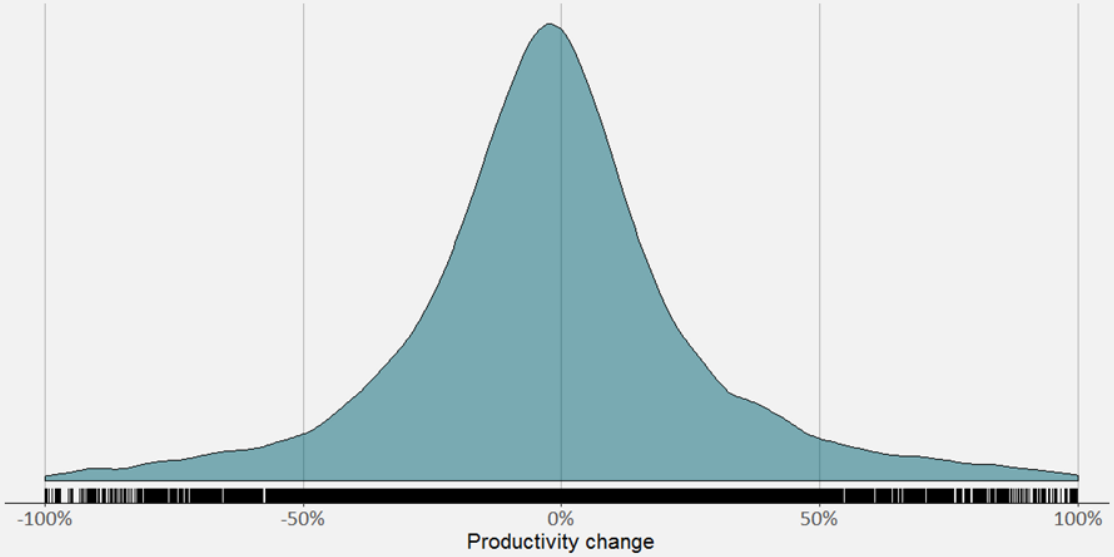
[19] In some cases, productivity estimates were only available in only one of the two years, in which case the available estimate was used.

What is above-average productivity growth?

The level of growth considered above average is dependent on economic conditions at the time. For this reason, average productivity growth was determined independently for each time interval used in the analysis. These values were drawn from the Statistics NZ labour productivity series rather than the productivity database in the LBD, as the former is more comprehensive.

Productivity change was roughly symmetrical around a mild productivity decline

FREQUENCY DISTRIBUTION OF TWO-YEAR PRODUCTIVITY CHANGES FOR NZ FIRMS 2006-2012



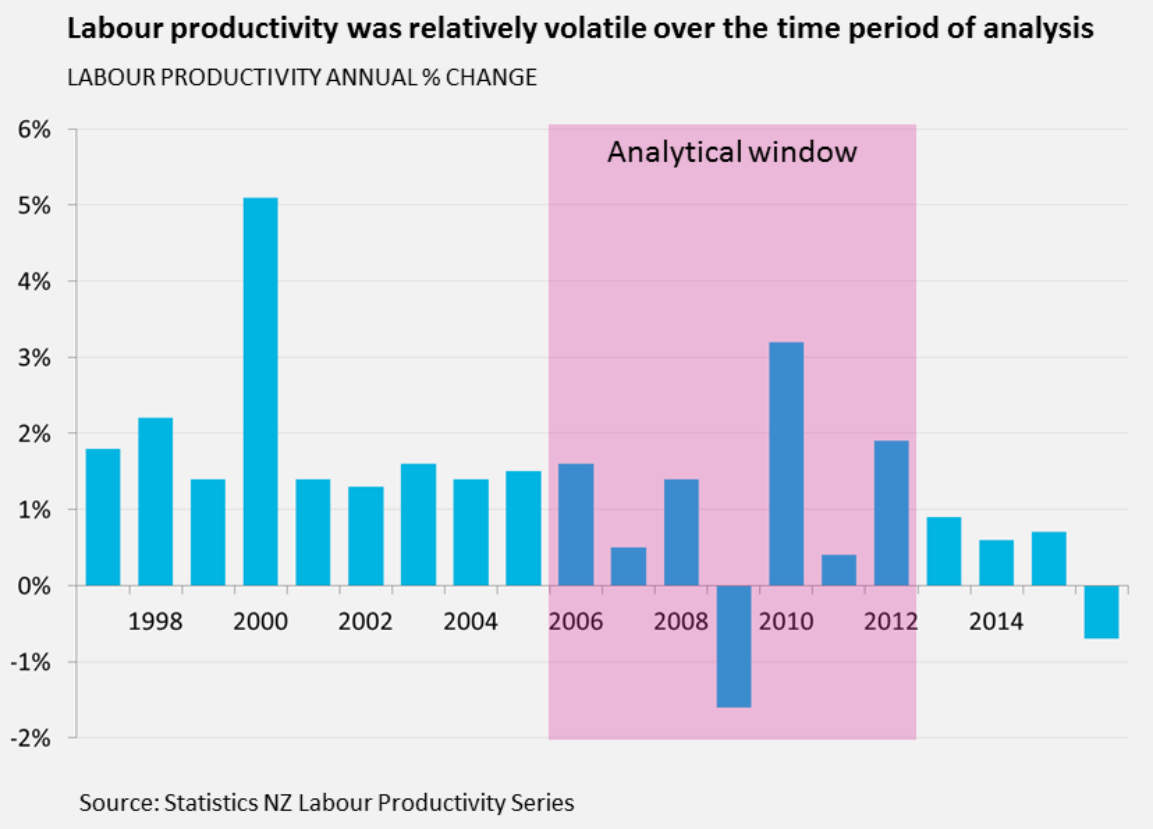
Source: Statistics NZ BOS; Fabling and Maré productivity dataset; MBIE analysis

Note: Firms with productivity changes < -100% or > 100% are not shown.

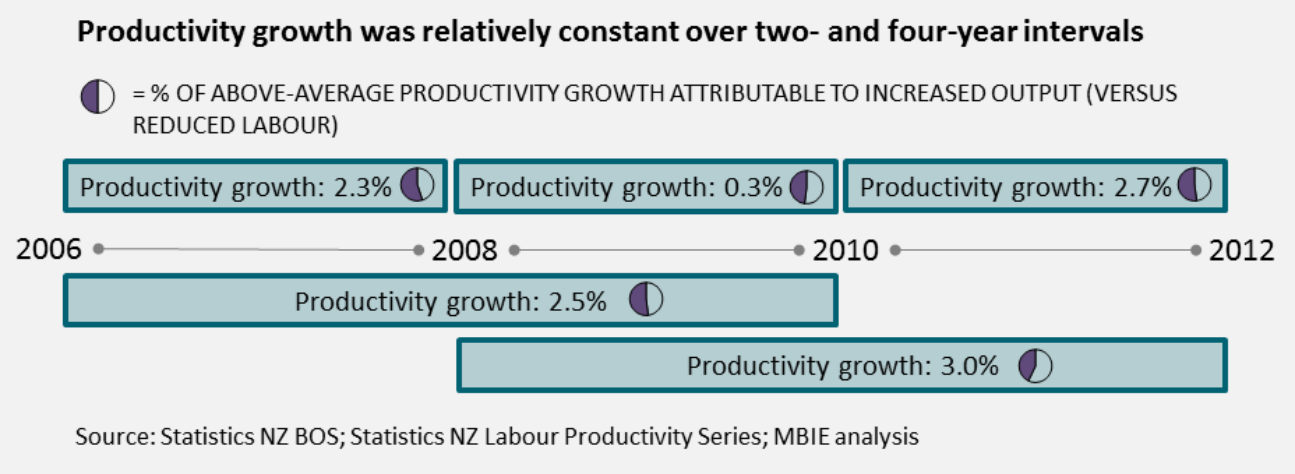
In practice, these thresholds identify 40-45% of firms as having above average growth in any given interval. This is because growth is disproportionately captured by a smaller number of more productive firms, such that the mean (average) growth is greater than median growth.

Firms that exit (i.e. cease to operate) are problematic in the sense that their growth trajectory prior to exit is unknown — a low growth firm may go out of business or a high growth firm may be bought out. Simply ignoring these firms may bias the results if one of these scenarios is more common than the other. Firms that exited were grouped with low or neutral growth firms under the assumption that this was the more common scenario. Exiting firms represented a very small proportion of firms over any two-year period (<1%), but a more substantial proportion over four-year intervals (12-14%).

It is worth noting that labour productivity over the time period of analyses (2006 to 2012) was relatively volatile, as New Zealand absorbed the effects of the global financial crisis. Output growth bottomed out in 2009, followed by labour growth in 2010 and capital growth in 2011, contributing to fluctuating productivity levels.



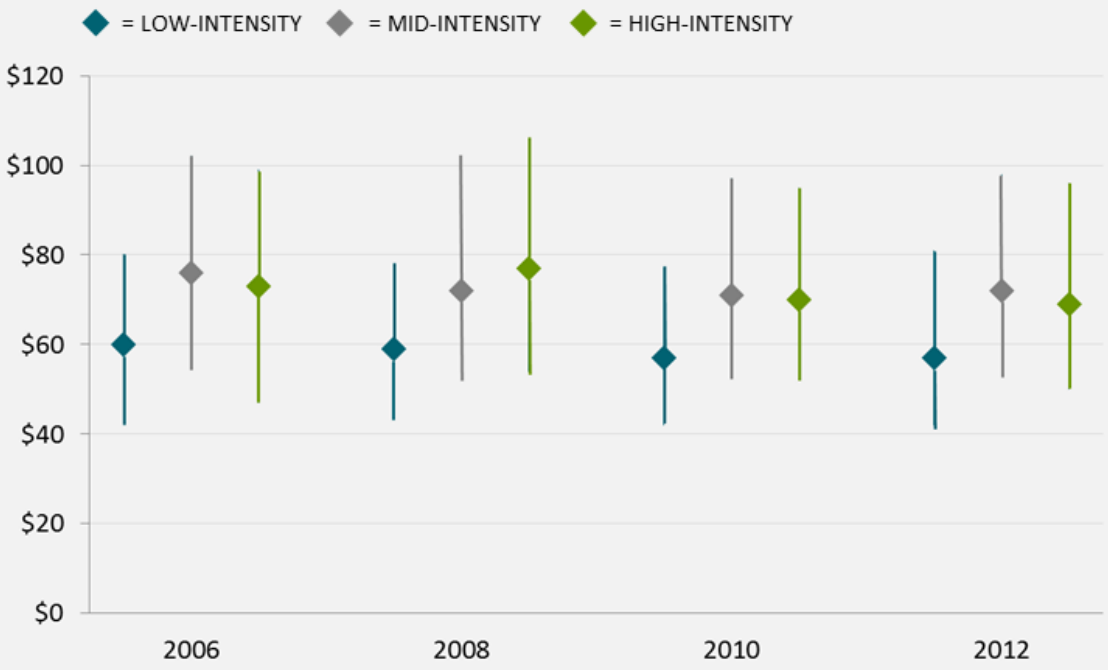
Despite year-on-year volatility, productivity growth over two- and four-year intervals was relatively constant from 2006 to 2012 (2-3%), with the exception of the immediate aftermath of the global financial crisis (2008 to 2010: 0.3%). Labour productivity is a ratio of value-add over labour; as such, productivity growth can be achieved by either increasing value-add or reducing labour, or both. Looking specifically at firms included in the analysis that achieved above-average productivity growth, there was no consistent tendency towards one of these strategies over the other.



The likelihood of a firm increasing productivity is a separate question from how productive a firm is, in absolute terms. To some extent, less productive firms should find it easier to achieve above-average growth, because they need less of an increase to their productivity in absolute terms than a more productive firm to achieve equivalent percentage growth. In aggregate, medium and high ICT-use firms were consistently more productive than low-use firms from 2006 through 2012, with a median productivity gap of at least $12,000 each year.

Mid- and high-intensity ICT-use firms were consistently more productive than low-use firms

MEDIAN LABOUR PRODUCTIVITY (VALUE-ADD/FTE, $1K) BY INTENSITY OF ICT USE



Source: Statistics NZ BOS; Fabling and Maré productivity dataset; MBIE analysis

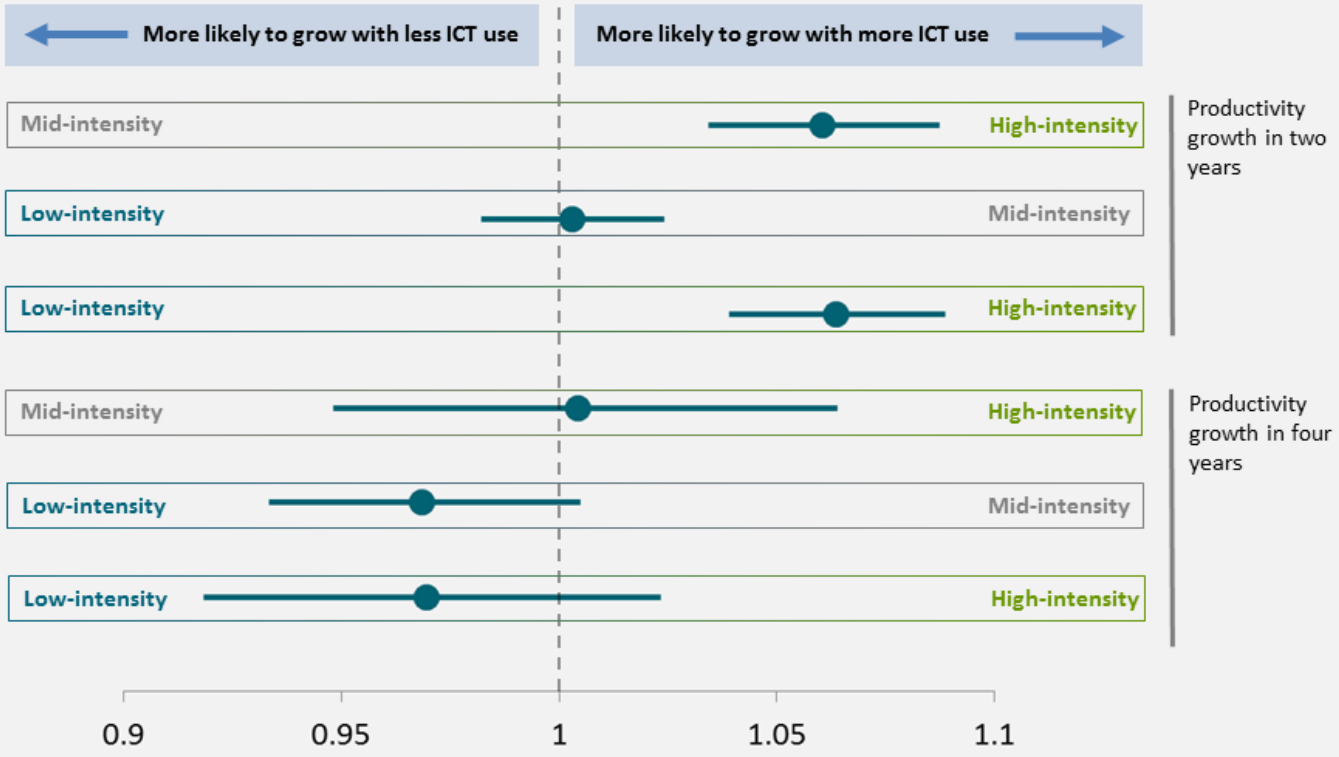
Note: Vertical lines demarcate the central 50% of labour productivity values around the median.

Firms with high-intensity ICT use were more likely to improve their productivity than other firms

Although firms with mid- or high-intensity ICT use were similarly productive on average, high-use firms were more likely to improve their productivity on a firm by firm basis. Put another way, a firm with high-intensity ICT use had better odds of achieving productivity growth than a firm with medium (or low) ICT use.

High-intensity ICT-use firms were more likely to increase their productivity over two years

THE RELATIVE LIKELIHOOD OF PRODUCTIVITY GROWTH WITH DIFFERENT INTENSITIES OF ICT USE OVER TWO AND FOUR YEARS

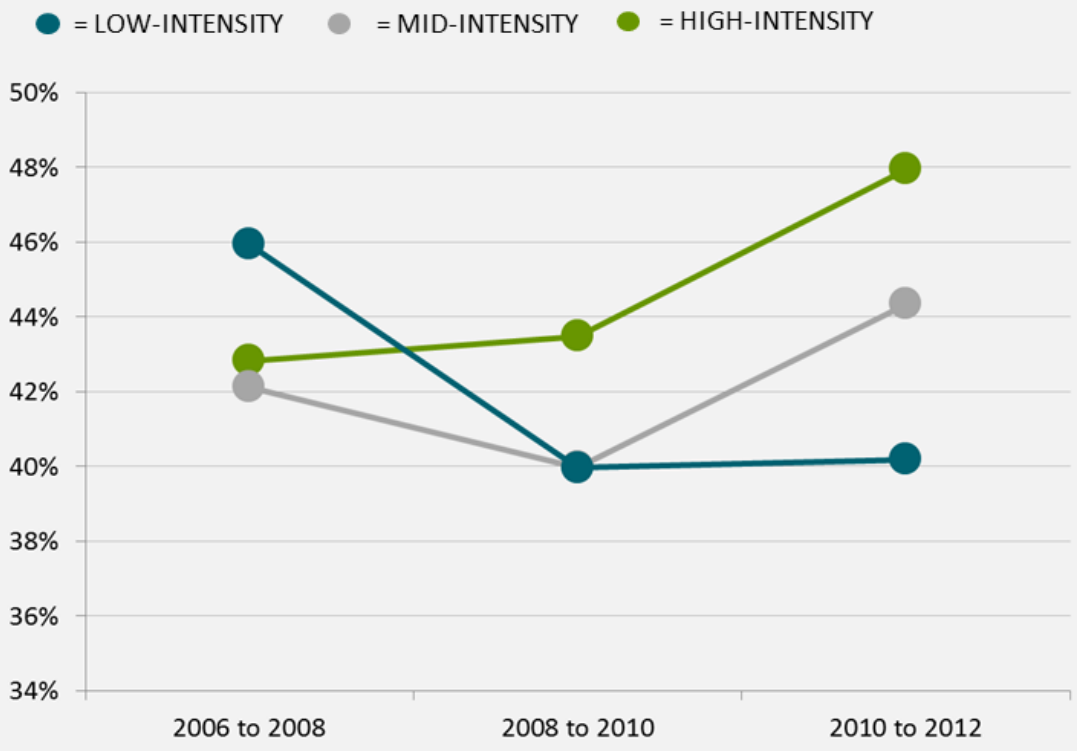


Source: Statistics NZ BOS; Fabling and Maré productivity dataset; MBIE analysis

Note: Relative likelihoods >1 indicate that firms with greater ICT use are more likely to grow. Horizontal lines represent 95% confidence intervals for the relative likelihoods and lines that cross 1 indicate a lack of significant difference. Productivity growth over two and four years is averaged over 2006-2012.

Across all sectors, firms with high-intensity ICT use were approximately 6% more likely to improve their productivity than other firms over two years. A similar difference was not observed for medium-use firms, relative to low-use firms. The relationship between productivity growth and ICT use changed between 2006 and 2012; initially, low ICT-use firms were most likely to improve their productivity, whereas in later years high ICT-use firms were the most likely. The changing outcomes for firms with different levels of ICT use may explain the lack of a detectable pattern over four year intervals.

The relationship between ICT use and productivity growth varied between years

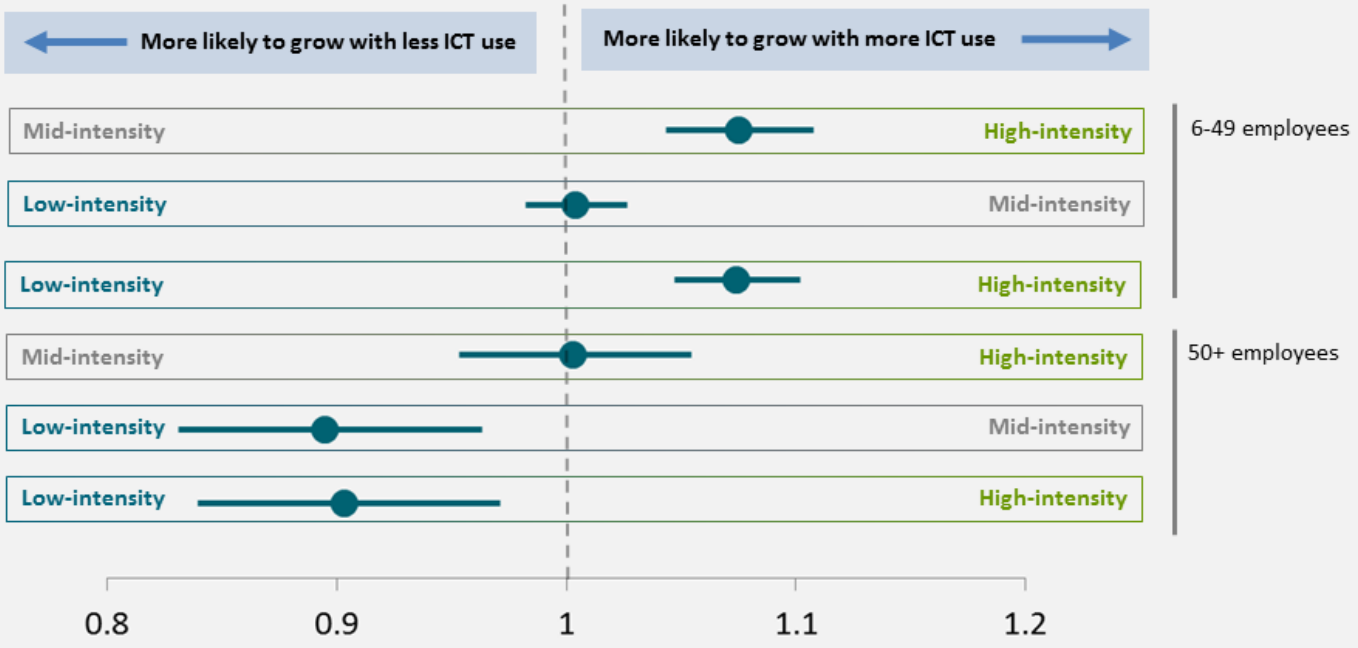


Source: Statistics NZ BOS; Fabling and Maré productivity dataset; MBIE analysis

Smaller firms (6 to 49 employees) were more likely to improve their productivity with high-intensity ICT use than larger firms. In fact, whereas firms with up to 49 employees were ***more likely*** to improve their productivity with high-intensity ICT use, firms with more than 50 employees were ***less likely*** to improve their productivity than low-intensity ICT-use firms.

Smaller firms with high-intensity ICT use were more likely to improve their productivity

THE RELATIVE LIKELIHOOD OF PRODUCTIVITY GROWTH WITH DIFFERENT INTENSITIES OF ICT USE FOR FIRMS WITH 6 TO 49 OR MORE THAN 50 EMPLOYEES



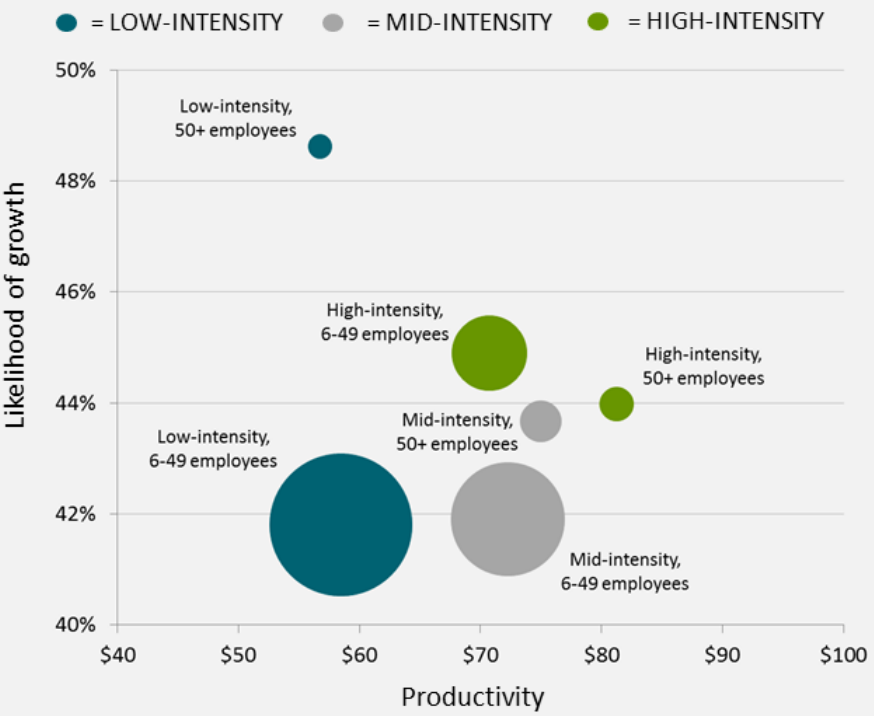
Source: Statistics NZ BOS; Fabling and Maré productivity dataset; MBIE analysis

Note: Relative likelihoods >1 indicate that firms with greater ICT use are more likely to grow. Horizontal lines represent 95% confidence intervals for the relative likelihoods and lines that cross 1 indicate a lack of significant difference. Productivity growth over two and four years is averaged over 2006-2012.

This somewhat counter-intuitive result may relate to the fact that the difference in productivity (i.e. the productivity gap) between low- and high-intensity ICT-use firms was much greater for larger firms (50+ employees) than smaller firms. The higher likelihood of growth among large, low ICT-use firms may indicate progress towards ***narrowing a productivity gap*** that averaged $25,000 from 2006 to 2012. Among smaller firms, for whom the productivity gap was much narrower ($12,000 from 2006 to 2012), high ICT-use firms were the more likely to grow, which may indicate that the ***productivity gap is increasing***. All else being equal, it should be easier for a firm to achieve a fixed percentage of productivity growth with lower starting productivity; thus, smaller, high-intensity ICT-use firms were more likely to improve their productivity than smaller, low-use firms despite the slight disadvantage of starting with higher productivity.

The productivity gap between high- and low-intensity ICT-use firms was greater for larger firms

THE LIKELIHOOD OF PRODUCTIVITY GROWTH BY MEDIAN LABOUR PRODUCTIVITY (VALUE-ADD/FTE, $1K), ICT USE AND FIRM SIZE



Source: Statistics NZ BOS; Fabling and Maré productivity dataset; MBIE analysis

Note: Median productivity and growth likelihoods were averaged over 2006-2012. Circle sizes are proportionate to the number of firms in each group.

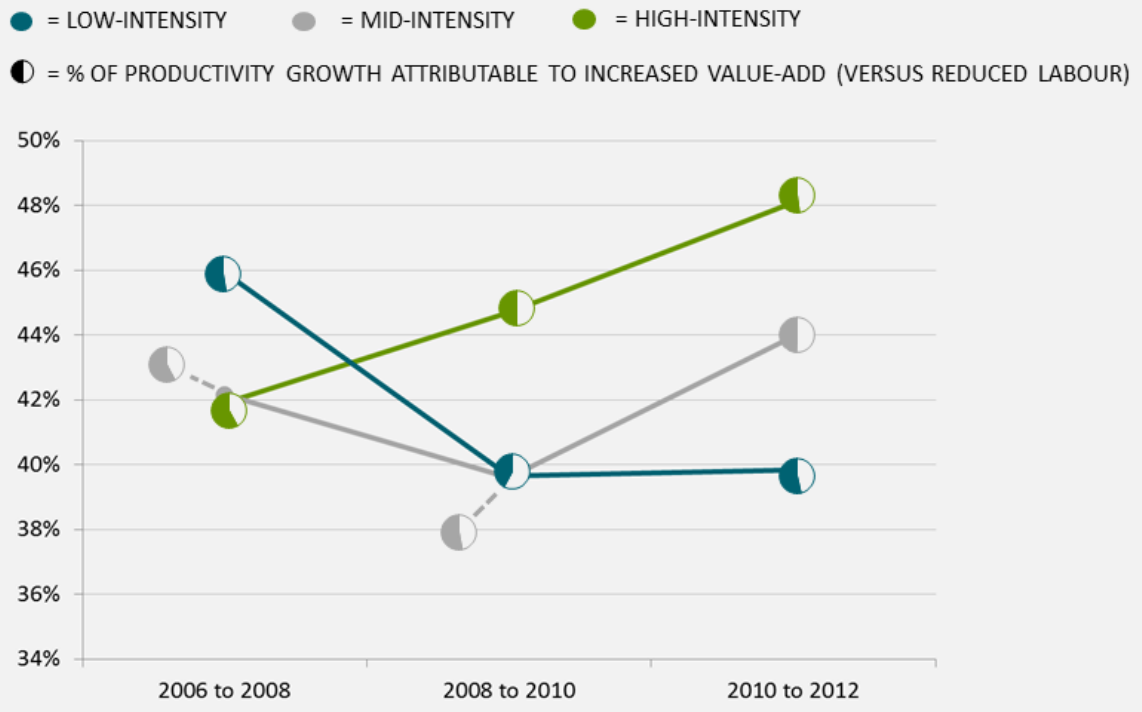
The remainder of the analyses focus on small to medium-sized firms (6 to 49 employees) as they are an intended target of planned policy intervention.

Small to medium-sized firms that increased ICT use were more likely to see productivity improvement the following two years

Among small and medium-sized firms, the relationship between ICT use and productivity growth varied across years, with high-intensity ICT-use firms becoming more likely to achieve growth over time. From 2010 to 2012, high-intensity ICT-use firms were 10% more likely than mid-intensity firms to increase their productivity and 21% more likely than low-use firms. Firms achieved this productivity growth through increased value-add and reduced labour in approximately equal measure, with no particular predilection for one mode over the other.

Small to medium-sized firms have an increasing likelihood of improving productivity with high-intensity ICT use

THE LIKELIHOOD OF PRODUCTIVITY GROWTH FOR 6 TO 49 EMPLOYEE FIRMS WITH A GIVEN LEVEL OF ICT USE



Source: Statistics NZ BOS; Fabling and Maré productivity dataset; MBIE analysis

Although smaller firms with higher ICT use were more likely to improve their productivity, there was no indication that upgrading to high ICT use led to productivity improvement in the short-term. The relative likelihood of productivity growth for a firm that recently upgraded to high ICT use was no different to similar firms that did not, either contemporaneously with the upgrade or two years hence.[20] This could

[20] Relative likelihood of productivity growth in 0 years = 0.93 (0.85-1.03 95% CI) or in 2 years = 0.99 (0.88-1.13 95% CI). Firms were matched by industry and size and results were averaged from 2006 to 2012.

indicate a methodological issue,[21] or that productivity gains from high ICT use take longer to materialize, or that business practices common to high ICT-use firms are driving the productivity relationship rather than ICT use itself.

An alternative version of the above analysis was performed that looked at how much more or less like a high ICT-using firm a business became over time, rather than whether a firm increased ICT use enough to jump from a low or medium use designation to high use (see Appendix: Additional Notes for details). There was no positive relationship between increased ICT use and productivity growth contemporaneous with the increase in use.[22] However, firms that increased ICT use from 2006 to 2008 were more likely to improve their productivity from 2008 to 2010 (p<0.01), and firms that increased ICT use from 2008 to 2010 were more likely to improve their productivity from 2010 to 2012 (p<0.01). In other words, firms with increased ICT use were ***no more likely*** to improve their productivity concurrent with the increase, but were ***more likely*** to improve their productivity the two years following. This provides some evidence that increasing ICT use has short-term (if not instant) productivity benefits.

Caution: Results based on larger aggregations are more reliable

- Analyses in this report pool results over several time periods or across sectors due to considerable variation in productivity estimates; firms grow and contract for many reasons other than ICT use and a certain sample size may be required to detect systemic patterns that are small but meaningful.
- ICT use categories (high, medium, low) originate from a fluid continuum of uses; in reality, some high and medium-intensity ICT-use firms and medium and low-use firms would be virtually indistinguishable. Where more or less productive firms sit on these boundaries will have a disproportionate effect on results.
- The sum effect of the above two points is that results based on larger aggregations are more reliable than results based narrower breakdowns, such as industry patterns.

[21] Both ICT use and productivity growth were grouped into categories (i.e. high-intensity ICT use, above-average growth), which could make a subtle relationship between the two harder to detect, particularly with low sample sizes.

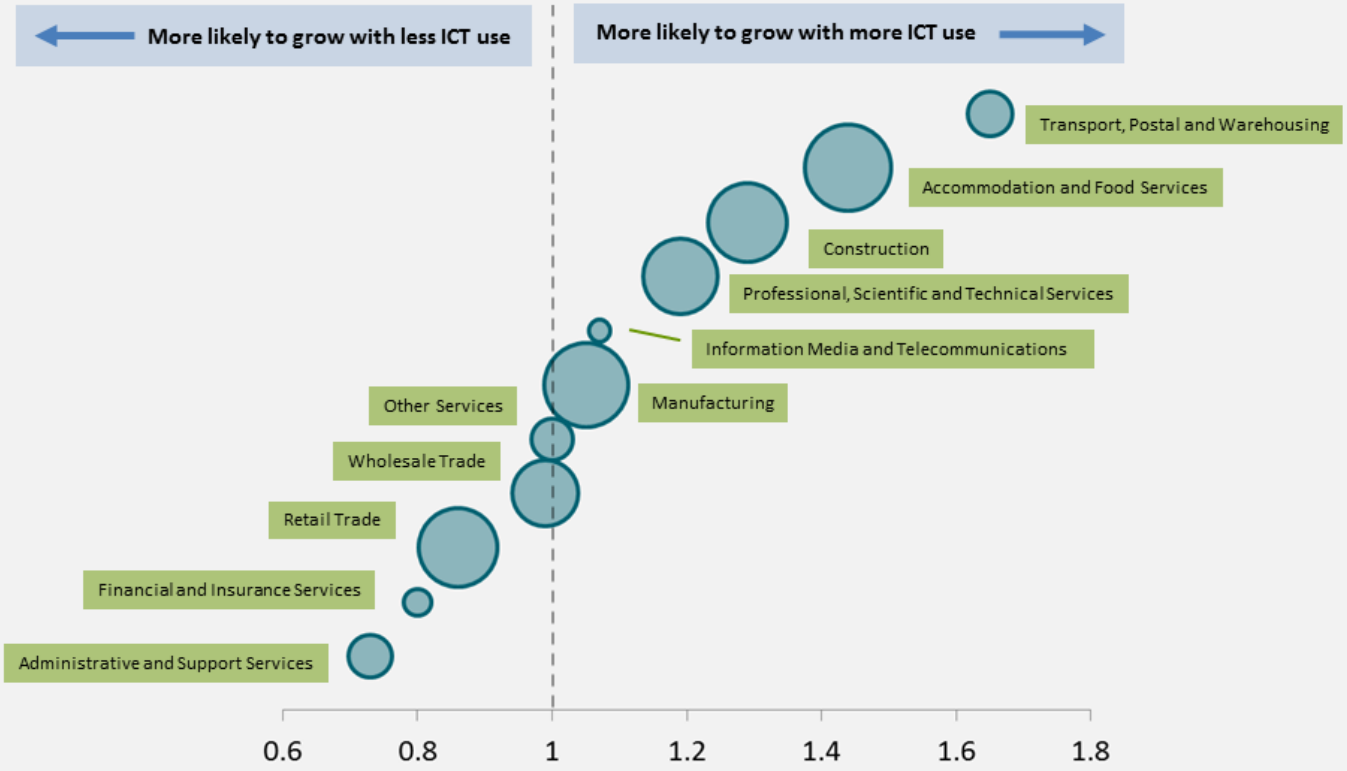
[22] From 2006 to 2008 (p=0.08), 2008 to 2010 (p=0.50), or 2010 to 2012 (p<0.01 but negative relationship; firms with increased ICT use were less likely to improve productivity).

In all industries, firms with a greater intensity of ICT use were either more productive or more likely to increase their productivity, or both

The relationship between high ICT use and productivity growth was uneven across industries, with the strongest positive relationship in four disparate industries (Transport, Postal and Warehousing; Accommodation and Food Services; Construction; Professional, Scientific and Technical Services).

Small to medium-sized firms in most industries were as or more likely to improve productivity with high-intensity ICT use

THE RELATIVE LIKELIHOOD OF PRODUCTIVITY GROWTH OVER TWO YEARS WITH HIGH VS MID- OR LOW-INTENSITY ICT USE



Source: Statistics NZ BOS; Fabling and Maré productivity dataset; MBIE analysis

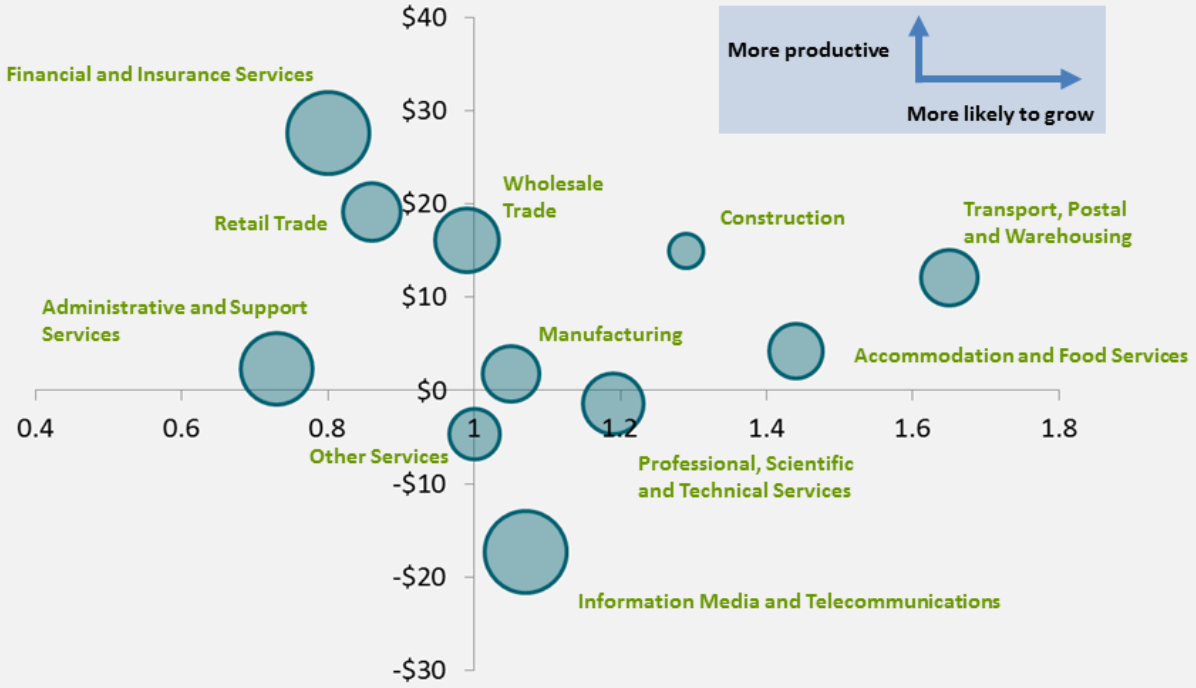
Note: Circle size is proportion to the number of small to medium-sized firms (6 to 49 employees) in the industry. Productivity growth over two years was averaged over 2006-2012.

The median productivity of high ICT-use firms was typically similar to or greater than the productivity of other firms in the same industry, with the exception of Information Media and Telecommunications. High ICT use firms in Information Media and Telecommunications were more productive than low ICT-use firms, but less productive than the more common medium ICT-use firms.

Firms in Financial and Insurance Services and Wholesale and Retail Trade with high ICT use were more productive than other firms in their respective industries, but were not more likely to improve their productivity. In the case of Wholesale and Retail Trade, the productivity gaps between high ICT use and other firms at the start of the time series were relatively high ($30,000 and $28,000 in 2006, respectively), and thus there may have been limited scope for further gains. Finance firms may be somewhat of an anomaly in that they were particularly exposed to the global financial crisis, which spanned the study period.[23] Only 33% of high ICT-use firms in Finance and Insurance Services experienced above-average productivity growth from 2006 to 2012, far fewer than the 45% across all small to medium-sized firms.

High-intensity ICT-use firms in most industries were either more productive or more likely to improve productivity, or both

THE RELATIVE LIKELIHOOD OF PRODUCTIVITY GROWTH AND DIFFERENCES IN MEDIAN PRODUCTIVITY (VALUE-ADD/FTE, $1K) BETWEEN HIGH ICT USE AND OTHER 6 TO 49 EMPLOYEE FIRMS



Source: Statistics NZ BOS; Fabling and Maré productivity dataset; MBIE analysis

Note: Median productivity and growth likelihoods were averaged in two-year intervals over 2006-2012. Circle sizes are proportionate to the number of high ICT use firms in each group.

[23] Commerce Committee 2011. Inquiry into finance company failures.

There was strongest evidence of a positive association between high ICT use and productivity amongst firms in the Transport, Postal and Warehousing industry, and Construction industry. In both sectors, high ICT-use firms were more productive than other firms in their industry and were more likely to improve their productivity. Furthermore, both sectors have a lower percentage of high ICT-use firms (7% for Construction, 14% for Transport, Postal and Warehousing in 2014) than the economy-wide average (20%), indicating scope for improvement.

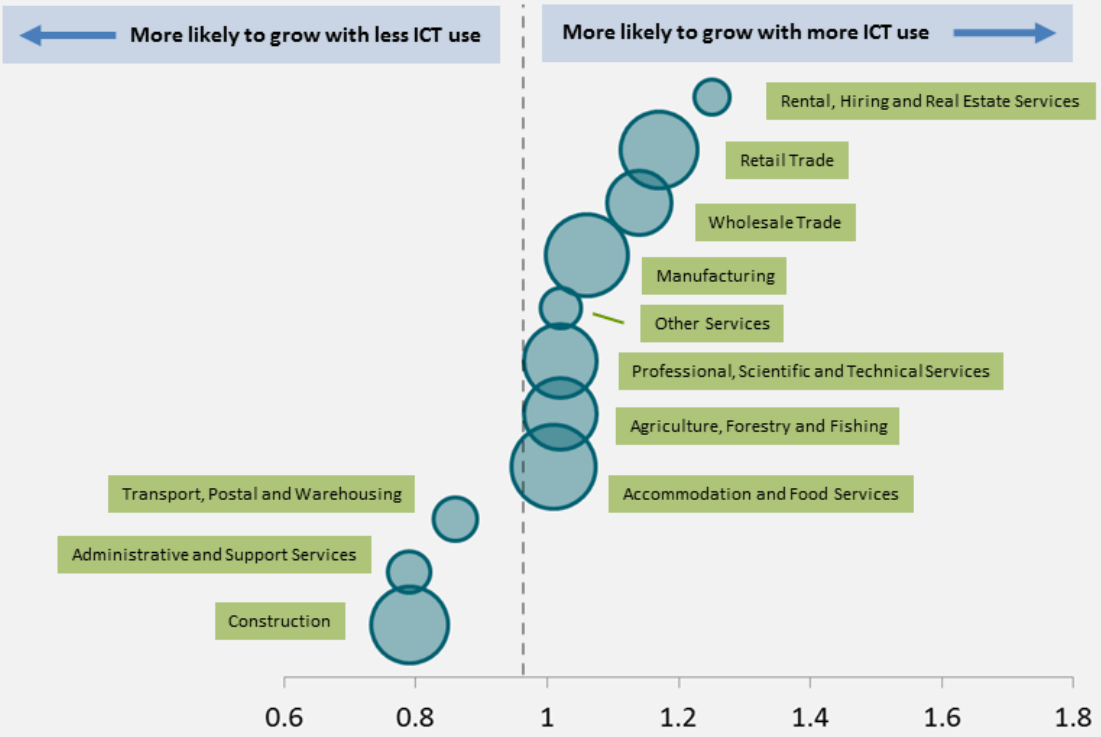
Although not differing from other firms in their industry in terms of productivity levels, high ICT-use firms in Accommodation and Food Services and Professional, Scientific and Technical Services were appreciably more likely to improve their productivity, which may presage the emergence of productivity differentials in the future. Conversely, high ICT-use firms in Financial and Insurance Services and Retail and Wholesale Trade were more productive than other firms in their industries but had no increased propensity to grow, for reasons discussed previously.

High ICT use associated with:	Similar or lesser likelihood of productivity growth	Increased likelihood of productivity growth (>10%)
Similar or lower productivity	• Administrative and Support Services • Manufacturing • Other Services • Information Media and Telecommunications	• Accommodation and Food Services • Professional, Scientific and Technical Services
Higher productivity (>$10K)	• Financial and Insurance Services • Retail Trade • Wholesale Trade	• Transport, Postal and Warehousing • Construction
Insufficient sample to assess: Agriculture, Forestry and Fishing; Mining; Electricity, Gas, Water and Waste Services; Rental, Hiring and Real Estate Services; Arts and Recreation Services		

Across industries, mid-intensity ICT use was more weakly associated with the likelihood of productivity growth (relative to low-use) than high-intensity ICT use. Firms in most industries were marginally more likely to see productivity improvement with mid-intensity ICT use than low use, with the notable exceptions of Transport, Postal and Warehousing, Administrative and Support Services, and Construction. The fact that firms in Transport, Postal and Warehousing and Construction were less likely to improve productivity with mid-intensity ICT use (relative to low use), but more likely to improve productivity with high-intensity ICT use (relative to medium or low use) reflects low productivity growth by mid-intensity ICT-use firms in each sector. In Construction, only 38% of mid-intensity ICT-use firms achieved above-average productivity growth; in Transport, Postal and Warehousing only 34%.

Small to medium-sized firms in most industries were marginally more likely to improve productivity with mid-intensity ICT use than low-intensity ICT use

THE RELATIVE LIKELIHOOD OF PRODUCTIVITY GROWTH OVER TWO YEARS WITH MID- VS LOW-INTENSITY ICT USE



Source: Statistics NZ BOS; Fabling and Maré productivity dataset; MBIE analysis

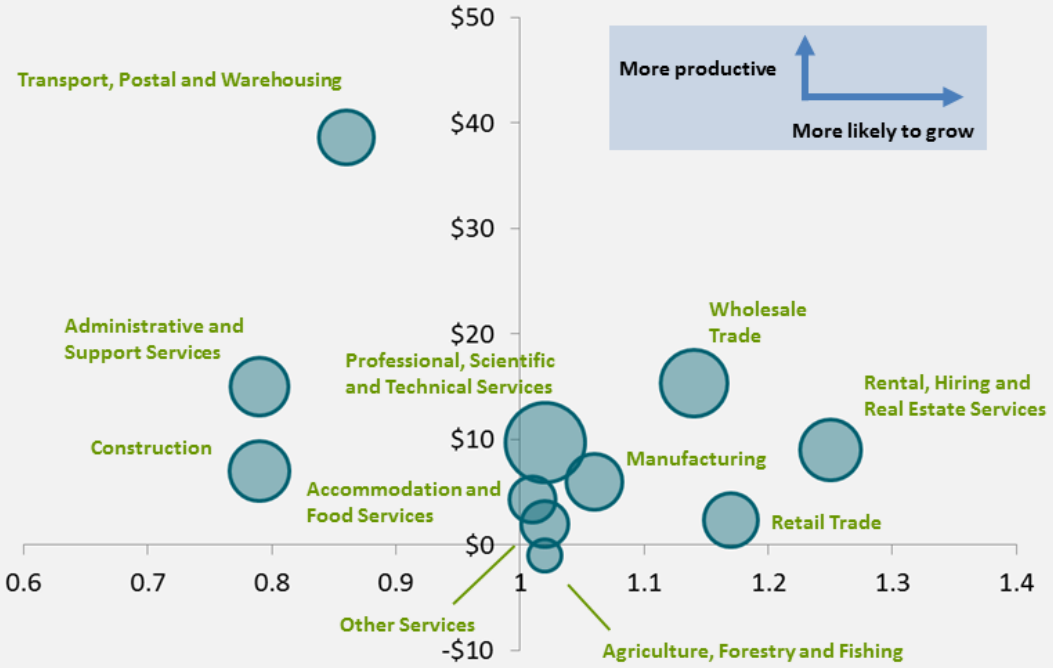
Note: Circle size is proportion to the number of small to medium-sized firms (6 to 49 employees) in the industry. Productivity growth over two years was averaged over 2006-2012.

Administrative and Support Services was the only sector in which low-intensity ICT-use firms were the most likely to see productivity improvement, and this was only true for two of the three two-year intervals on record (2006 to 2008 and 2008 to 2010, but not 2010 to 2012). A sector which had too few firms to report productivity associations with high-intensity ICT use, Rental, Hiring and Real Estate Services, was the most likely to see productivity improvement with mid-intensity ICT use (52% of mid-intensity ICT-use firms achieved above-average productivity growth vs 46% of low-use firms).

With the exception of Transport, Postal and Warehousing, firms in most sectors were modestly more productive ($0 to $15,000) with mid-intensity ICT use than low-intensity ICT use. Mid-intensity ICT-use firms in Transport, Postal and Warehousing were particularly productive relative to other firms in their industry.

Mid-intensity ICT-use firms in most industries were more productive than low-intensity firms

THE RELATIVE LIKELIHOOD OF PRODUCTIVITY GROWTH AND DIFFERENCES IN MEDIAN PRODUCTIVITY (VALUE-ADD/FTE, $1K) BETWEEN MID- AND LOW-INTENSITY ICT-USE FIRMS WITH 6 TO 49 EMPLOYEES



Source: Statistics NZ BOS; Fabling and Maré productivity dataset; MBIE analysis

Note: Median productivity and growth likelihoods were averaged in two-year intervals over 2006-2012. Circle sizes are proportionate to the number of mid-intensity ICT-use firms in each group (relative to low use).

In most sectors, productivity differences were generally more pronounced between high-use and other firms than between medium-use and low-use firms. A consistent pattern was that firms with greater ICT use were either more productive or more likely to improve their productivity, regardless of sector, albeit marginally so in some cases. Put another way, there were no sectors in which firms were both less productive and less likely to improve their productivity with more ICT use.

The lack of clear productivity difference between firms with different intensities of ICT use in some sectors does not imply that they would not benefit from greater ICT use; rather, that there were no obvious advantages over the time period examined. This could indicate that firms with lower levels of ICT use are comparatively competitive in these industries, or that ICT is not being used as effectively as it could be. To some degree these patterns may be muted by comparing high-use firms to medium- and low-use firms, and medium- to low-use firms; if a simple high/low dichotomy was used instead the patterns would most likely be exaggerated.

Medium ICT use associated with:	Similar or lesser likelihood of productivity growth	Increased likelihood of productivity growth (>10%)
Similar or lower productivity	• Professional, Scientific and Technical Services • Manufacturing • Accommodation and Food Services • Other Services • Agricultural, Forestry and Fishing • Construction	• Rental, Hiring and Real Estate Services • Retail Trade
Higher productivity (>$10K)	• Transport, Postal and Warehousing • Administrative and Support Services	• Wholesale Trade
Insufficient sample to assess: Mining; Electricity, Gas, Water and Waste Services; Information Media and Telecommunications; Financial and Insurance Services; Arts and Recreation Services		

Appendix: Business Operations Survey (BOS) ICT use

The following questions from the ICT module of the 2014 Business Operation Survey were used to quantify ICT use by firms. To maintain backwards compatibility, only response options included in all iterations of the survey (2006 through 2014) were used. Activities to get more benefit from ICT use were not incorporated into analyses and are shown for reference.

9 Mark all that apply. Has this business's **use of ICT** been important in achieving any of the following outcomes?

- improved responsiveness to customer needs (eg customised goods or services) B0901
- greater understanding of markets (eg analysing customer purchasing patterns) B0902
- better sales or marketing methods B0903
- introduced goods or services not possible without ICT B0904
- reduced prices from suppliers (eg through ability to shop around) B0905
- improved efficiency of work flow, inventory management, or ordering systems (eg just-in-time processes) B0906
- better coordination of staff and business activities B0907
- improved efficiency of production processes (eg due to reduced downtime or automation) B0908
- improved management of quality B0909
- improved management information systems (eg real-time performance monitoring) B0910
- reduced costs of entering new markets B0911
- shifted activities to other businesses (eg contracting out payroll functions) B0912
- improved collaboration with other businesses (eg on joint development or marketing) B0913

or none of the above B0914

10 Mark all that apply. In the **last 2 financial years**, has this business done any of the following activities **to get more benefit from its ICT**?

- changed staff levels or skills mix B1001
- trained employees B1002
- introduced new work practices (eg teamworking) B1003
- restructured the organisation B1004
- implemented new business strategies or management techniques B1005
- physically relocated any business activities B1006
- invested in capital other than ICT B1007
- performed research and development B1008
- redesigned processes for producing or distributing goods or services B1009
- shifted production towards goods or services that use ICT more intensively B1010

or no, none of the above were done to increase the benefits of ICT B1011

11 Does this business use the Internet?

- ○ 1 yes → go to **12**
- ○ 2 no → go to **25** B1100

12 Please give a careful estimate. What percentage of this business's staff have access to the Internet at work? ☐☐☐% B1200

18 Mark all that apply. For which of the following activities, if any, does this business use the Internet?

- ○ finance (eg on-line banking, invoicing, making payments) B1801
- ○ internal or external recruitment (eg details of vacant positions on an intranet or website) B1802
- ○ staff training (eg e-learning applications available on an intranet or the Internet) B1803
- ○ sharing information within your business (eg intranet, knowledge management software) B1804
- ○ sharing information with other organisations (eg collaboration with business partners) B1805

or ○ no, the Internet is not used for any of these activities B1806

19 Mark all that apply. For which of the following activities, if any, does this business use the Internet for dealing with central or local government?

- ○ obtaining information from government websites or via email B1901
- ○ downloading or requesting government forms (eg tax forms) B1902
- ○ completing forms on-line or sending completed forms (eg applications for permits, claims for grants, tender documents, tax forms) B1903
- ○ making on-line payments (eg tax, rates, fines) B1904

or ○ no, the Internet is not used for any of these activities in dealing with government B1905

20 In the last financial year, did this business use the Internet to place orders to purchase goods or services?

Include:
- capital and current purchases (eg travel and other services, office supplies, equipment)
- orders placed via the Internet whether or not payment was made on-line
- orders placed via websites, specialised Internet marketplaces, and extranets

Don't include:
- orders submitted via conventional email
- orders which were cancelled or not completed

- ○ 1 yes
- ○ 2 no
- ○ 3 don't know B2000

21 In the last financial year, did this business use the Internet to receive orders to sell goods or services?

Include:
- orders received on behalf of other businesses, and orders received by other businesses on behalf of this business
- orders received via the Internet whether or not payment was made on-line
- orders received via websites, specialised Internet marketplaces, and extranets

Don't include:
- orders submitted via conventional email
- orders which were cancelled or not completed

1 yes → go to **22**
2 no
3 don't know → go to **25**

B2100

22 Mark all that apply. How were those Internet orders in question **21** received?

email linked to your website B2201
on-line ordering facility on your website (eg shopping cart) B2202
third party website (eg specialised Internet marketplace or an agent's site) B2203
none of the above B2204

23 Please give a careful estimate. In the last financial year, what percentage of total dollar sales did this business's Internet sales represent?

Note:
- in respect of Internet orders received on behalf of other organisations, include only fees or commissions earned. However, include the value of Internet sales orders received by other organisations on your behalf (eg by agents)
- for financial services, include commissions, premiums, and fees earned in respect of services offered over the Internet

1 zero → go to **25**
2 1–10%
3 11–25%
4 26–50%
5 more than 50% → go to **24**
6 don't know → go to **25**

B2300

24 Please give a careful estimate. In the last financial year, what percentage of this business's total dollar Internet sales was sold to customers outside New Zealand?

- 1 zero
- 2 1–10%
- 3 11–25%
- 4 26–50%
- 5 more than 50%
- 6 don't know

B2400

25 Does this business have a website, homepage, or other web presence?

Include a presence on another entity's website if this business has **substantial control** over the content of the page.
Don't include listings in an on-line directory.

- 1 yes → go to **26**
- 2 no → go to **27**

B2500

26 Mark all that apply. Which of the following features and facilities are offered on this business's web presence(s)?

- goods or services information or prices B2601
- facility for collecting customer information on-line B2602
- on-line ordering facility for this business's goods or services B2603
- facility for on-line payment B2604
- provision of on-line after sales support (eg on-line queries, customer feedback) B2605
- customised web page or information provided for repeat customers B2606
- information about privacy or security (eg privacy or security policy statements) B2607

Appendix: Additional notes

Document information

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The results in this report are not official statistics; they have been created for research purposes from the Integrated Data Infrastructure (IDI), managed by Statistics New Zealand.

The opinions, findings, recommendations, and conclusions expressed in this report are those of the author, not Statistics NZ or MBIE.

Access to the anonymised data used in this study was provided by Statistics NZ in accordance with security and confidentiality provisions of the Statistics Act 1975. Only people authorised by the Statistics Act 1975 are allowed to see data about a particular person, household, business, or organisation, and the results in this report have been confidentialised to protect these groups from identification.

Careful consideration has been given to the privacy, security, and confidentiality issues associated with using administrative and survey data in the IDI. Further detail can be found in the Privacy impact assessment for the Integrated Data Infrastructure available from www.stats.govt.nz.

The results are based in part on tax data supplied by Inland Revenue to Statistics NZ under the Tax Administration Act 1994. This tax data must be used only for statistical purposes, and no individual information may be published or disclosed in any other form, or provided to Inland Revenue for administrative or regulatory purposes.

Any person who has had access to the unit record data has certified that they have been shown, have read, and have understood section 81 of the Tax Administration Act 1994, which relates to secrecy. Any discussion of data limitations or weaknesses is in the context of using the IDI for statistical purposes, and is not related to the data's ability to support Inland Revenue's core operational requirements.

Sector coverage

The analysis was conducted for the measured sector only, meaning only firms that produce goods and services for economically significant prices that affect the amount customers are willing to purchase were included. In terms of Australian and New Zealand Standard Industrial Classification (ANZSIC), this excluded firms in the Public Administration and Safety, Education and Training, and Health Care and Social Assistance sectors.

Weighting

Results were weighted to be nationally representative using frequency weights assigned to the BOS ICT module in the LBD. The analyses excluded firms without a matching record in the productivity database in the same year; however, this represented less than 0.5% of all firms. When tracking firm productivity outcomes over time, only firms with no reported earnings in all subsequent intervals were assumed to have ceased operations; otherwise, a lack of productivity information for a given interval was treated as a non-sample and excluded. Given the high match rates above, it is unlikely that re-weighting for excluded samples would have an appreciable impact of results.

Estimating uncertainty

The standard errors used to produce confidence intervals and conduct tests of significance are underestimates of the true degree of uncertainty. This is because BOS survey responses up-weighted to national totals are treated as having the sample size of national totals, which makes the results appear more robust. Calculating standard errors through bootstrapping or other re-sampling techniques is problematic because the original sampling design was complex and involved different sampling probabilities for different firms. Therefore, confidence intervals and tests of significance are relatively liberal and should be taken as indicative only. Given the primary emphasis of the analyses was to document patterns rather than to establish causality, there are few tests of significance or confidence intervals presented, and the narrative is not overly reliant on those results.

Economy-wide patterns: by firm or by industry?

Economy-wide productivity patterns were derived from the results of individual firms; in essence this gave equal weight to all firms regardless of industry. In practice, this means that industries with more firms have a greater impact on results. An alternate presentation would be to calculate the results by industry, and then average the industry results together to get an economy-wide effect. The advantage of this presentation is that results would be less sensitive to changes in the distribution of

firms among industries over time; a disadvantage is that it would not reflect the distribution of firms among industries when determining the scale of effects.

To test the extent to which a by-industry analysis would impact the headline findings, the relationship between ICT use the relative likelihood of productivity growth was analysed for each industry, with the effects averaged to an economy-wide total. A direct comparison between these results and the original by-firm approach was not possible because not all industries had sufficient sample size to produce a reliable industry effect (whereas all firms were included in the original analysis). Instead, by-industry results were compared to by-firm results using only the industries with sufficient sample size to compute industry effects.

Using a by-industry approach instead of a by-firm approach affected these relationships as follows:

- High- vs mid-intensity ICT use: High-intensity +6% more likely to improve productivity
- High- vs low-intensity ICT use: High-intensity +3% more likely to improve productivity
- Mid- vs low-intensity ICT use: Mid-intensity -3% less likely to improve productivity

Using a by-industry approach, the association between high-intensity ICT use and productivity growth was marginally stronger and the association between mid-intensity ICT use and productivity growth was marginally weaker. The productivity growth pattern between years was relatively unaffected.

The relative contributions of increased value-add and decreased labour to increased labour productivity

Labour productivity (LP) was taken as the ratio of value-add (VA, gross output minus intermediate consumption) over labour (full time equivalents) as follows:

$$LP = VA/Labour$$

Or equivalently,

$$LP = VA * 1/Labour$$

The expression can be made additive by taking the natural log of each side:

$$\ln(LP) = \ln(VA) + \ln(1/Labour)$$

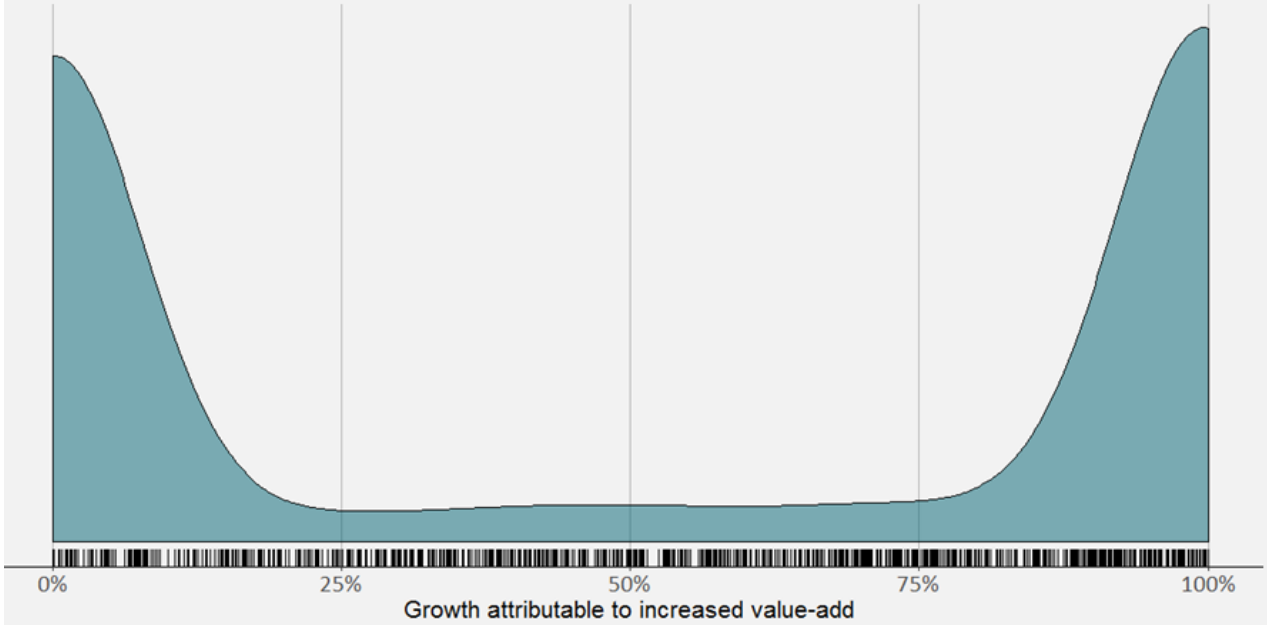
The change in ln(LP) over time can be expressed in terms of change in the component parts:

$$\Delta\ln(LP) = \Delta\ln(VA) + \Delta\ln(1/Labour)$$

To estimate the relative contribution of increased value-add and reduced labour to above-average productivity growth, the magnitude of change in Δln(LP) from each of Δln(VA) and Δln(1/Labour) was compared. If labour increased or value-add decreased, productivity growth was attributed to value-add or labour, respectively. In cases where firms transitioned from negative to positive productivity, growth was attributed to increased value-add.

In most cases, productivity growth was unequivocally due to reduced labour or increased value-add

FREQUENCY DISTRIBUTION OF GROWTH ATTRIBUTABLE TO INCREASED VALUE-ADD FOR FIRMS WITH ABOVE-AVERAGE PRODUCTIVITY GROWTH 2006-2012



Source: Statistics NZ BOS; Fabling and Maré productivity dataset; MBIE analysis

Note: Productivity growth not attributable to increased value-add was attributable to reduced labour.

Cluster analysis

K-medoid clustering was used to partition firms into three different groups (or clusters) based on their responses to 39 questions in the BOS. K-medoid clustering is an unsupervised technique, which means the clusters were not formed in relation to a particular variable (e.g. productivity), but instead were natural groupings of how firms jointly responded to questions in the BOS. At the centre of each cluster was an actual firm, and distances were calculated that represent how similar each firm was to the different cluster centres. Each firm was given the identity of the nearest (i.e. most similar) cluster. The clusters themselves were not formed with any pre-existing identities; rather, what they represent can be inferred by looking at how firms in that cluster responded to individual BOS question.

Some of the 39 questions had a greater influence on cluster identity than others. To determine which questions were the most influential, a discriminant function analysis was performed with clusters as the dependent variable and responses to the 39 questions as independent variables. Discriminant functions were formed that maximize differences between clusters in multivariate space; the variables that correlate most strongly with functions (r>0.35) contributed most to cluster differences.

Clusters were created, which were in turn related to the likelihood of productivity growth. An alternate way to conduct the analysis would have been to create discriminant functions that combine BOS responses to the likelihood of productivity growth directly. The latter approach is only marginally more predictive of productivity

growth than the clustering approach, and none of the variables correlate strongly enough with discriminant functions to make actionable inferences about what ICT uses are important (all $r<0.10$).

The likelihood of productivity growth can also be related to individual responses in the BOS, although caution should be used in reading too much into patterns, given uses tend to have a high degree of overlap.

The most common ICT uses were associated with an increased likelihood of productivity growth

LIKELIHOOD OF PRODUCTIVITY GROWTH WITH A POSITIVE RESPONSE, RELATIVE TO A NEGATIVE RESPONSE

	Relative likelihood of productivity growth	% use
Does this business use the internet?	1.2	96%
Did the business use the internet to purchase goods and services?	1.07	78%
Did the business use the internet to receive orders?	1	47%
Does the business have a website, homepage, or other web presence?	1	70%
What activities does this business use the internet for?		
Sharing information with your business	1.04	50%
Finance	1.13	90%
Sharing information with other organisations	1.03	39%
Internal or external recruitment	1.02	52%
Staff training	1.05	37%
How does this business use the internet for dealing with central or local government?		
Completing forms on-line or sending completed forms	1.06	66%
Obtaining information from government websites or via email	1.1	72%
Making online payments	1.06	81%
Downloading or requesting information	1.06	73%
ICT has been important for achieving what outcomes?		
Improved collaboration with other businesses	0.99	11%
Better coordination of staff and business activities	1.02	50%
Improved efficiency of work flow, inventory management or ordering systems	1.01	47%
Introduced goods or services not possible without ICT	0.99	20%
Improved management information systems	1.04	37%
Reduced costs of entering new markets	0.96	8%
Better sales or marketing methods	1.01	40%
Reduced prices from suppliers	0.92	20%
Improved efficiency of production processes	1.04	30%
Improved management of quality	1.02	32%
Improved responsiveness to customer needs	1.08	55%
Shifted activities to other businesses	0.93	11%
Greater understanding of markets	1	27%
How were internet orders received?		
Third party website	0.99	12%
Emailed linked to business website	1.02	34%
Online ordering facility on business website	1.01	17%
What features and facilities are offered on the business' web presence?		
Customised web page or information provided for repeat customers	0.96	18%
Goods or services information or prices	1.02	63%
Facility for collecting customer information online	1.01	24%
Online ordering facility for the business' goods or services	1.03	21%
Facility for online payment	1.07	12%
Information about privacy and security	1.04	15%
Provision for online after sales support	1.01	23%

Source: Statistics NZ BOS; Fabling and Maré productivity dataset; MBIE analysis

Notes: Likelihoods are averaged over two-year intervals over 2006-2012. % use refers to the percentage of firms responding positively to each question in the 2014 BOS.

In an effort to link productivity growth with recent increases in ICT use, firms were identified that used a low or medium amount of ICT in one interval and a high amount in the next. This required a 'jump' in use sufficient enough to change cluster identity; few firms made this jump across any two-year interval, possibly making it difficult to detect small but meaningful productivity growth differences.

In an effort to detect more subtle patterns, the multivariate distance (gower) between each firm and the high-intensity ICT use cluster centre was calculated for firms across time intervals. If this distance decreased, firms were becoming more like high-intensity ICT-use firms, and the distance itself serves as an approximation for how much more (or less) like high-intensity firms they became. These distances were used as the input variables in a logistic regression, with productivity growth (yes or no) as the dependent variable.

Clusters were formed with responses from the 2014 BOS; these identities were back-cast onto firms from 2006 through 2012. To some extent, the ways that firms use ICT in combination changes over time, such that clusters formed from a different BOS survey (e.g. the 2006 BOS) would likely lead to some classification differences. To test the consistency of cluster composition over time, clustering was performed with responses from the 2006 BOS. Firms were broadly sorted into low-, mid-, and high-intensity ICT-use firms, as with the 2014 BOS, and the primary determinants of high-intensity (internet sales, using ICT to achieve numerous business outcomes) and mid-intensity (web presence, internet purchases) were highly similar.

Thirteen of the 39 BOS questions asked whether ICT had been used to achieve a business outcome. Answering positively to these questions implied that a firm not only used ICT, but used it successfully, which may have tilted findings towards a positive ICT use / productivity relationship (assuming firms that achieve business outcomes are generally more productive). Removing those 13 questions from clustering would result in a mild decrease of ~2% in the relative likelihood of productivity growth for high-intensity ICT-use firms, economy-wide. Cluster identity would remain the same for 77% of firms.

Appendix: Relationship to previous studies

The results from this study cannot be compared directly to those of the Sapere studies because methods differed – the latter focused on differences in productivity levels between firms that used the internet in particular ways,[24] whereas this study focused on evidence of productivity growth associated with a collection of ICT uses. For context, this study did examine differences in median productivity between firms using more or less ICT from 2006 to 2012. Firms with a mid-intensity or high-intensity of ICT use were consistently more productive than low-intensity ICT-use firms. This is broadly consistent with the finding of the Sapere studies that firms using the internet more are more productive.

Sapere estimated that making low internet use firms more like high-use firms could be worth an additional $34 billion to the nation's economy through productivity impacts. Making similar assumptions, the productivity impact of transitioning firms from a low-intensity of use to medium use could be worth a more conservative $360 million.[25] There was no comparable advantage to making mid-intensity ICT-use firms more like high-intensity ICT-use firms, although high-intensity ICT-use firms more consistently raised their productivity. Given that neither this study nor the Sapere studies controlled for confounding factors or provided evidence relating increased ICT use to productivity levels, these values should be viewed as highly speculative.

A key finding of this study is that firms using more ICT in one way typically use more ICT in other ways, making it difficult to ascertain which aspects of ICT use have the greatest impact on productivity. The Sapere studies found that productivity was most closely associated with whether firms made more than 25% of their sales online, a group that comprised less than 10% of all firms. In the current study, productivity growth was most closely associated with the most common ICT uses, such as using the internet for finance. In both cases, isolating a small group that has unusually low or high ICT use made it easier to detect a productivity gradient, but caution should be taken in inferring productivity differences are due to online sales or finance because a) any firm that has >25% online sales almost certainly uses ICT in many other ways and b) any firm that does not use the internet for finance probably uses ICT for little if anything. In a sense, these could both simply be good signals of the overall intensity of ICT use within a given firm.

Cluster identity in this study was most closely associated with internet sales, a web presence, and the number of business outcomes ICT was used to achieve. These are useful indicators of the intensity of ICT use within a firm, but should not be interpreted as the aspects of use having the largest impact on productivity growth; for reasons above, this study is agnostic about which are the substantial drivers. In general, though, more ICT use is better.

[24] Sapere looked at five aspects of internet use from the BOS: What percentage of staff has access to the internet? Did the business have a website, homepage, or other web presence? Did the business use the internet to purchase goods and services? Did the business use the internet to receive orders? What types of connection to the internet does the business use (fibre)?

[25] The average difference in mean productivity between low- and medium-use firms from 2006 to 2012 was approximately $29K. The total economic benefit was derived by multiplying this figure by the number of low-intensity ICT-use firms in 2014 (12,500).

The Sapere studies did not explicitly address the issue of productivity growth. The existence of differences in productivity levels between high and low internet use firms might suggest that high-use firms grow more, but alternatively the pattern could have arisen from historical processes that no longer apply. The current study found that the relationship between ICT use and productivity growth was variable over time and between industries, but overall, high-intensity ICT-use firms were more likely to see productivity improvement between 2006 and 2012. Should this trend continue, one might expect the productivity of high-intensity ICT-use firms to increase relative to other firms (albeit slowly). Extending the analysis to future years, when available, would speak to this possibility.

Though taking different approaches to get there, both the current study and the Sapere studies identify Construction and Transport, Postal, and Warehousing as the sectors of the economy most likely to benefit from increased ICT use. The remaining rankings were somewhat consistent, with some exceptions. For example, Sapere placed Manufacturing among the top five industries in terms of modelled productivity gain from increased internet use, whereas the current study found only modest productivity differences between firms using more or less ICT in the industry. Conversely, the current study noted a strong relationship between productivity and increased ICT use in Wholesale Trade, whereas Sapere ranked it among the least likely sectors to realise productivity benefits from high internet use.

The majority of studies on ICT productivity effects in New Zealand have focused on ICT investment (e.g. broadband, fibre) rather than on how firms use ICT once they have acquired the requisite components.[26] According to the complementarity hypothesis, firms derive a productivity benefit from ICT capital by making complementary adjustments to business practices that take advantage of the new ICT; for example, by hiring employees with a different skill mix or changing how goods and services are developed, produced, or marketed.[27] It may take several years for firms to develop the business practices around new ICT to realise the full productivity benefit. In this study, with its focus on ICT use, firms should be closer in time to observable productivity benefits, because firms would have needed to invest in ICT and made the necessary organisational adjustments to use ICT for business purposes. A slight lag of about two years was noted from when a firm increased ICT use to when the likelihood of productivity growth increased. In exploring the productivity effects of ultra-fast broadband uptake, Fabling and Grimes found contemporaneous benefits only among firms that paired uptake with organisational investments that complemented faster access.

[26] Grimes et al. 2009. The need for speed: impacts of internet productivity on firm productivity. Fabling and Grimes 2016. Picking up speed: does ultra-fast broadband increase firm productivity? Statistics NZ 2013. Information technology's contribution to labour productivity growth.
[27] Biagi 2013. ICT and productivity: A review of the literature.

References

Baller, S., Dutta, S. and B. Lanvin, editors. (2016). *The Global Information Technology Report 2016: Innovating in the Digital Economy*. World Economic Forum and INSEAD.

Biagi, F. (2013). *ICT and productivity: a review of the literature*. European Commission; Joint Research Centre; Institute for Prospective Technological Studies.

Blick, G. Sin, M., Davies, P. and H. Glass. (2015). *Identifying sectors of the economy for more effective use of ICT*. Sapere Research Group.

The Business Growth Agenda. (2016). *Building a Digital Nation: A BGA Building Innovation Occasional Paper*.

The Commerce Committee. (2011). *Inquiry into finance company failures*.

Fabling, R. and A. Grimes. (2016). *Picking up speed: does ultra-fast broadband increase firm productivity?* Motu Economic and Public Policy Research.

Fabling R. and D. Maré. (2015). *Production function estimation using New Zealand's Longitudinal Business Database*. Motu Economic and Public Policy Research.

Glass, H., Davies, P., Hefter, E. and G. Blick. (2014). *The value of internet services to New Zealand businesses.* Sapere Research Group.

Grimes, A., Ren C. and P. Stevens. (2009). *The need for speed: impacts of Internet connectivity on firm productivity*. Motu Economic and Public Policy Research.

Jaffe, A., Le. T. and N. Chappell. (2016). *Productivity distribution and drivers of productivity growth in the construction industry*. Motu Economic and Public Policy Research.

Mason, G. (2013). *Investigating New Zealand-Australia productivity differences: New comparisons at industry level*. New Zealand Productivity Commission.

Miller, B. and R.D. Atkinson. (2014). *Raising European productivity growth through ICT.* The Information Technology & Innovation Foundation.

Ministry of Business, Innovation & Employment. (2015). *Statement of Intent: 2015-2019*.

The Organisation for Economic Co-operation and Development. (2004). *The Economic impact of ICT: Measurement, evidence and implications*.

Statistics New Zealand. (2013). *Information technology's contribution to labour productivity growth.*

Statistics New Zealand. (2016). *Tourism Satellite Account: 2016.*

Appendix: Sector case studies

Caution: Results based on smaller aggregations are less reliable

- The sectors examined in this section are smaller units of industries examined in the main report. Previously stated cautions about industry patterns, based on their relatively low sample sizes, are especially applicable to sector trends, for which sample sizes are even lower.
- Productivity values in particular should be treated as indicative only as there are some known inconsistencies between productivity statistics in the LBD and official productivity statistics.[28]

The Digital Economy team has a particular interest in productivity patterns among construction trades, tourism, and arable farming firms as targets for a pilot programme in boosting productivity through greater ICT use. Though the patterns are somewhat dated, they should provide some context as to how ICT use and productivity growth in these subindustries compare with other industries and the overall economy. These case studies focus on smaller firms (6 to 49 employees) as they are the target population for the pilot programme.[29]

Firms engaged in tourism, construction, and arable farming were approximated based on their ANZSIC classification codes. Codes for tourism-characteristic industries were based on Tourism Satellite Accounts.[30] Firms classified as Construction Services were taken to represent construction trades, and a custom collection of classifications within Agriculture were used to represent arable farmers. To some degree these characterisations will include firms that are not engaged in those activities and exclude firms that are.

[28] Jaffe et al. 2016. Productivity distribution and drivers of productivity growth in the construction industry.

[29] Firms with fewer than six employees are also of interest to the pilot programme, but are not represented in the BOS survey from which ICT use intensities were derived.

[30] Statistics NZ 2016. Tourism Satellite Account: 2016.

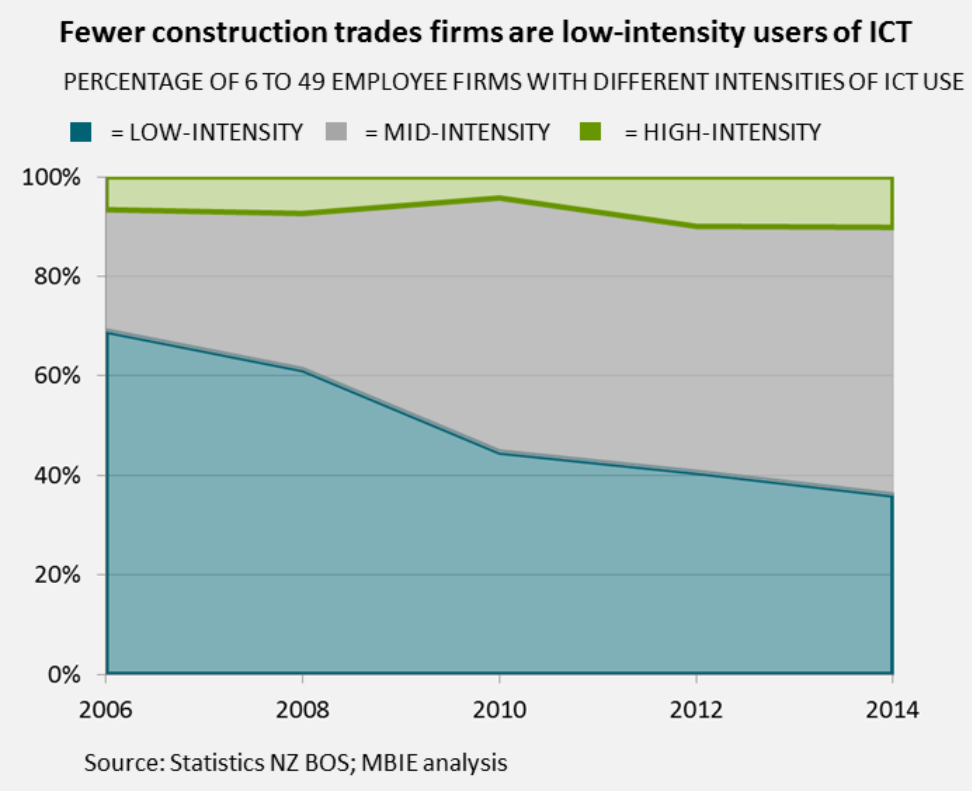
Australian and New Zealand Standard Industrial Classification (ANZSIC) codes used for classification of construction trades, tourism and arable farming

Sector	ANZSIC codes	Description
Construction trades	E32	Construction services
Tourism	H44	Accommodation
	H45	Food and beverage services
	I46	Road transport
	I47	Rail transport
	I48	Water transport
	I49	Air and space transport
	I50	Other transport
	I52	Transport support services
	N722	Travel agency and tour arrangement services
	L661	Motor vehicle and transport equipment rental and hiring
	R89	Heritage activities
	R90	Creative and performing arts activities
	R91	Sports and recreation activities
	R92	Gambling activities
Arable farming	A0146	Rice growing
	A0149	Other grain growing
	A0151	Sugar cane growing
	A0152	Cotton growing
	A0159	Other crop growing

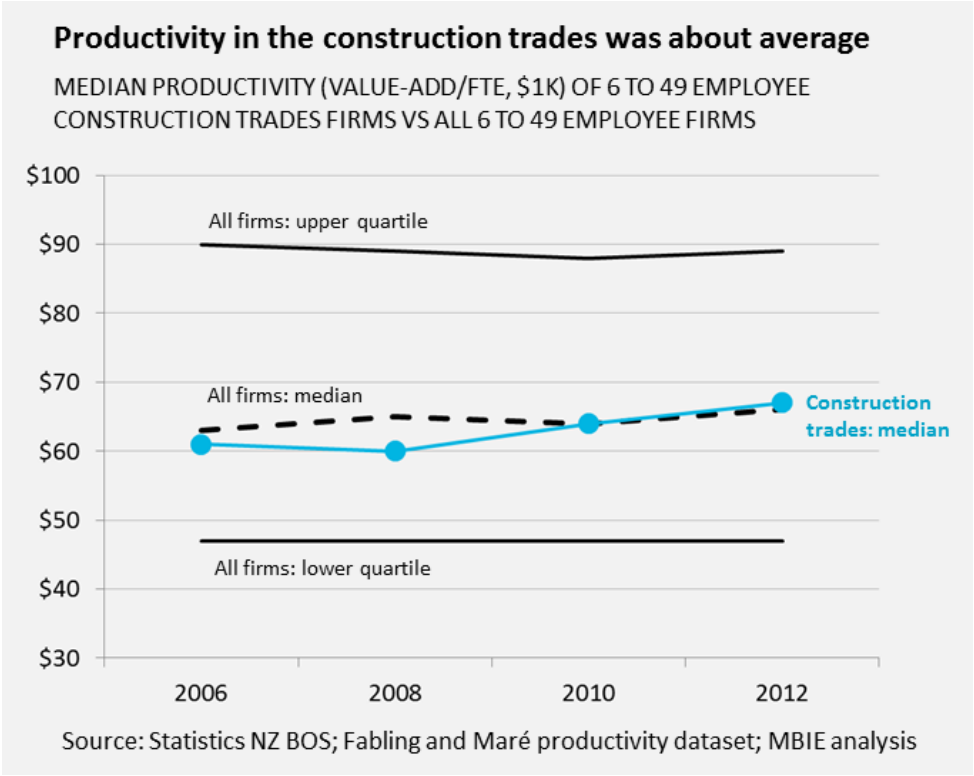
Construction Trades

In 2014, the construction trades comprised approximately 71% of all small to medium-sized firms (6 to 49 employees) in the construction sector. Virtually all construction trades firms had fewer than 50 employees (96%).

The percentage of low-intensity ICT-use firms in 2014 was the same as the economy-wide average (36%), but there were about half as many high-intensity ICT-use firms (10% vs 20%), indicating few firms on the digital frontier but most with some incorporation of ICT into business practice. Almost half (48%) used the internet to receive orders (usually via email) and 69% had a web presence, both of which are in line with economy-wide norms. They had a somewhat low percentage of staff with access to the internet (41% vs 55% economy-wide) and were somewhat more likely to use ICT to get reduced prices from suppliers (32% vs 20%). The intensity of ICT use in the construction trades notably increased from 2006 to 2014, with about half as many firms using a very low level of ICT.



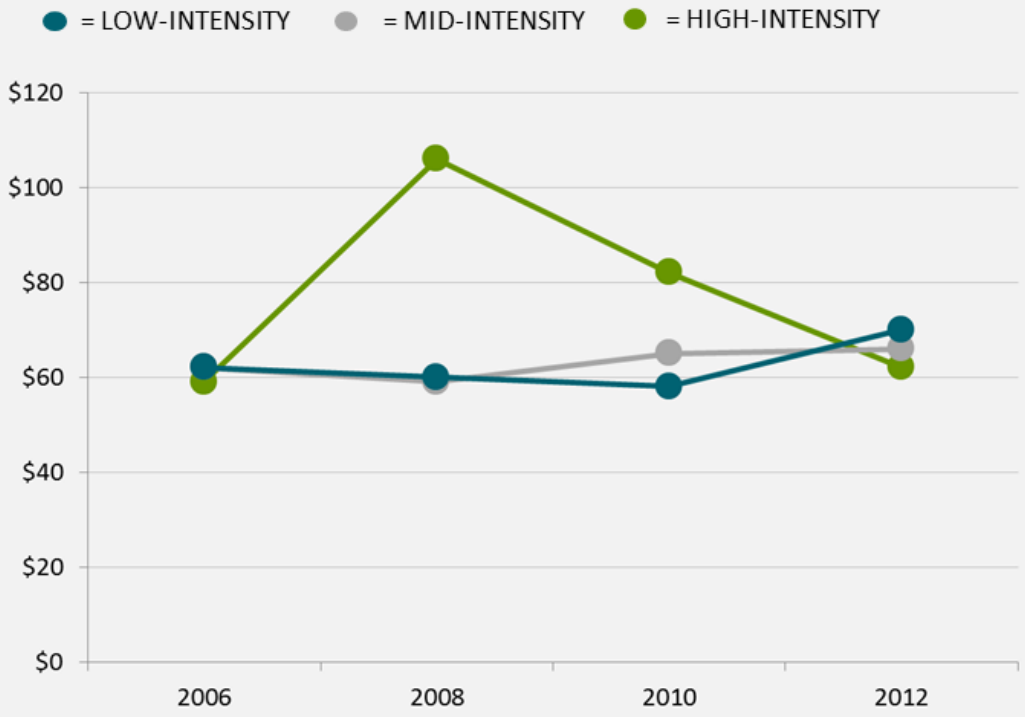
The median productivity level among construction trades firms has modestly increased from $61,000 value-add per full time equivalent in 2006 to $67,000 in 2012. This increase has seen median productivity in the subindustry rise from slightly below the economy-wide average to about average.



There was no evidence of a difference in productivity levels between mid-intensity and low-intensity ICT-use firms, which collectively comprised 90% of small to medium-sized construction trades firms in 2014. High-intensity ICT-use firms appeared more productive in two of four years, potentially the result of measurement volatility given the low number of high-use firms; a cautious interpretation would be that high-intensity firms were equally or more productive than other firms.

High-intensity ICT-use firms in the construction trades were more productive in some years, but not others

MEDIAN PRODUCTIVITY (VALUE-ADD/FTE, $1K) BY INTENSITY OF ICT USE FOR 6 TO 49 EMPLOYEE CONSTRUCTION TRADES FIRMS

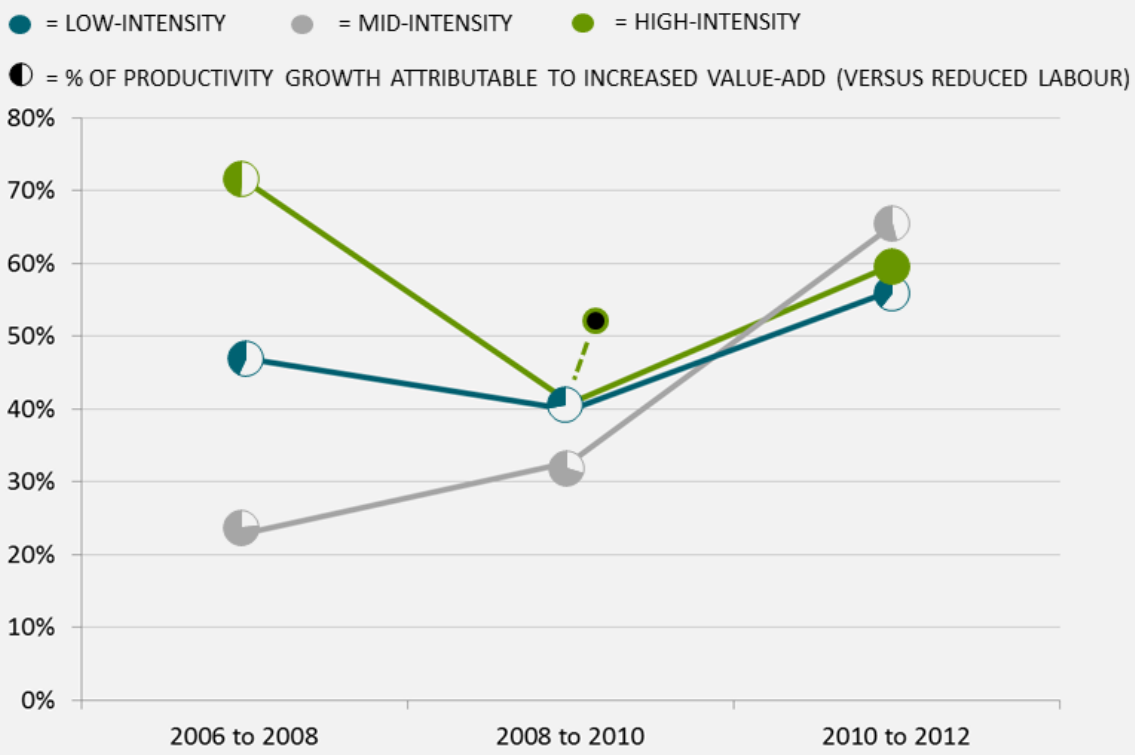


Source: Statistics NZ BOS; Fabling and Maré productivity dataset; MBIE analysis

Productivity growth likelihoods were variable across years for all levels of ICT use – one takeaway would be that all firms had a high likelihood of growth from 2010 to 2012, presumably reflecting strength in the construction industry over this time. Also, low-intensity ICT-use firms tended to achieve productivity growth by reducing labour inputs, whereas mid- and high-intensity ICT-use firms tended to achieve productivity growth through increased value-add. Though the differences in the likelihood of growth from 2006 to 2008 are striking, caution should be used in reading too much into a pattern that is based on relatively few firms and is not replicated in subsequent time intervals. As in the case of productivity levels, a cautious interpretation would be high-intensity ICT-use firms were equally or more likely to improve their productivity than other firms.

Low-intensity ICT-use firms in the construction trades were more likely to achieve productivity growth through labour reduction

THE LIKELIHOOD OF PRODUCTIVITY GROWTH FOR 6 TO 49 EMPLOYEE CONSTRUCTION TRADES FIRMS BY INTENSITY OF ICT USE



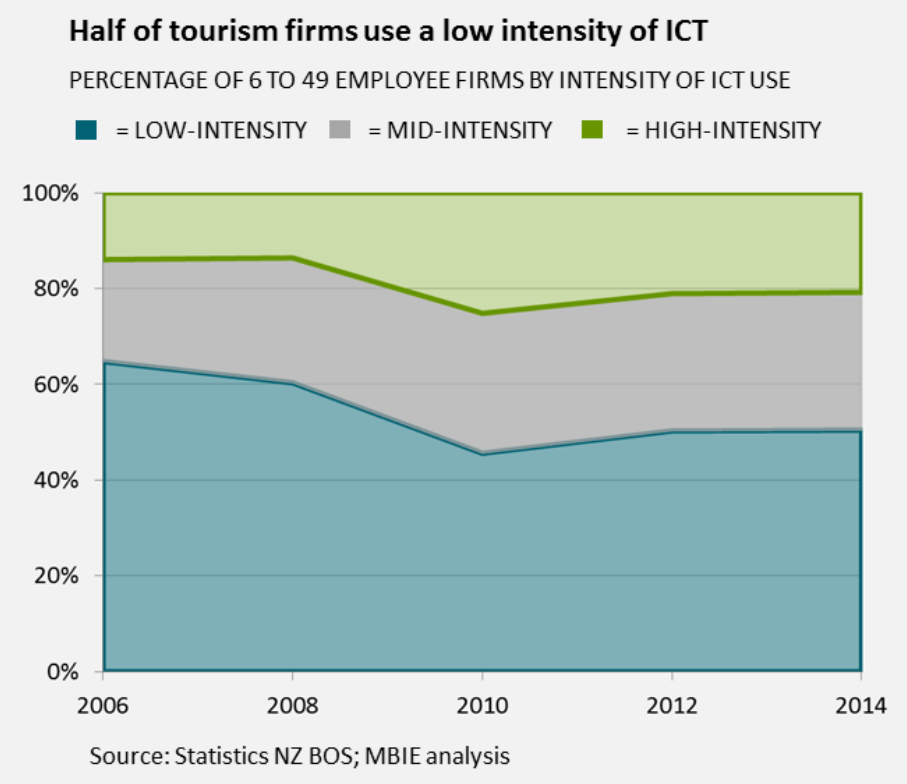
Source: Statistics NZ BOS; Fabling and Maré productivity dataset; MBIE analysis

Note: The enclosed black circle indicates sample size was insufficient to report attribution.

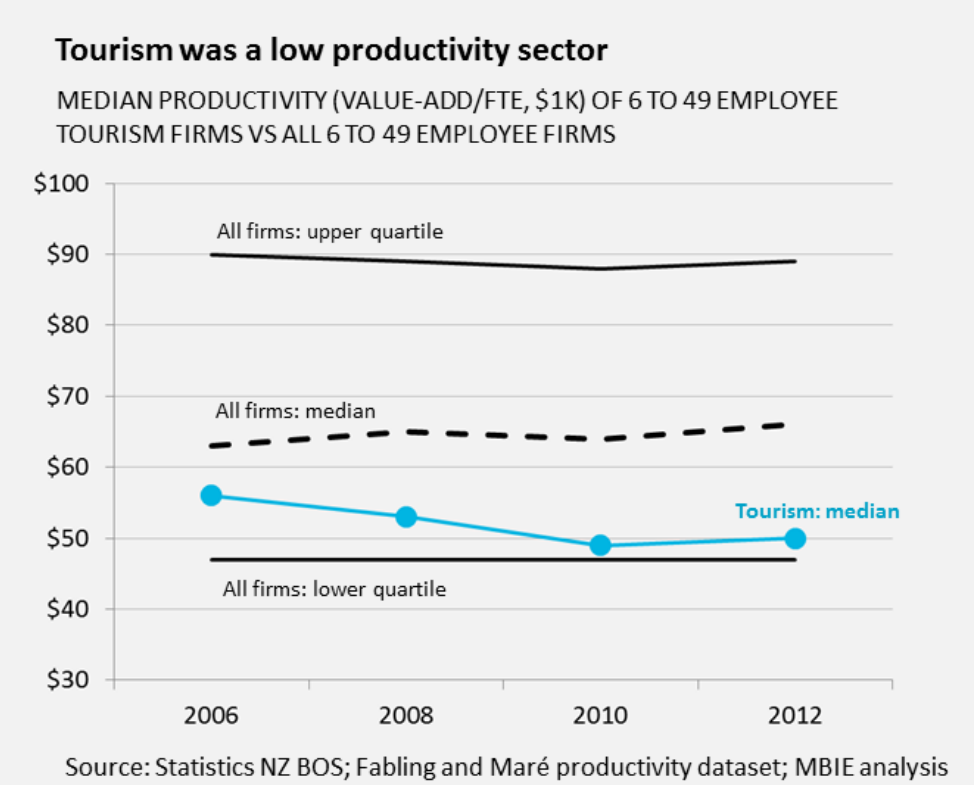
Tourism

In 2014, small to medium-sized firms represented 93% of the total firms in the tourism industry. There were about the same proportion of high-intensity ICT-use firms in tourism (21%) as in the economy at large (20%), but more low-intensity ICT users (50% vs 36%). Low-intensity ICT use in tourism was similar to the construction trades in 2006, but where the latter upgraded to mid-intensity ICT use at a high rate, comparatively few have made the change among tourism firms.

In broad profile, the level of ICT use among tourism firms was fairly typical, with 48% of firms using the internet to receive orders and 71% with a web presence (both rates similar to the broader economy). Although tourism firms received internet orders at a similar rate as construction trades firms, they were more likely to receive orders through a third party website (20% vs 4%) or online ordering facility (25% vs 5%). They also generally had a greater range of facilities and features on their website such online payment facilities (20% vs 1%), information about privacy and security (15% vs 3%), and provisions for online after-sales support (26% vs 16%). The emergent picture is that a small proportion of tourism firms has a relatively high level of digital sophistication (in particular relating to online sales), but there remains an unusually large block of firms with a very low level of digital sophistication.



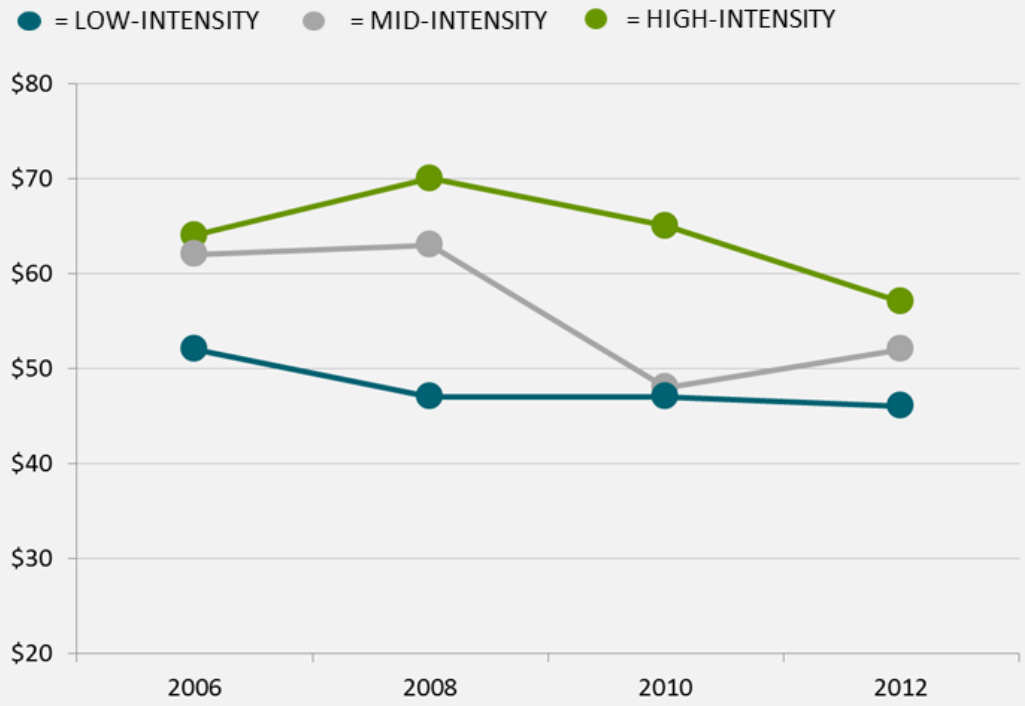
Productivity among tourism firms was low compared with the economy in general, with a slight downward trend from 2006 to 2012. In 2012, the median productivity of small to medium-sized tourism firms ($50,000) was just above the lower quartile of small to medium-sized firms across the economy ($47,000), indicating that about half of tourism firms were among the 25% least productive firms in the economy.



High-intensity ICT-use firms were consistently more productive ($11,000 to $23,000 per year) than low-intensity ICT-use firms from 2006 through 2012. Mid-intensity ICT-use firms were generally intermediate to the two.

High-intensity ICT-use tourism firms were more productive than low-intensity ICT-use firms

MEDIAN PRODUCTIVITY (VALUE-ADD/FTE, $1K) BY INTENSITY OF ICT USE FOR 6 TO 49 EMPLOYEE TOURISM FIRMS

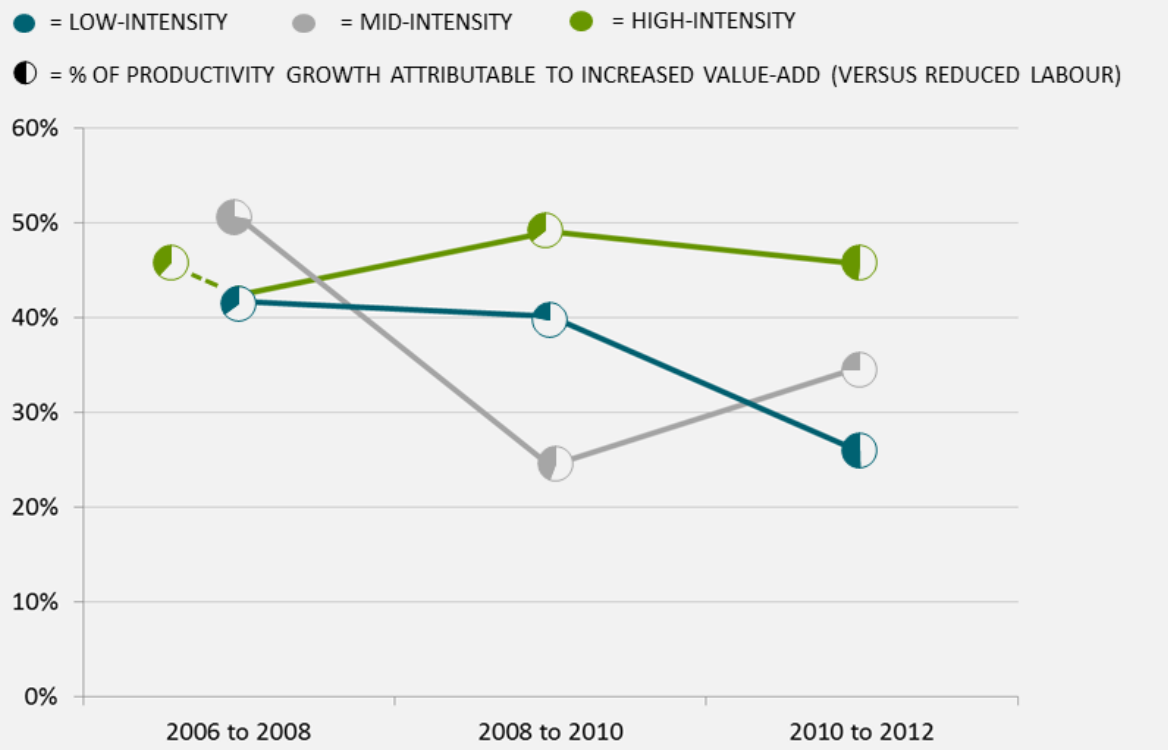


Source: Statistics NZ BOS; Fabling and Maré productivity dataset; MBIE analysis

Productivity growth patterns were variable by year. All tourism firms had a similar likelihood of growth from 2006 to 2008, whereas high-intensity ICT-use firms had a higher likelihood than other firms from 2008 through 2012. On average across all years, high-intensity ICT-use firms were 28% more likely to improve their productivity than other firms. There was a tendency across all firms for growth to be achieved through labour reduction rather than increased value-add.[31]

Small to medium-sized tourism firms tended to achieve productivity growth through labour reduction

THE LIKELIHOOD OF PRODUCTIVITY GROWTH FOR 6 TO 49 EMPLOYEE TOURISM FIRMS BY INTENSITY OF ICT USE



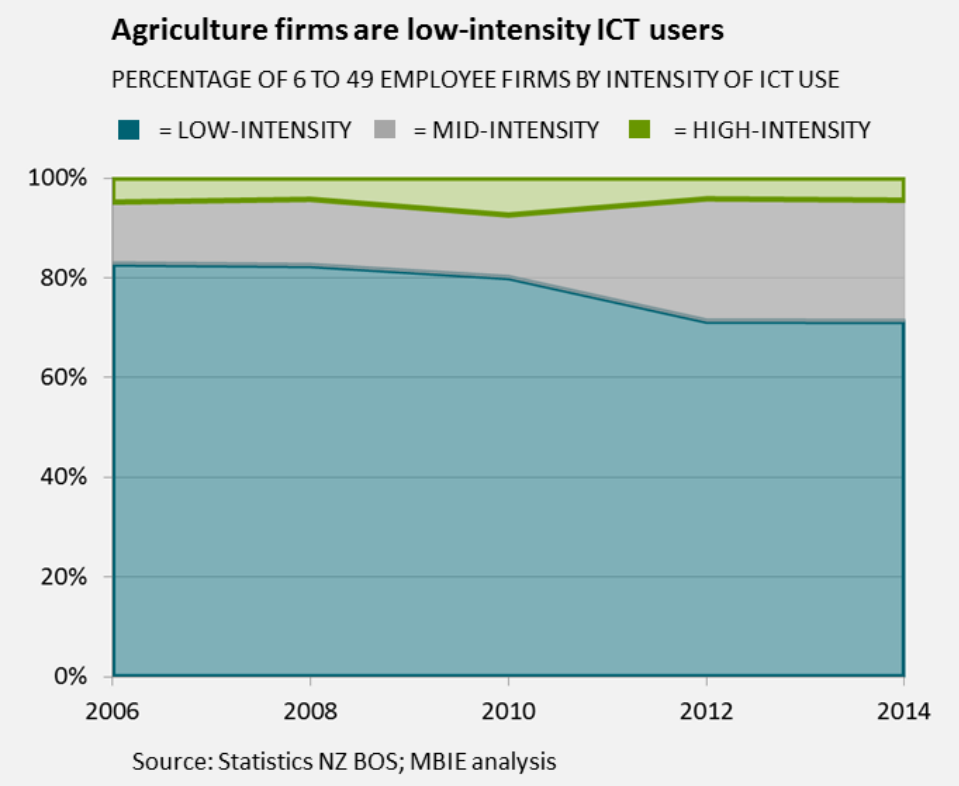
Source: Statistics NZ BOS; Fabling and Maré productivity dataset; MBIE analysis

[31] The percentage of growth attributable to labour reduction across all years for all small to medium-sized tourism firms was 62% (vs 38% attributable to increased value-add).

Agriculture

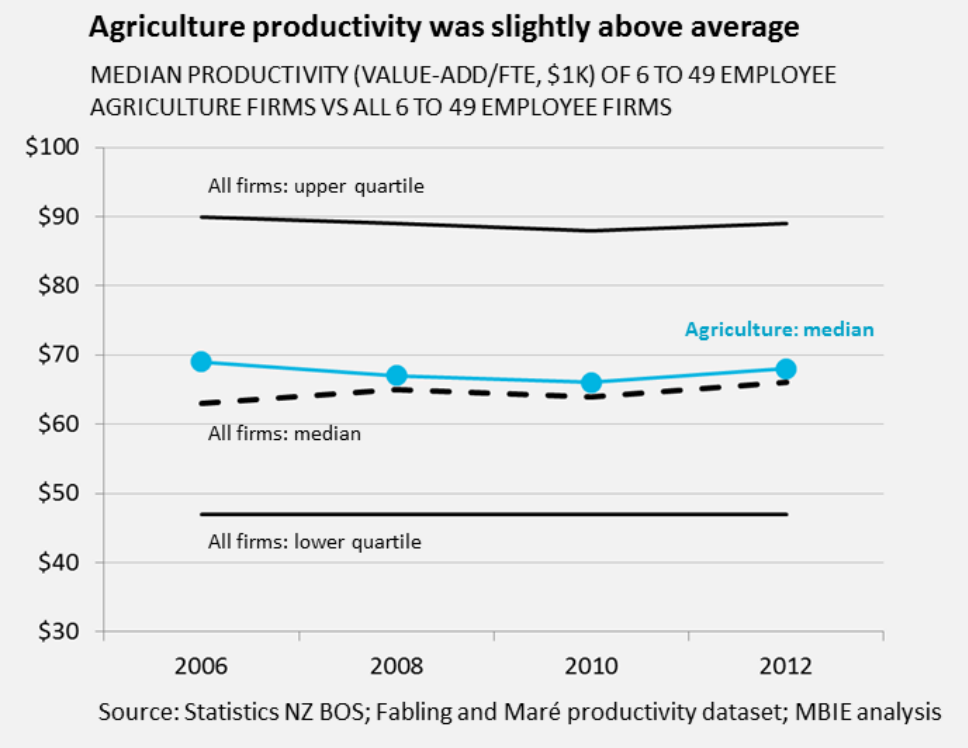
Arable farmers are of interest to MBIE as the target of a pilot programme to increase digital use; however, there were too few arable farming businesses sampled in the BOS to report on productivity growth. Trends at a higher level of aggregation (the agriculture sector[32]) are reported instead. Arable farming firms represent only about 2% of all firms in the agriculture sector.

Agriculture has a much larger proportion of low-intensity ICT-use firms (71%) than the economy-wide average (36%). Additionally, there are far fewer high-intensity ICT-use firms (4%) than the economy-wide average (20%). The subindustry as a whole could be characterized as having mostly digital laggards and very few firms at the digital frontier.



[32] Incudes meat, dairy, horticulture etc. and is represented by ANZSIC code A01

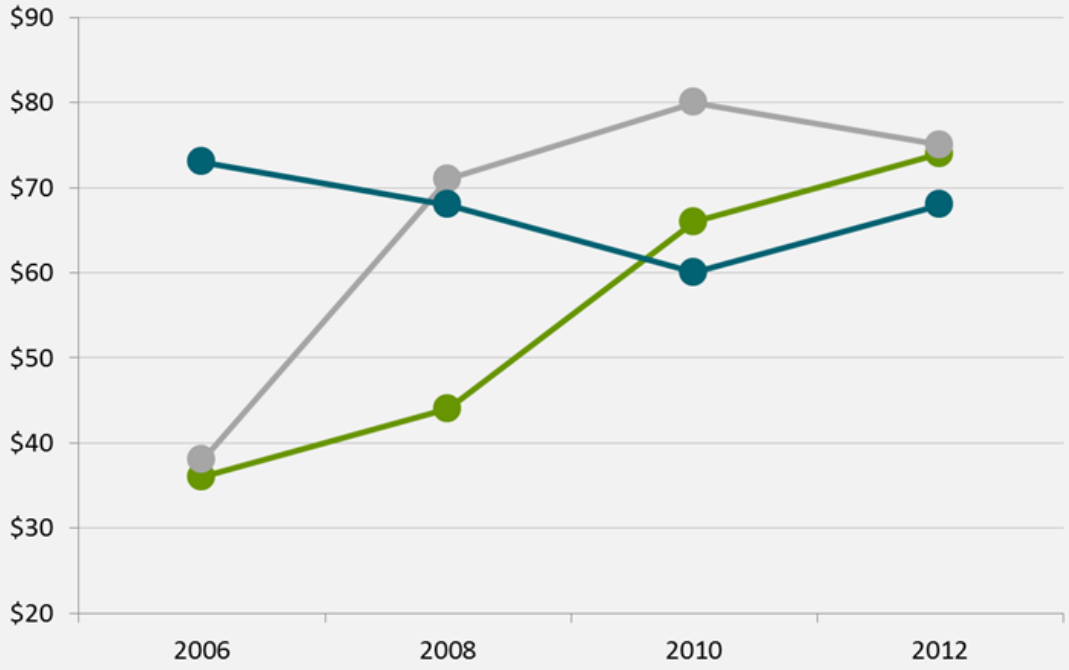
Despite low levels of ICT use, agriculture firms on the whole were reasonably productive. Across all years, the median productivity of small to medium-sized agriculture firms was greater than that of small to medium-sized firms across the economy.



Productivity among mid- and high-intensity ICT use agriculture firms was considerably lower than low-intensity ICT use firms in 2006; by 2012 this difference had disappeared (and may have modestly reversed). It should be borne in mind that the proportion of mid- and high-intensity ICT-use firms in agriculture was relatively low, and thus the estimate of median productivity was more volatile year-to-year than for low-intensity ICT-use firms. The emergent picture is one of a sector where low-intensity ICT-use firms were reasonably productive compared with higher use firms, which may explain the low rates of digital uptake in the sector as a whole.

Productivity of mid- and high-intensity ICT-use agriculture firms has increased relative to low-intensity ICT-use firms

MEDIAN PRODUCTIVITY (VALUE-ADD/FTE, $1K) BY INTENSITY OF ICT USE FOR 6 TO 49 EMPLOYEE AGRICULTURE FIRMS

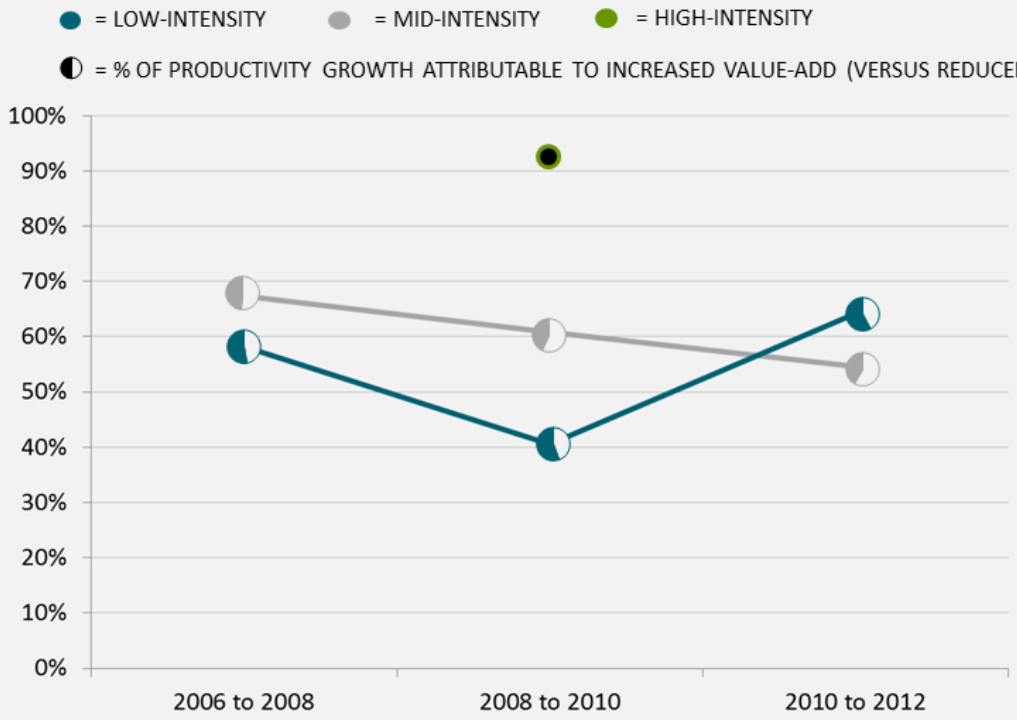


Source: Statistics NZ BOS; Fabling and Maré productivity dataset; MBIE analysis

Reinforcing the picture that low-intensity ICT use was not as much of a productivity disadvantage for agriculture firms as perhaps in other sectors, all small to medium-sized agriculture firms had a reasonably high likelihood of productivity growth across years. There were too few high-intensity ICT-use firms in most instances to estimate growth rates, but from 2008 to 2010, virtually all (93%) high-intensity ICT-use firms in agriculture experienced above-average productivity growth, perhaps contributing to a sharp increase in median productivity (from $44,000 per FTE to $66,000 per FTE).

Small to medium-sized agriculture firms of all levels of ICT use had a reasonably high likelihood of productivity growth

THE LIKELIHOOD OF PRODUCTIVITY GROWTH FOR 6 TO 49 EMPLOYEE AGRICULTURE FIRMS BY INTENSITY OF ICT USE



Source: Statistics NZ BOS; Fabling and Maré productivity dataset; MBIE analysis

Note: Sample size was insufficient to report growth rates for high-intensity ICT use from 2006 to 2008 or 2010 to 2012. The enclosed black circle indicates sample size was insufficient to report attribution.

Small to medium-sized firms that use more ICT in one way use more ICT in many ways

PERCENT AGREEMENT OF 6 TO 49 EMPLOYEE FIRMS

		Intensity of ICT use			Sector		
	Overall	High	Mid	Low	Construction	Tourism	Agriculture
Does the business use the internet?	95%	100%	100%	88%	96%	91%	90%
Did the business use the internet to purchase goods and services?	78%	97%	88%	57%	74%	71%	67%
Did the business use the internet to receive orders?	46%	89%	43%	29%	48%	48%	22%
What percentage of staff has access to the internet?	57%	77%	66%	37%	41%	41%	33%
Does the business have a website, homepage, or other web presence?	68%	97%	82%	39%	69%	71%	21%
What activities does this business use the internet for?							
Sharing information with your business	47%	74%	60%	18%	41%	34%	34%
Finance	89%	98%	96%	77%	88%	82%	88%
Sharing information with other organisations	37%	70%	39%	18%	27%	29%	34%
Internal or external recruitment	49%	74%	63%	22%	49%	54%	46%
Staff training	34%	56%	47%	8%	28%	25%	19%
How does this business use the internet for dealing with central or local government?							
Completing forms on-line or sending completed forms	65%	87%	84%	33%	69%	58%	58%
Obtaining information from government websites or via email	70%	93%	91%	36%	73%	61%	58%
Making online payments	80%	93%	93%	60%	81%	72%	79%
Downloading or requesting information	72%	93%	94%	37%	75%	63%	62%
ICT has been important for achieving what outcomes?							
Improved collaboration with other businesses	10%	29%	8%	3%	3%	11%	6%
Better coordination of staff and business activities	48%	83%	63%	15%	49%	40%	29%
Improved efficiency of work flow, inventory management or ordering systems	45%	74%	59%	15%	48%	36%	23%
Introduced goods or services not possible without ICT	19%	60%	13%	6%	11%	14%	7%
Improved management information systems	34%	75%	37%	12%	34%	27%	24%
Reduced costs of entering new markets	7%	28%	3%	2%	5%	6%	3%
Better sales or marketing methods	39%	87%	39%	16%	34%	39%	16%
Reduced prices from suppliers	19%	41%	19%	9%	32%	14%	13%
Improved efficiency of production processes	28%	63%	29%	9%	32%	17%	17%
Improved management of quality	30%	67%	31%	13%	24%	24%	25%
Improved responsiveness to customer needs	54%	92%	66%	21%	58%	42%	23%
Shifted activities to other businesses	10%	28%	9%	4%	9%	9%	7%
Greater understanding of markets	25%	64%	22%	10%	26%	22%	22%
How were internet orders received?							
Third party website	12%	32%	9%	6%	4%	20%	6%
Emailed linked to business website	34%	74%	30%	18%	39%	36%	14%
Online ordering facility on business website	16%	47%	10%	8%	5%	25%	5%
What features and facilities are offered on the business' web presence?							
Customised web page or information provided for repeat customers	17%	35%	16%	9%	17%	18%	5%
Goods or services information or prices	61%	91%	73%	33%	54%	66%	20%
Facility for collecting customer information online	22%	63%	19%	7%	14%	27%	6%
Online ordering facility for the business' goods or services	20%	51%	17%	9%	12%	28%	7%
Facility for online payment	12%	36%	8%	4%	1%	20%	4%
Information about privacy and security	13%	45%	9%	3%	3%	15%	3%
Provision for online after sales support	21%	60%	17%	7%	16%	26%	7%
What has the business done to get more benefit from ICT?[1]							
Invested in non-ICT capital	9%	17%	11%	3%	6%	8%	7%
Shifted production towards goods or services that use ICT more extensively	5%	17%	4%	1%	2%	7%	1%
Redesigned processes for producing or distributing goods or services	11%	30%	10%	3%	5%	11%	4%
Physically relocated any business activities	5%	11%	6%	2%	2%	2%	3%
Performed research and development	6%	21%	5%	1%	4%	4%	3%
Restructured the organisation	11%	25%	12%	4%	12%	10%	6%
Changed staff levels or skill mix	18%	35%	22%	5%	16%	11%	16%
Implemented new business strategies or management techniques	18%	43%	18%	6%	16%	17%	13%
Introduced new work practices	22%	45%	25%	7%	21%	15%	13%
Trained employees	38%	66%	46%	16%	36%	27%	30%
What percentage of total dollar sales does internet sales represent?[2]	0.51	1.17	0.42	0.30	0.39	0.66	0.21
What percentage total dollar internet sales was sold to customers outside New Zealand?[2]	0.16	0.50	0.10	0.06	0.08	0.27	0.10

Source: Statistics NZ BOS 2014; MBIE analysis

Notes: Cells with a bold outline indicate aspects of ICT use that contribute most to differences between low-, mid-, and high-intensity ICT use groups. [1]Supporting activities were not included in the analysis of the intensity of ICT use. [2]0 = no internet sales, 1 = 1-10% of sales, 2 = >10% of sales