New Zealand Productivity Commission
Te Kōmihana Whai Hua o Aotearoa

Does high-speed internet boost exporting?

Working paper 2022/02

Authors: Lynda Sanderson, Garrick Wright-McNaughton, and Naomitsu Yashiro

NEW ZEALAND
PRODUCTIVITY COMMISSION
Te Kōmihana Whai Hua o Aotearoa

New Zealand Productivity Commission
Te Kōmihana Whai Hua o Aotearoa

December 2022

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How to cite this document

Lynda Sanderson, Garrick Wright-McNaughton and Naomitsu Yashiro (2022) Does high-speed internet boost exporting?, New Zealand Productivity Commission. Working paper 2022/02. Available from www.productivity.govt.nz/research

Productivity Commission
PO Box 8036
The Terrace
Wellington 6143
New Zealand

+64 4 903 5160
info@productivity.govt.nz
www.productivity.govt.nz

@nzprocom
NZ Productivity Commission

Abstract

This paper examines the links between uptake of high-speed internet and entry into exporting among New Zealand firms. The analysis draws on on rich, longitudinal information about firms' use of ICT captured in Stats NZ's Business Operations Survey to both identify firms which shifted to UFB and infer differences across firms in their capability to exploit the faster internet connections. It shows that firms that shifted to fibre broadband in the early years of New Zealand's Ultra-Fast Broadband rollout were subsequently more likely than otherwise similar firms to start exporting, and that the strength of this relationship depends upon both the industry in which firms operate and their pre-existing use of the internet for core business activities. To explore the causality lying behind this relationship, the paper makes use of a policy choice to prioritise schools in the rollout of the new fibre broadband infrastructure as an instrument for early uptake. While the results are consistent with a positive effect of UFB uptake on export entry, the instruments are not strong enough to draw firm conclusions on causality.

JEL classification: F14; O33; H54
Keywords: High-speed internet; UFB; Export propensity; Digital capability

Lynda Sanderson (corresponding author)
New Zealand Productivity Commission
lynda.sanderson@productivity.govt.nz

Garrick Wright-McNaughton
FNZ Group

Naomitsu Yashiro
International Monetary Fund
nyashiro@imf.org

Acknowledgements

The authors are grateful for the valuable comments and suggestions from David Carey, Richard Fabling, Daniela Glocker, David Maré, Sébastien Miroudot, Caroline Paunov, Lynn Riggs and Philip Stevens, as well as participants at the internal workshop at the New Zealand Ministry of Business, Innovation and Employment and the International Trade Workshop at Niigata Prefecture University, Japan.

1 Motivation

This paper explores the relationship between adoption of ultra-fast broadband (UFB) and the export propensity of New Zealand firms. Access to high-speed internet provides a range of potential benefits to firms looking to enter export markets. At the most basic level, internet-based digital technologies, such as websites and online platforms, can increase the visibility of firms to potential foreign customers and reduce the search costs and informational frictions in establishing trade relationships (Fernandes et al. 2019). As internet technologies develop, new opportunities also open up in areas that were traditionally considered non-tradable, as complex services and digital goods can increasingly be delivered remotely. If used well, these technologies can also have an indirect impact on firms' ability to trade internationally, through increasing their productivity and reducing costs, thus giving them a competitive edge in the global market.

The importance of internet-mediated trade and communications has increased through the Covid-19 pandemic as firms across the globe, faced with lockdowns and physical distancing requirements, moved operations online and learnt to operate remotely, largely through the use of internet-enabled digital tools (OECD 2021a; OECD 2021c). For a small open economy such as New Zealand, which has long been disadvantaged in trade due to its geographic location, access to faster internet and greater acceptance of digital communications presents an opportunity to strengthen integration into the world economy and enhance trade opportunities.

This paper considers an earlier advance in internet technology – the rollout of ultra-fast broadband (UFB) connections in the early 2010s – and examines whether uptake of the new, faster UFB connections was associated with a higher propensity to enter exporting among New Zealand firms. We use rich information on ICT use captured in Stats NZ's Business Operations Survey (BOS) to both identify firms which shifted to UFB and infer differences across firms in their capability to exploit the faster internet connections. We first show that exporters are more intensive users of internet and are more likely to invest in complementary activities to benefit from ICT, as well as having more rapid uptake of UFB. To explore the relationship between UFB uptake and exporting, we then make use of both the longitudinal nature of the data collection and the policy choices made in prioritising the rollout of UFB to particular locations, while controlling for a wide range of other firm-level factors that are known to predict entry into exporting.

We find that New Zealand firms that adopted UFB in the early years of the national rollout were subsequently more likely to start exporting than similar firms which did not shift to UFB. This relationship was stronger among firms that were already using the internet more intensively prior to adopting fibre, or had made complementary investments to benefit from their ICT use. Looking across industry groups we find that the positive relationship between exporting and UFB uptake is limited to services industries, consistent with their greater use of the internet to communicate with potential customers and to deliver products via digital channels. In contrast we find no significant relationship for industries that produce and trade goods, which typically use ICT less intensively.

To address the question of whether higher export propensity among UFB adopters re-

flects a causal relationship from UFB uptake to export entry, we employ an instrumental variable (IV) estimation that exploits the historical patten of UFB rollout, reflecting the New Zealand government's policy to prioritise schools and hospitals. These estimates are consistent with a positive causal relationship from UFB adoption to exporting – firms predicted to have earlier access to UFB due to their proximity to schools are more likely to enter exporting in the years immediately following adoption. However, we remain cautious about this result due to the limited predictive power of our instruments over UFB adoption, particularly in the sub-samples where the descriptive regressions suggest that UFB uptake is most relevant.

This paper differs from existing studies in two ways: first, it examines the links between export propensity and the shift to high-speed internet, rather than the use of the internet itself. It thus belongs to the small literature that highlights the importance of internet speed on trade and productivity (Grimes, Ren, and Stevens 2012; Kneller and Timmis 2016; Abeliansky and Hilbert 2017; Fabling and Grimes 2021). Second, it explores the role of firms' pre-existing digital capabilities in shaping their use of faster internet. It observes that while adoption of faster internet is a consistently positive predictor of export entry, the strength of the relationship depends on how firms are already using the internet. This finding is in line with the nascent literature that stresses the role of management quality in exports (Bloom et al. 2021) as well as established findings that complementary investments in intangible assets are necessary for firms to fully benefit from their use of ICT (Bloom, Sadun, and Van Reenen 2012; Fabling and Grimes 2021).

New Zealand is a particularly interesting case for studying the role of faster internet in exports. New Zealand suffers from the "tyranny of distance", where its geographic isolation from large markets and suppliers puts it at a disadvantage against other countries. This disadvantage stems from higher shipping costs as well as increased costs in searching for foreign buyers and addressing information asymmetry, which increase with distance (Blum and Goldfarb 2006). As a result, New Zealand's exports account for only 27% of GDP, considerably below comparable OECD economies, and New Zealand is among the OECD economies least integrated into global value chains (OECD 2021b). Low integration into global trade has weighed on New Zealand's productivity growth by constraining its production scale to the small domestic market and limiting technology diffusion from the global productivity frontier (de Serres, Yashiro, and Boulhol 2014; New Zealand Productivity Commission 2021). It is therefore particularly important for New Zealand to exploit digital technologies effectively to overcome the disadvantages of geographic isolation.

The remainder of this section provides a review of related literature and describes the New Zealand context for the study. Section 2 describes the data used in the analysis and explores the aggregate links between ICT use and exporting. Section 3 presents the empirical estimation and Section 4 concludes.

1.1 Exporting and the internet

Since the seminal works by Freund and Weinhold (2002, 2004), the role of the internet in international trade has been studied extensively. The basic idea underlying these studies is that the internet reduces search frictions and information asymmetries, which are more prominent in international transactions than domestic (Freund and Weinhold 2004; Fernandes et al. 2019). These transaction and search costs gen-

erate a sizeable fixed cost of export entry, which in turn determines the productivity threshold at which firms can viably compete in export markets (Melitz 2003). As only the more productive firms can profitably bear the additional entry costs and the higher ongoing costs of exporting, firms which export tend out-perform non-exporters on a range of metrics, including being larger and more productive than domestically-oriented firms (Fabling and Sanderson 2013). The use of digital tools has the potential to reduce these fixed costs and can thereby allow firms with productivity levels just below this threshold to start exporting (Lawless 2010). In the case of services trade, the internet can also increase exports by drastically reducing the cost of delivering services to foreign customers (Freund and Weinhold 2002).

Internet speed and bandwidth are important when large amounts of information need to be transferred – for example, for real-time video communication, data transfer, or the use of cloud-based tools. Many explanations for the persistent negative effect of distance on trade, despite dramatic falls in transport costs over recent decades, relate to the need for greater interaction between suppliers and customers, as the composition of traded goods shifts towards more complex differentiated products (Duranton and Storper 2008). As well as raising the direct costs of transport and logistics, distance creates barriers to trade through a lack of familiarity with local institutions and preferences and a lack of social or business networks (Rauch 1999). In this context, high-quality digital communication can help to substitute for face-to-face contact, which is important for building trust and transferring complex, tacit information (Leamer and Storper 2001; Storper and Venables 2004).

Improved internet access is especially likely to increase export entry by small firms, as these firms often struggle to cover the transaction and search costs associated with exports. Sun (2021) argued that widespread use of the internet increases the share of SMEs in a country's exports, as it reduces the costs of exporting online more than those of traditional exports, thus allowing more small firms to start exporting.

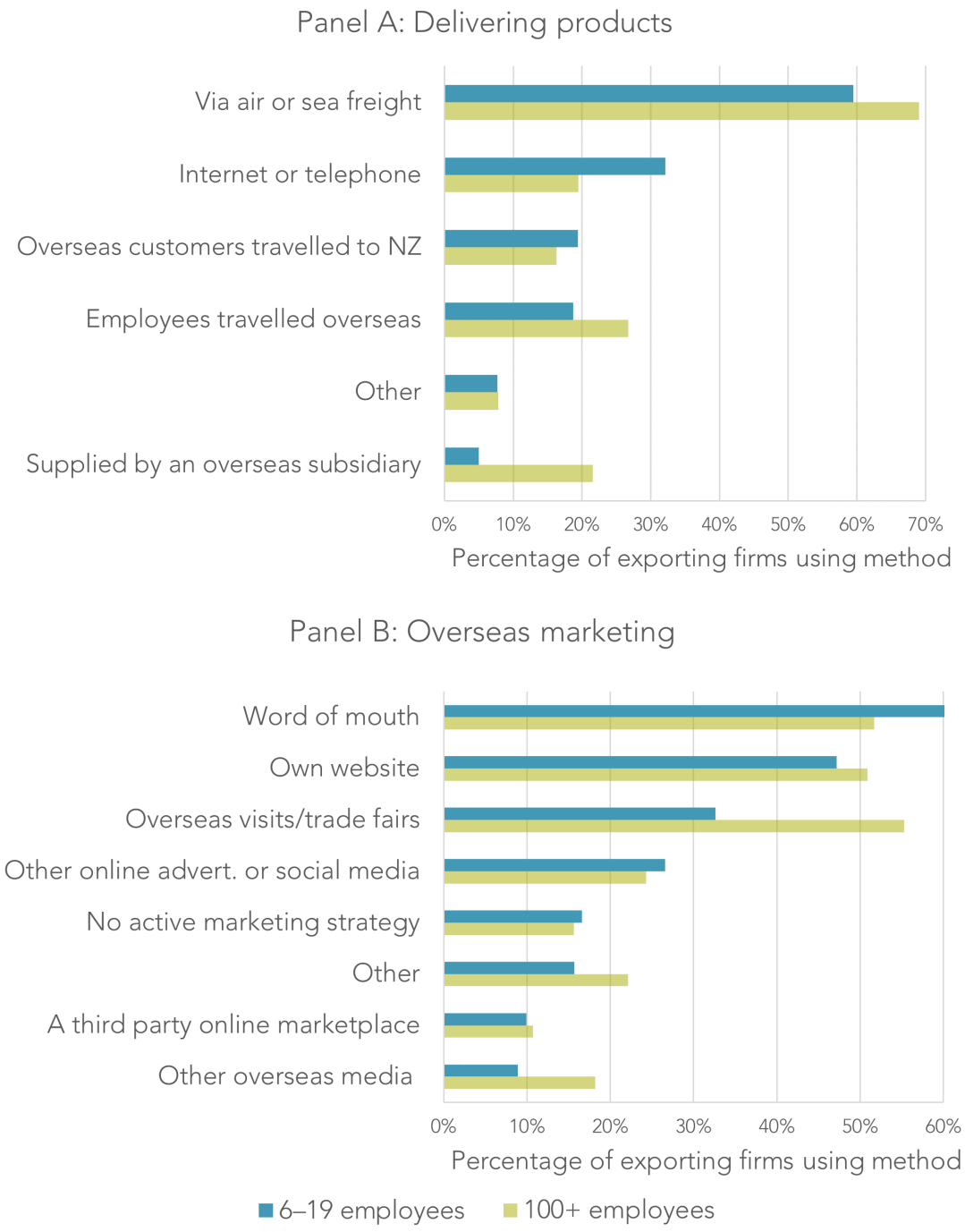
Figure 1 illustrates the higher relative use of internet-based marketing and product delivery among small firms, as reported in the International Engagement module of the BOS.[1] While air and sea freight remain the most common means of product delivery among firms that identify as having earned overseas income over the past financial year, 32% of firms with 6–19 employees report that they delivered their products digitally, using either the internet or telephone, compared to 19.5% among firms with 100+ employees (Figure 1, panel A). In contrast, smaller firms are less likely to deliver products through an overseas subsidiary or through employees of the business travelling overseas.[2]

Small firms are also relatively more reliant on digital media for marketing their products overseas. They have a similar use of online media such as their own websites, third party marketplaces, and other online advertising or social media as large firms, but are much less likely to make use of costly and targeted marketing activities including traditional media such as print and television advertising, overseas visits, and trade fairs (Figure 1, panel B).

[1] Further details of the BOS are given in Section 2.

[2] Across the latter three variables, the gaps between large and small firms remains significant after controlling for differences in industry composition at the 1-digit level. In contrast, the gap of 9.5 percentage points in the use of air and sea freight (69.0% for larger firms vs 59.5% for small firms) drops to a statistically insignificant gap of 2.5 percentage points when industry controls are included.

Figure 1: Methods of product delivery and marketing to customers overseas, % of exporting firms, 2019



Notes: Firms reporting the use of each method of delivering or marketing their products overseas as a share of all firms with overseas income. Reported figures use Stats NZ's imputation and sampling weights in order to represent the population of firms with six or more employees.
Source: Authors' calculations based on BOS International Engagement module, 2019. Survey question text is provided in Annex A.

The internet can also indirectly help firms to start exporting if firms use digital tools to reduce production costs or improve their productivity. For instance, firms can use the internet to find suppliers as well as customers, enabling them to source cheaper or better quality inputs from offshore. Digital tools can also help firms improve their processes or restructure their activities. Faster internet supports the use of more recent digital technologies that facilitate communication (eg, video conferencing tools) or boost productivity (eg, big data analysis or artificial intelligence). In 2018, 19% of New Zealand firms surveyed in BOS reported that their use of ICT helped them reduce the input prices paid to suppliers, 50% reported that it played a role in improving workflow efficiency and inventory management, and 29% reported that it contributed to the efficiency of production (Business Operations Survey, 2018). This supports the argument above that better access to internet-enabled tools may push some firms over the productivity threshold at which exporting becomes viable.

Early studies estimated gravity equation models augmented with indicators of internet penetration to test whether countries with better internet access export more. For instance, Freund and Weinhold (2004) reported that a 10 percentage point increase in the growth of web hosts in a country leads to around a 0.2 percentage point increase in its export growth during the period 1995–99, while Lin (2015) reported a similar impact during 1990–2006. Osnago and Tan (2016) examined whether the internet has a stronger effect on the number of goods exported (extensive margin) or on the average export value per exported good (intensive margin). They found that a 10% increase in a country's share of individuals using the internet increases the number of goods exported to a given country by an average of 1.5%, and the value per good by 0.4%. Along the same lines, Visser (2019) reported that higher internet use increases the extensive margin of exports from developing to developed countries and alleviates the negative impact of language dissimilarity between trade partners on the extensive margin. Lawless (2010) exploited data from the US Census Bureau to decompose exports by US firms into the number of exporting firms and average exports per exporting firm. She found that a larger number of internet users in the destination country increases the number of US firms exporting but reduces average export sales per firm. She interpreted this result as evidence that the internet reduces the fixed cost of export entry, with smaller and lower productivity firms able to profitably enter despite lower values of export sales.

Conventional measures of national or regional internet use, such as the number of internet subscriptions, may not capture communication capacity accurately since bandwidth speed is highly variable across subscriptions. Abeliansky and Hilbert (2017) reported that average bandwidth data speed per subscription is a more important determinant of exports in non-OECD countries than the number of internet subscriptions per capita. They interpret this result as reflecting the large variance in internet speed among developing countries, and evidence of fast internet promoting exports. In contrast, in OECD countries the number of subscriptions was a more important determinant of exports than the average internet speed, which the authors attribute to the greater availability of faster internet in developed countries.

More recent studies have exploited firm-level data to directly identify the links between internet use and export entry. Ricci and Trionfetti (2012) used the World Bank's Enterprise Survey and found that, among their sample of firms in developing countries, the use of e-mail and websites is associated with a 14% or 7% higher probability, respec-

tively, of being an exporter. Hagsten and Kotnik (2017) used sample data of SMEs in several European countries and regressed the probability of export entry and export sales on the use of digital tools. They found that firms that have a website are more likely to enter exporting in the following year, while selling products online is associated with stronger export growth among incumbent exporters but not with export entry. However, these findings may reflect endogeneity caused by unobserved factors driving both UFB uptake and exporting. Moreover, with a relatively short time lag (one year) between the adoption of ICT tools and export entry, such findings can be prone to reverse causality, where firms adopt digital tools as part of a strategy to enter export markets.

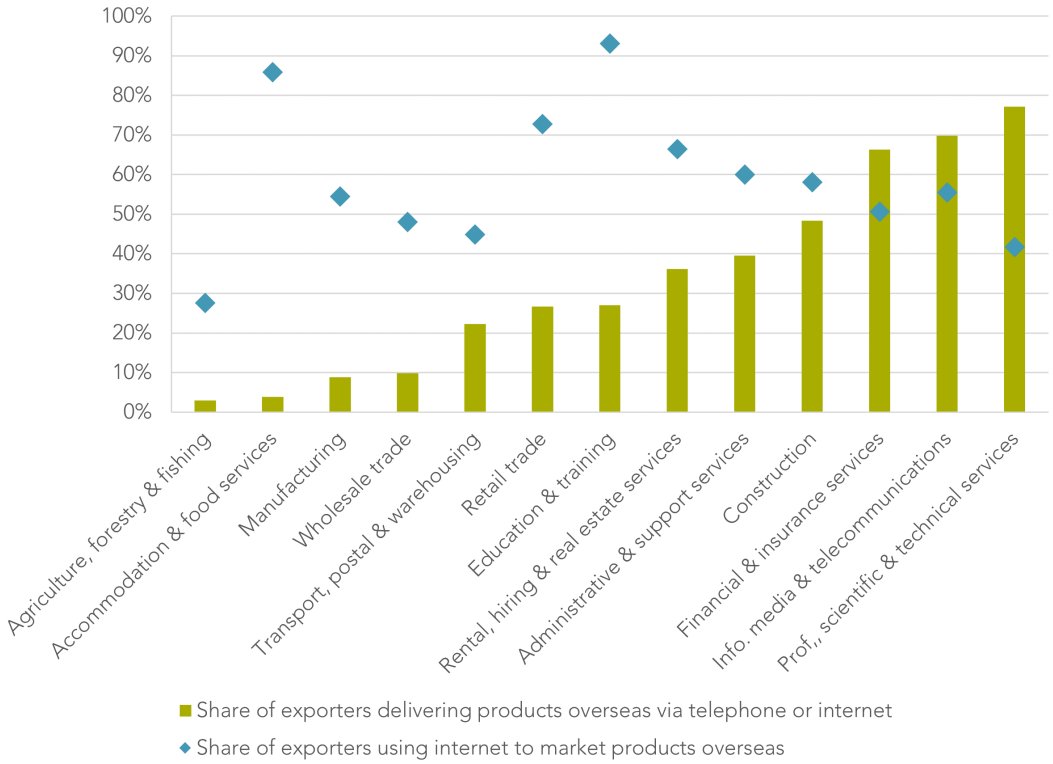
Empirical evidence from studies seeking to identify the causal impact of the internet on export entry is limited and nuanced. Kneller and Timmis (2016) explored the impact of adopting broadband on export entry by service-sector firms in the United Kingdom. They addressed the potential endogeneity by instrumenting broadband adoption by these firms using spatial differences in broadband availability, an approach commonly used in literature assessing the impact of broadband on firms' performance. They found that broadband adoption had a significant positive effect on export entry only for firms in the business services sector. Fernandes et al. (2019) applied a difference-in-difference approach pioneered by Rajan and Zingales (1998) to the microdata of Chinese manufacturing firms and data on China's province-level internet usage (the number of internet users per 10,000 people). They found that higher internet usage in a province is positively correlated with the probability of a firm being an exporter and with the export value of incumbent exporters in industries that rely more on the internet. The authors see this as evidence that the rapid internet rollout in China after the late 1990s boosted exports.

Overall, existing studies suggest that the export-promotion effects of the internet depend on both sector- and firm-level characteristics, as well as on the quality of internet infrastructure in both the exporting and destination markets. For instance, the extent to which products can be exported via the internet is determined by the characteristics of the products concerned, with services that involve either physical proximity or intensive communication and customisation less amenable to digital sales and delivery. In contrast, services which can be delivered digitally, including many financial, professional, and administrative services, provide a stronger opportunity to benefit from faster or higher quality internet access.

Figure 2 illustrates the variation in the use of the internet to market and deliver goods and services overseas. Among New Zealand exporters, digital delivery is most common among professional and high-tech services industries, and much lower amongst goods-producing industries.[3] Marketing via the internet (including through the firm's own website, through a third-party website, or via social media) is common among exporters in almost all industries, but particularly so among industries where the mode of delivery tends to involve foreign residents travelling to New Zealand (eg, Education and Accommodation and food services).

[3]Construction is an exception, which may reflect low export rates (only 3% of construction firms reported overseas income in the 2019 survey) and firms offering technical support services that can be delivered digitally alongside physical construction services.

Figure 2: Digital delivery and marketing of products overseas, 2019



Notes: Firms delivering their product via internet or telephone, and marketing via their own website, a third-party website, and/or social media, as a share of all firms with overseas income. Mining; Electricity, gas, water and waste; Healthcare and social services; Art and recreational services; and Other services industries not shown due to very low numbers of firms with overseas income. Reported proportions use Stats NZ's imputation and sampling weights in order to represent the population of firms with six or more employees. *Source:* BOS International Engagement Module, 2019 (published tables).

1.2 The importance of complementary investments

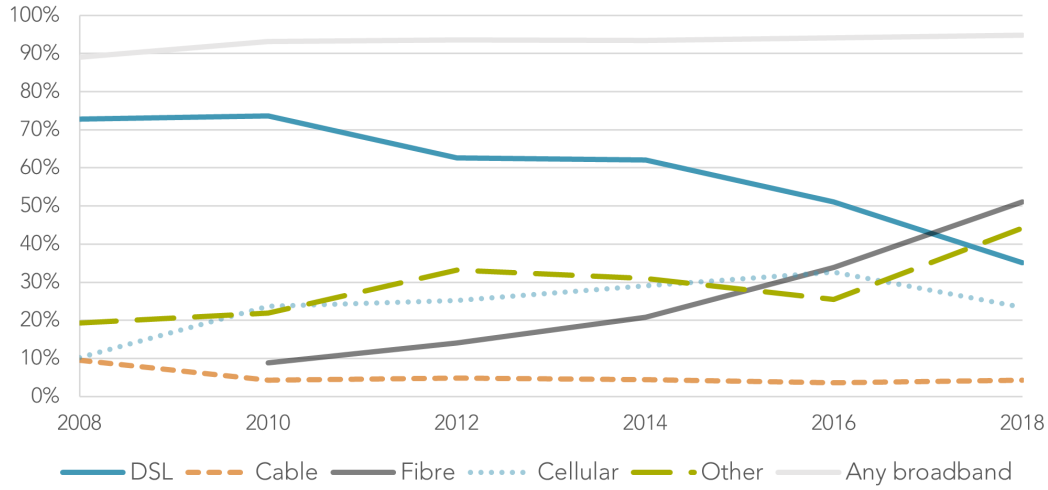
The benefits of new technologies also hinge on how effectively they are deployed. Firms' capabilities to exploit new technologies such as digital tools are underpinned by complementary investment in intangible capital (Brynjolfsson, Rock, and Syverson 2021; Corrado et al. 2021). An example of such intangible capital is organisational changes that include new processes and structures, knowledge sharing, redesigned monitoring, reporting, and incentive systems (Brynjolfsson, Hitt, and Yang 2002; Garicano 2010; Cardona, Kretschmer, and Strobel 2013). Investment in intangible capital is often risky, as the value of the investment is specific to the firm and is often not known at the outset, and typically costs more than the direct financial costs of adopting faster internet or digital tools (Brynjolfsson, Rock, and Syverson 2021). However, a successful combination of digital technologies and organisational capital acts as a source of competitive advantage, which competitors may find difficult to replicate.

Although it is difficult to capture the impact of strategic deployment of digital technologies on corporate performance, some of their aspects have been documented. Bloom, Sadun, and Van Reenen (2012) reported that US multinational enterprises operating in Europe use digital technologies more intensively than European firms and reap larger productivity gains from ICT capital. They found that the higher productivity of ICT capital is mostly explained by superior human resource management by the US multinationals, suggesting that better people management practices boost the benefits of digital technologies. Black and Lynch (2001) estimated the contribution of various workplace practices to US firms' productivity and found that a higher share of non-managerial workers using computers is associated with higher plant-level productivity, while a higher share of managers using a computer is not. Their finding that computer usage by mid- to low-level workers improves firm performance is in line with findings by Bloom et al. (2014) that lower costs in gathering information enabled by digital tools increase the value of more decentralised decision-making. These studies indicate that the impact of high-speed internet hinges on good management strategies that make the most of it to enhance efficiency or capture more sales. For instance, Fabling and Grimes (2021) reported that adopting UFB improved the productivity of New Zealand firms mainly for those that also implemented complementary measures, such as introducing new work practices or changing staffing levels or the skills mix of employees.

Strong managerial capabilities are also essential for exporting, since firms that seek to export must build up not only larger production capacity but also successful globalisation strategies (Gkypali, Love, and Roper 2021). Bloom et al. (2021) observed for a large sample of US and Chinese firms that those with better management practices are more likely to export, and conditional on exporting, sell more products to more destinations and earn higher export revenues and profits. They also reported that better-managed firms sell higher-quality products and charge higher export prices, while making use of higher-quality imported inputs and sourcing inputs from a more diversified set of countries. Bloom et al. (2020) found that improved management practices, especially product quality control, led to a significantly higher chance of export entry, based on a randomized control trial that offered management consulting to Indian firms. Good global marketing and production strategies, in turn, enhance export entry.

While the capabilities of New Zealand firms to exploit UFB cannot be captured directly,

Figure 3: Type of broadband connection, 2010–2018



Notes: Firms may report more than one type of connection. Fibre-to-the-premises was not asked for in 2008.Reported proportions are based on Stats NZ's imputation and sampling weights in order to represent the population of firms with six or more employees.
Source: Authors calculations based on BOS ICT module, 2010–2018.

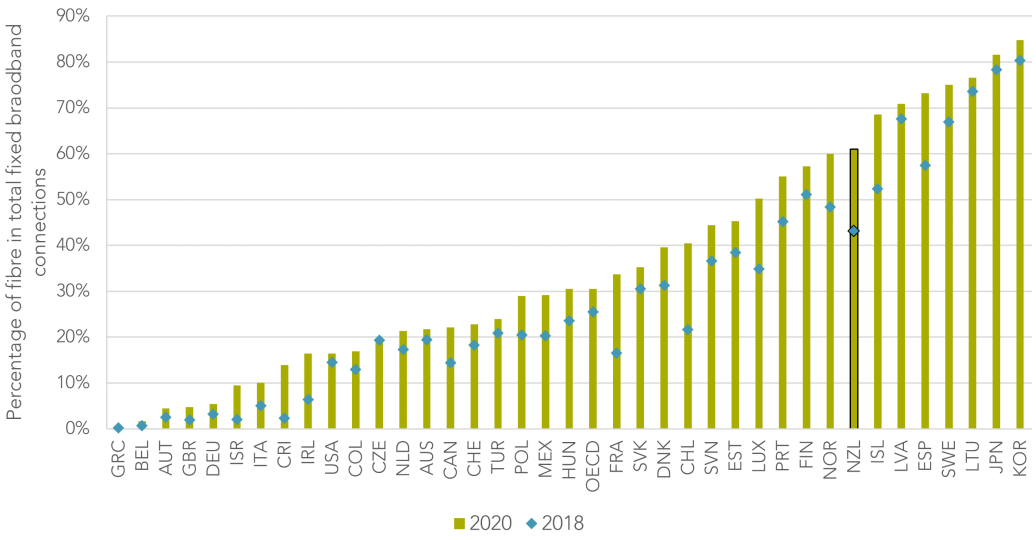
this paper infers them from their past ICT use. By capturing the intensity with which firms were using the internet or investing in complementary activities before adopting UFB, the paper examines whether firms with more advanced ICT use are more likely to benefit from UFB adoption.

1.3 Ultra-Fast Broadband rollout in New Zealand

New Zealand started its nationwide rollout of fibre broadband in 2010 under the Ultra-Fast Broadband (UFB) Initiative. While the use of broadband by New Zealand firms was already widespread by 2010, the composition of broadband connection types changed drastically over the following decade (Figure 3). The share of firms with fibre-to-the-premises connections rose from 9% in 2010 to 52% in 2018 and reached 64% in 2020. At the same time, the share of firms with slower digital subscriber line (DSL) connections decreased from 74% to 35%. The government aims to provide fibre connections to 87% of the population in over 412 towns and cities by the end of 2022. According to Crown Infrastructure Partners (2022), the agency responsible for managing the Government's investment in UFB and rolling out rural broadband and mobile coverage under the Rural Broadband Initiative and Mobile Black Spots Fund, by mid-2022 86% of New Zealanders could access fibre, while 70% had taken it up so far. The share of fibre in fixed broadband connections in New Zealand is higher than in many other OECD countries (Figure 4).

Despite the progress in the nationwide rollout, local unavailability has remained a key factor preventing New Zealand firms from taking up UFB. While just over 50% of firms had fibre connections by 2018, only half of the remaining firms were planning to adopt UFB. Among those without a plan to adopt UFB, close to 60% cited the unavailability of UFB in their locations as the reason, a share that is somewhat higher than in 2012 (Table 1).

Figure 4: Percentage of fibre connections in total fixed broadband connections



Notes: Fibre subscriptions data includes FTTH, FTTP and FTTB and excludes FTTC and FTTN. *Source:* OECD, Broadband Portal, `http://www.oecd.org/sti/broadband/broadband-statistics/`

One notable feature of the UFB rollout in New Zealand is that it has prioritised schools. While only 10% of primary schools had fibre connections in 2012, almost all state schools had them by 2016 (Grimes and Townsend 2018). This provided a basis for expanding UFB access to nearby households and businesses. In their exercise to identify the effect of adopting UFB on subsequent changes in productivity of New Zealand firms, Fabling and Grimes (2021) exploited this fact by instrumenting the UFB adoption by firms by their geographic proximity to a primary or secondary school. We adapt this approach to assess the causal relationship between UFB uptake and export entry.

2 Data

This paper exploits linked survey and administrative data from Stats NZ's Longitudinal Business Database (LBD) and Integrated Data Infrastructure (IDI). The LBD contains information on the full population of firms operating in New Zealand since April 1999, linking wide-ranging firm-level information from both administrative and survey data sources. The IDI holds a diverse range of datasets at the individual and household level and is directly linked to the LBD through individual and corporate income tax records.[4]

The use of these linked data brings together a range of firm characteristics known to predict firms' export propensity, such as firm size (represented by the number of employees and working proprietors), capital intensity, multi-factor productivity, industry, and indicators of R&D and foreign investment. Furthermore, the data include information on UFB uptake and on how firms were using the Internet before adopting UFB, as

[4]See Fabling and Sanderson (2016) for further detail on the structure and coverage of the LBD, the Stats NZ website `https://www.stats.govt.nz/integrated-data/integrated-data-infrastructure/` for information on the IDI, and Fabling and Maré (2015) for an in-depth discussion of employment measures.

well as detailed information on firm location, which is used to construct an instrument for UFB adoption.

The primary dataset of interest for this paper is the Business Operations Survey (BOS) — an annual, modular survey of businesses administered by Stats NZ. The survey population is defined as all private-for-profit firms with rolling mean employment of at least six (roughly 35,000 to 40,000 firms). From this population, between 5,500 and 7,500 usable responses are collected each year, based on a random sample of the population, stratified by industry and firm size. In addition to the representative random sample, Stats NZ also implements a panel top-up for the BOS, in which all respondents to the 2005 survey were re-sampled in every year till 2011, regardless of whether they would have been included under the standard annual sampling procedure. The top-up sample was then re-set, with respondents from the 2012 survey re-sampled in the same way in every year since 2012. These top-up responses are allocated a weight of zero by Stats NZ in the preparation of their official statistics releases, but are available to researchers through the Stats NZ datalabs to improve the longitudinal coverage of firms.

The BOS's modular nature allows the collection of information on a wide range of topics, including business and management practices, R&D, and innovation. Two aspects of the BOS are of particular interest for this paper:[5]

- Basic information on firms' international engagement is collected annually, in Module A of the survey. Specific items used in the current paper include export intensity (exports as a proportion of total sales) and indicators of whether the firm has inward and outward foreign direct investment.[6]
- Information on firms' use of ICT is collected biennially in a topic-specific module, administered in even-numbered years. Responses to this module provide information on: connection type -– whether or not the firms are connected to broadband, and more specifically to UFB (fibre-to-the-premises); their uptake of a range of ICT tools and practices, including whether the firm has a web presence, and whether they use the internet to share information internally or with other organisations; perceived outcomes from ICT use, such as better sales or marketing methods or better coordination of staff and business activities; and activities that the firm has undertaken in order to get more benefit from their ICT, such as training employees or introducing new work practices.[7]

These data are complemented by more detailed information on firms' overseas sales of goods and services from the International Engagement Module which has been run (in varying forms) on a four-year cycle since 2007. Statistics on the use of digital media to market goods and services overseas and the mode of delivery to overseas customers, as reported in Figures 1 and 2 above, are drawn from the 2019 wave of the International Engagement module.

With a comprehensive sampling frame supported by administrative and survey data,

[5] A copy of the relevant questions is provided in Annex A.

[6] Module A also includes a question on new market entry. As New Zealand has relatively few exporting firms, low sample sizes prevented analysis of new market entry, export intensity, and exit of incumbent exporters.

[7] The BOS ICT module was developed in the mid-2000s and does not survey the use of more recent or specialised digital technologies, such as the Internet of Things, AI, or industry-specific technologies such as smart monitoring systems. An updated ICT module was introduced in the 2022 survey round.

and response rates consistently above 80%,[8] the BOS provides a representative picture of the internationalisation and ICT use of New Zealand firms, including the large population of small and medium-sized enterprises (firms with 6–20 employees). Nevertheless, there are some caveats to the use of BOS data. First, the BOS surveys the use of UFB only from 2010 when the UFB initiative was implemented. Consequently, the empirical analysis in this paper is limited to the period from 2010 onwards. Second, the 2012 BOS included a modification to the text of the survey question used in this paper to identify exporters. Before 2012, firms were asked to report the share of export sales as a proportion of total sales in a 3-digit free-text box. Following the observation that some firms were reporting a decimal, rather than an integer, an additional note was added in 2012 directing firms to round the export sales share to the nearest percentage. It specifically directed firms to round up any share between 0 and 1% to 1%. This additional instruction appears to have led to a substantial rise in the measured number of exporters in 2012, suggesting that firms with small or occasional export shipments were now identifying as exporters where they would not have under the old instructions. To maintain consistency over time and to focus the analysis on firms with a meaningful level of export activity, we classify only the firms reporting exports that exceed 1% of total sales as exporters.[9]

Finally, we make use of location-based data that help capture the availability of UFB to individual firms. These data are based on the location of primary and secondary schools, sourced from the Longitudinal Business Frame within the LBD, and historical information on the timing of the UFB rollout by region, provided by Crown Infrastructure Partners. The information on the location of schools is used to compute the physical linear distance between each firm and the nearest school. This is motivated by the fact that the government prioritised connecting schools and hospitals to the fibre network, enabling firms located nearby to also have fibre connected to their premises (see Section 1.3). The historical information on the UFB rollout indicates the year when the rollout began and the year it was completed for each region. A degree of judgement is required in terms of where the boundaries of these regions should be drawn. Combining distance to schools with historical data on regional coverage gives a plausible proxy for the availability of UFB at the firm level. We use this proxy to instrument the adoption of UFB in our empirical analysis, discussed in Section 3 below.

2.1 The use of the Internet and digital tools in exports

Based on the linked data described above, this section describes how the use of the internet and digital tools differs between New Zealand's exporting and non-exporting firms. In 2010, when the government initiated the nationwide UFB rollout, exporting firms were more than twice as likely as non-exporting firms to report having a UFB connection, with 16.7% of exporters and 7.6% of non-exporters reporting they had a fibre broadband connection (Table 2). This gap narrowed over time as the UFB rollout progressed and fibre-to-premises connections became more readily available. After controlling for differences in size and industry composition between exporters and non-exporters, the gap in UFB uptake remains significant through 2014, but narrowed to almost zero by 2018.

[8] Responses to official Stats NZ surveys are mandatory under the Statistics Act 1975.
[9] In robustness tests we re-estimate the models for firms adopting UFB in 2014 and 2016 to confirm that results are not substantially affected by the change in the question.

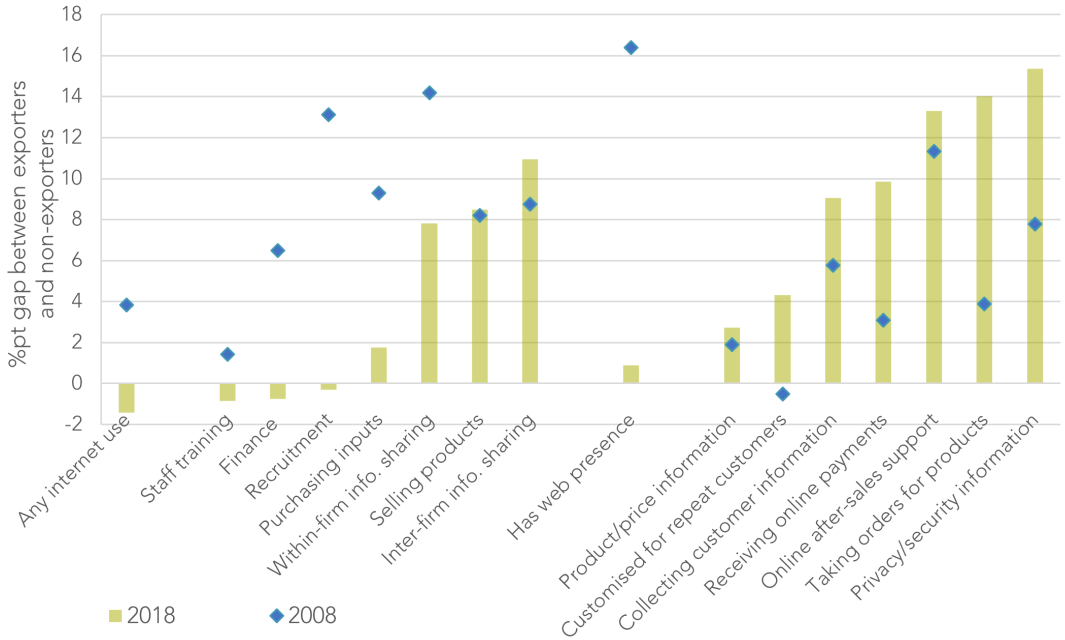
Overall, some 95% of New Zealand firms had access to some type of broadband by 2018 (Table 3, panel A). Nevertheless, not all firms were using the Internet or digital tools to the same extent or purposes. While 92% of the BOS respondent firms used the Internet for finance and banking in 2018 and 85% used it to purchase goods and services, only 57% used the Internet for enhancing internal communication and 45% used it to enhance collaboration with business partners (panel B). Similarly, while 73% of BOS firms had a web presence (i.e., they had websites, home pages or other online presence), relatively few were making use of their websites for functions other than providing information. While 89% of firms with a web presence used it to provide information on their product prices, less than a third used it to take orders, receive online payment, or provide after-sales support (panel C).

While access to UFB became widespread over the 2010s, capabilities to make best use of faster internet continue to differ significantly between exporters and non-exporters. Figure 5 illustrates the percentage point gap in reported uses of the internet, and website functionality, between exporters and non-exporters in 2008 and 2018. In 2008, exporters were substantially more likely than non-exporters to be making use of the internet for a range of activities, including recruiting, buying inputs and sharing information within the firm, and were 16 percentage points more likely to report that they had a web presence. By 2018, the gap between the two groups had narrowed, with many simpler activities (eg, finance, recruitment, having a web presence) being widespread and little or no difference between the two groups (see also Table 3 for statistics on overall digital uptake). However, substantial gaps between exporters and non-exporters remain in some areas, particularly within-firm and inter-firm information sharing, and selling products via the internet. While non-exporters caught up with exporters in terms of the the probability of having a web presence, substantial gaps remained in terms of the functionality of that web presence. Conditional on having a web presence, by 2018 the two groups were similarly likely to have simple information such as price and product details available, but exporters were 13 percentage points more likely to use their website to offer after-sales support and 15 percentage points more likely to offer privacy or security information than non-exporters.[10] These gaps, particularly in the early years, imply that controlling for pre-existing ICT capabilities will be important when assessing the role of UFB uptake in export entry decisions.

Exporters are also more likely than non-exporters to engage in complementary activities to maximise the impact of their ICT investment (Figure 6). They are more likely to upgrade employees' skills, invest in research and development (R&D), or introduce new work practices. While gaps between exporters and non-exporters in their ICT use and web presence functionality have generally declined over time, as digital technologies become more widespread in workplaces, gaps in the prevalence of complementary investments remained strong in 2018. These activities can be interpreted as investment in intangible capital, which has been observed to complement digital technologies in boosting productivity (Corrado et al. 2021).

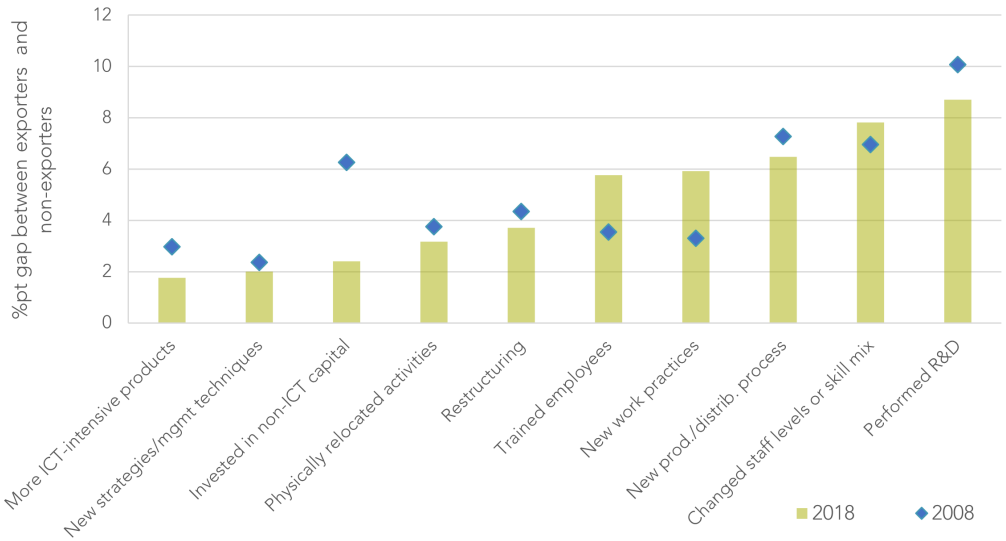
[10] These gaps remain significant, though slightly smaller, after jointly controlling for differences in the industry and size composition of the two groups.

Figure 5: Comparison of exporter and non-exporter use of the internet, percentage point gap, 2008 & 2018



Notes: The chart displays how much more likely exporters are than non-exporters to use the internet for a given purpose or to have a given website function (conditional on having a web presence). Reported proportions are based on Stats NZ's imputation and sampling weights to represent the population of firms with six or more employees. Exporting defined as reporting greater than one percent of sales from exports.
Source: Authors' calculations based on BOS ICT module 2008 & 2018

Figure 6: Comparison of exporter and non-exporter activities to complement ICT, percentage point gap, 2008 & 2018



Notes: The chart displays how much more likely exporters are than non-exporters to undertake a given activity in order to benefit from ICT. See also notes to Figure 5.
Source: Authors' calculations based on BOS ICT module 2008 & 2018

3 Empirical estimation

This section explores empirically the link between UFB adoption and exporting. Several factors can drive the apparent difference between exporters and non-exporters in their adoption of UFB and the use of digital tools, even after controlling for firm size and industry. For instance, the positive correlation between UFB adoption and exporting can be the result of hysteresis in exports and UFB connection status. The large fixed costs firms incur to enter export markets create inertia in export participation: since these fixed costs are non-recoverable, firms that exported last year are very likely to export this year, even if they run small losses, as leaving the market risks having to re-incur these costs to return to exporting in future. At the same time, firms that adopted UFB are unlikely to downgrade to a slower connection. By focusing on export entry rather than export status, and adoption of UFB instead of UFB connection status, this paper reduces the potential bias caused by these related forms of hysteresis.[11]

3.1 Event study approach

To infer how UFB adoption predicts export entry, this section focuses on export entry by New Zealand firms in the early years of the UFB rollout and tests whether firms that adopted UFB were subsequently more likely to start exporting. This event study-type analysis provides a rather straightforward timeline from UFB adoption to exporting, while controlling for observable differences between adopting and non-adopting firms. Nevertheless, the adoption of UFB itself may not have been random: firms that foresaw great benefits from the use of faster internet, including its potential to facilitate export entry or improve productivity, could have self-selected into adopting UFB, and these differences may not be observable in the data. As such, the relationship between UFB adoption and export entry from our event study model cannot be interpreted as causal. To address these issues, in Section 3.4 we seek to identify the causal impact of UFB adoption by exploiting geographic variation in the timing of the fibre rollout across New Zealand (described in Section 3) as an instrument for each firm's UFB adoption.

This section estimates a predictive model of whether a firm will enter exporting conditional on adopting UFB, controlling for prior usage of ICT and firm characteristics.[12] It restricts the analysis to the population of firms that neither exported nor had a UFB connection in the previous wave of BOS (conducted two years earlier since the BOS ICT module is biennial). It then observes whether firms that adopted UFB between the previous wave of BOS (at year t-2) and the current wave (year t) have a higher probability of exporting, conditional on their observed characteristics and ICT use at t-2. To focus on early adopters, we restrict attention to two cohorts of firms – those adopting

[11] We also conducted exploratory analysis on the relationships between UFB adoption and firms' export intensity (the share of sales coming from exports), entry into new export markets, and exit from exporting. These analyses are not included in the paper due to the small number of incumbent exporters with the required longitudinal BOS information.

[12] In common with past studies, we do not empirically distinguish between fixed entry costs, ongoing transport and communications costs, and productivity improvements when examining whether internet access, and high-speed broadband in particular, can raise a firm's export propensity. Rather, we consider an implicit reduced form model of the relationship between UFB and exporting, drawing tentative inferences on the mechanisms driving this relationship by comparing outcomes for firms with different characteristics.

UFB (or not) in either 2012 or 2014. This reflects both the timing of the UFB rollout and the firm-level data on fibre connections, which is available from 2010 onwards. As discussed above, the impact of UFB adoption may take time to materialise if, for example, firms need to invest in complementary intangible assets. Therefore, we separately estimate the probability of exporting in the period immediately following UFB adoption $(k = t)$ and in the next period $(k = t + 2)$:

$$\begin{aligned} P(X_{ik} = 1) \quad &= \alpha + \beta_1 adoptsUFB_{it} + \beta_2 ICTindex_{i,t-2} + \beta_3 adoptsUFB_{it} \times ICTindex_{i,t-2} \\ &\quad + \lambda Z_{it-2} + \phi_t + \epsilon_{it} \end{aligned}$$

The key explanatory variables are: $adoptsUFB_{it}$, an indicator variable taking the value one if the firm reports having a fibre-to-the-premises connection in the current survey (at year t) but not in the previous survey (at year t-2), and an index variable capturing the firm's prior use of ICT (at t-2), described in detail below. The model also includes an interaction between UFB adoption and prior ICT use. Positive coefficients on the interaction terms indicate the role of existing capabilities in enhancing the effects of UFB in enhancing export entry. The term $Z_{i,t-2}$ is a vector of firm characteristics which have been shown in the literature to predict export entry. These are: firm size, captured by the natural log of the number of employees (including working proprietors); capital intensity; multifactor productivity (MFP); indicator variables for whether the firm had inward or outward foreign direct investment; a full set of industry dummies, at the 1- or 2-digit level corresponding with the MFP estimation; and the natural logarithm of employment density in the area the firm is located in, measured as employed persons per square kilometre. The latter is intended as a proxy for regional characteristics that can promote export entry and also controls for the possibility that the UFB rollout prioritised regions with greater economic activity in addition to schools and hospitals. The model also includes a set of year dummies denoted as ϕ_t. Appendix A provides detailed information on the sources and definitions of these variables, as well as summary statistics for the samples used in core estimations. For simplicity, the model is estimated as a linear probability model (OLS).[13]

The share of exporting firms differs considerably across industries, partly because the nature of some services makes them difficult to export. For this empirical analysis, we restrict our sample to firms operating in industries where exporting is expected to be technically feasible. The six 1-digit ANZSIC06 industries where at least 10% of firms report export sales in most years are: Agriculture, Forestry and Fishing; Manufacturing; Wholesale Trade; Information Media and Telecommunications; Professional and Technical Services; and Administrative and Support Services. While the share of exporting firms is also high in the Transport, Postal and Warehousing industry, we exclude firms in this sector due to the possibility that some respondents are reporting the international transportation of goods on behalf of their customers as an export activity.

To conduct the longitudinal analysis of export entry, we restrict the sample to firms that self-reported as non-exporters and had no UFB connection in the initial period (t-2). We only use firms which have the requisite information — that is, BOS responses with complete answers to the questions on exporting and broadband connection at time t and t+2, and information on firm characteristics in the initial period (t-2). At the

[13] An alternative version of the model using a probit specification yielded qualitatively similar results.

same time, we boost the sample size for the estimation by including the BOS top-up sample. This is the sample of between 140 and 1650 firms per year that are not included when Stats NZ computes the aggregate statistics but were sampled either to increase the longitudinal coverage of the survey or to fulfil a specific purpose (such as oversampling minority groups or creating an overlapping sample to facilitate the transition from the ANZSIC96 to ANZSIC06 industry classification). Overall, firms in the estimation sample tend to be slightly larger than the average of the overall population, as larger firms are more likely to be tracked across multiple waves of the BOS, despite the removal of incumbent exporters (which tend to be relatively large) from the entry regressions.

3.2 Measures of prior ICT intensity

The extent to which firms can benefit from UFB is expected to differ according to their capabilities in leveraging digital tools (as discussed in Section 1). Faster internet speed is unlikely to increase the probability of export entry by firms using the Internet for generic purposes such as e-mail and banking. In contrast, it can boost export propensity if firms use the internet more intensively to deepen inter-firm collaboration – for instance through joint innovation or better communications with their customers – or to improve their productivity by enhancing the efficiency of internal processes. To assess the role of existing capabilities in shaping the impacts of UFB, we construct measures that capture aspects of these capabilities based on the rich information on ICT use by New Zealand firms.

We consider three groups of BOS variables: the activities for which firms use the internet, whether the firm has a web presence and the functions included in that web presence, and the extent to which they invest in complementary activities to get more benefit from ICT. We apply a principal components analysis (PCA) to data from the biennial ICT modules for the period 2010–2018 to reduce each group of variables to a single index. PCA reduces the dimensionality of large datasets while retaining as much information as possible. In particular, it summarises a large number of variables into a smaller number of linear functions of these variables (principal components) by maximising their variance (information) while ensuring that the principal components are not correlated with each other (Joliffe and Cadima 2016). We treat the three principal components as alternative proxy measures for firms' ability to benefit from faster internet speeds. We therefore estimate the principal components independently of each other and consider the relationship between each index and future export entry separately. Table 4 presents the loadings on the individual variables for each index and appendix Table A.2 shows the correlation between the different proxies for ICT capability used in the regressions.

Consistent with the results shown above for individual practices, mean levels of both the internet use index and the website functionality index increase over time while that for complementary investments shows no distinct trend, and exporters have a higher mean level of each index than non-exporters in all years. However, there is also a large amount of variation within each group, with confidence intervals for the two groups consistently having a large overlap (Table 5). To aid interpretation, in the regressions below we normalise each component to have a mean of zero and a standard deviation of one for the specific regression samples used. Thus, the coefficients on this variable can be interpreted as the difference in the probability of export entry for a firm one

standard deviation above the mean compared to a firm at the mean of the regression sample.

3.3 Event study results

Table 6 presents the estimation results for the full sample of export industries, starting from the parsimonious model with UFB adoption as the key explanatory variable then adding each ICT capability variable in turn, both independently and as an interaction with UFB adoption. We present two columns related to firms' existing web presence: column 3 has a simple dummy variable indicating whether the firm reports having a web presence or not (*has website*) while column 4 includes the dummy variable in addition to the index of website functionality discussed above (*website functions*). Firms which do not have a website have a value of zero for both variables.

The results imply that, for the sample as a whole, UFB adoption helps to predict export entry but with a lag – there is no significant relationship for contemporaneous exports (columns 1–5) but a consistent and significant relationship for exports two years later (columns 6–10).[14] Across the sample as a whole, firms which adopted UFB in the two years prior to 2012 and 2014 exhibit between a 5 and 12 percentage point higher probability of exporting in 2014 and 2016 than observably similar firms that continued to use non-fibre broadband, a substantial difference compared to the overall export rate of 9 percent. The inclusion of the indices of ICT use and complementary investments slightly weakens the estimated coefficients on UFB adoption, consistent with a positive but imprecisely estimated coefficient on the respective interaction terms. In contrast, inclusion of the web presence variables noticeably increases both the estimated coefficient and the standard error on fibre adoption, while the web presence variables are not themselves significant. As discussed further below, the existence and functionality of a firm's web presence may provide a less consistent signal of their underlying ICT capability than measures of ICT use and related investments.[15] In later tables we present only the estimates for the web presence dummy variable for brevity.

The overall estimation results in Table 6 mask heterogeneity across firm sizes and industry groupings. As discussed in Section 1, internet access may particularly help smaller firms to start exporting by reducing the fixed costs of export entry related to search and information costs. However, smaller firms often lack managerial capabilities to make the best use of digital tools (OECD, 2021b), which may limit the benefits of high speed internet. Table 7 presents the estimation results from the full model for separate samples of larger and smaller firms. Smaller firms are defined as firms with fewer than 20 employees (the number that is close to the median of the sample firms, thereby allowing us to split the sample into two roughly equal groups). Results for large firms are similar to those for the full sample, with a positive association between UFB adoption and export entry at t+2 but not in the year immediately following adoption, and no evidence that the positive relationship is mediated by prior ICT capability. In contrast, smaller firms that adopt UFB are more likely than non-adopters to export both in year t and in year t+2 only if they already had relatively high levels of ICT capabilities (compared to other small firms). For example, small firms which adopted UFB and had a

[14] Results here and in the following tables are consistent when estimated for a common sample of firms with data available at both t and t+2.

[15] As shown in Table A.2, the correlation between ICT use and complementary investments is higher than the correlation of either of those variables with the web presence variables.

level of prior ICT use one standard deviation about the mean are 9.6 percentage points more likely to export at time t than firms with the same level of prior ICT usage but which did not adopt UFB, and 4.3 percentage points more likely to export at time t than firms which adopted UFB but had the mean level of prior ICT usage.[16]

The contribution of faster internet to export entry can also differ across industries depending on the nature of industrial activities. For instance, faster internet is more likely to promote the export of services that can be delivered online than of goods or services that can only be delivered though physical proximity. Table 8 reports results of the event study model for three industry groups: Goods (Manufacturing; and Wholesale trade);[17] Services (Information media and telecommunications; Professional and technical services; and Administration and support services) and Advanced services (Information media and telecommunications; and Professional and technical services), a subset of the wider Services group. Panel A reports the results for the manufacturing and wholesale trade ("goods") industries, showing no significant association between any of the ICT variables and export entry. This reflects the overall low explanatory power of the export entry model for these industries – while lagged MFP, outward direct investment, and local employment density help to predict export entry over the following two years (by time t), the model provides little insight into firm-level factors predicting exports over the longer period (to t+2).

The model's explanatory power is stronger for services industries, and shows a positive and significant association between UFB adoption and exporting at both t and t+2 when our broad proxies for ICT capabilities (prior internet uses and complementary investments) are included, particularly for firms which were already using the internet for a range of activities (columns 1 and 4). This is consistent with faster internet enabling firms to reduce the costs of delivering their products overseas, potentially through lower cost and higher quality communication with customers and staff offshore. Inclusion of prior web presence again presents a mixed picture, which may reflect an unobserved qualitative difference between firms with websites and those without (at least in the late 2000s/early 2010s when business websites were less common). While most of the activities captured by the ICT use and complementary investment variables are potentially relevant for almost all firms (eg, online purchasing or training, or introducing new processes or business strategies), many website functions (eg, taking orders and receiving online payment) are more relevant for firms with a core set of undifferentiated products that can easily be advertised and ordered online. If web presence is associated with a particular type of product, these variables may be less an indication of firms' potential capabilities to make good use of their ICT than an indicator of the type of products they offer.

As a final breakdown of the event study analysis we further segment our two services industries sub-samples by firm size (Table 9). These results largely mirror those above – for large firms the relationship between ICT use, UFB adoption and exporting is weak, while for smaller firms the relationship is stronger, more immediate, and conditional on the firm's existing ICT capabilities.

[16] Differences are significant at 5% and 10% level respectively.
[17] We exclude Agriculture, forestry and fishing from the goods industry as many firms in this industry export indirectly through processing firms, producer boards, or other industry intermediaries.

3.4 Instrumental variables (IV) estimation

In this section, we seek to assess the causality of the predictive relationships described above by instrumenting UFB adoption using historical geographic variance in UFB availability. This approach is in line with previous studies that instrument a firm's broadband adoption with spatial differences in broadband availability. For instance, Akerman, Gaarder, and Mogstad (2015) instrumented the use of broadband by Norwegian firms with the share of households with access to broadband at each municipality level. They showed that broadband raises the productivity of Norwegian firms and that productivity gains are achieved through an increase in the relative productivity of skilled labour. Similarly, Canzian, Poy, and Schuller (2019) used a staggered rollout of the asymetric digital subscriber line (ADSL) network within Italy as an instrument and reported that the use of broadband boosts firm revenue and total factor productivity.

We construct an instrument based on each firm's proximity to schools drawing on the methodology of Fabling and Grimes (2021) and incorporating regional differences in the timing of the UFB rollout. This instrument should be correlated with a firm's UFB adoption, since adoption of UFB in the early 2010s was largely driven by the availability at the firm's location (Table 1) and a large share of New Zealand firms were located in areas that did not have access to fibre broadband in the early years of UFB rollout (Fabling and Grimes 2021). At the same time, there is no obvious reason to expect that a firm's distance to the nearest school is correlated with export entry, since the location of schools in urban and rural areas is not determined by the agglomeration of industrial activities or other infrastructure.

We define a "UFB-enabled school" as a school located in a region where the UFB rollout already started.[18] For each firm, we calculate the minimum distance between the firm's location (at t-2, either 2010 or 2012) and the nearest "UFB-enabled school" at t (2012 or 2014). This provides us with a reasonable proxy for each firm's access to UFB in the two years leading up to time t.

The first-stage estimation for our IV estimation is the following:

$$\begin{aligned} P(\textit{adopts fibre}_{it} = 1) \quad &= \alpha + \beta_1 \textit{UFB school distance}_{i,t-2} + \beta_2 \textit{ln(local empl. density)}_{i,t-2} \\ &\quad + \lambda Z_{t-2} + \phi_t + \epsilon_{it} \end{aligned}$$

where *UFB school distance*$_{i,t-2}$ is the log of the minimum distance (in kilometres) between the centre of the meshblock where the firm is located and the centre of the meshblock the nearest UFB-enabled school is located.[19] Z_{t-2} is the vector of firm char-

[18] Fabling and Grimes (2021) use simple distance to a school, regardless of whether the UFB rollout to that area was underway, and control for broad regional factors using the firm's employment share in each Territorial Authority. This approach works well for their analysis of changes in productivity, where a first or long difference model can be used to difference out permanent and unobserved firm characteristics. In contrast, our interest in the binary outcome of whether a firm exports or not requires that we include controls for a range of other firm characteristics known to affect export success. Once these additional firm-level variables are included in the model, the simple school distance variable remains strongly and negatively associated with UFB uptake (firms closer to schools are more likely to adopt, even after controlling for other observable characteristics), but is not a sufficiently strong predictor to overcome the weak instruments problem. We therefore supplement the simple measure with additional information on the timing of the rollout, giving sufficiently strong instruments in a subset of our estimation samples.

[19] Meshblocks are the smallest geographic unit available in the Business Register. Defined on the

acteristics (excluding local employment density but including the principal component-based indicators of firms' pre-existing ICT capabilities) and ϕ_t is a vector of year dummies. Lagged employment density is included as an additional instrument for UFB adoption, to allow for the possibility that UFB rollout prioritised areas with dense economic activity in addition to the focus on schools and hospitals. While employment density may be correlated with export entry if agglomeration of economic activities generates knowledge spillovers that facilitate exports (Fabling, Grimes, and Sanderson 2012), the coefficient on this variable was not statistically significant in the estimation of the event study model. Anderson-Rubin tests of overidentification also suggest that employment density is a valid instrument alongside *UFB school distance*$_{i,t-2}$ (Table 10). Other firm characteristics are treated as exogenous and included in the model in their lagged form, consistent with the event study models above.

Table 10 presents the estimation results for the full sample of export industries (columns 1 and 2) and for a sub-sample of those firms whose pre-existing ICT index was above the mean (column 3), estimated by Limited Information Maximum Likelihood (LIML) method. The first stage IV coefficients indicate that firms located closer to UFB-enabled schools were indeed more likely to have adopted UFB by 2012 or 2014, even after controlling for other firm characteristics. For instance, a 1% shorter distance to the nearest school is associated with around a 3 percentage point higher probability of UFB adoption. However, although the school distance variable is a statistically significant predictor of UFB uptake, it explains only a small part of the variation in UFB adoption across firms. Partial R^2s for the first stage equation are low and F-statistics for the instruments are close to the Stock–Yogo critical values for assessing weak instruments. Estimates in the second stage regression for the effect of UFB adoption on export entry are positive and significant bu implausibly large, consistent with a remaining problem of weak instruments.

All in all, the lack of plausible and robust effects of UFB adoption in the IV model means that we cannot rule out the possibility that the positive relationship between UFB adoption and export entry reported in the event study model (Tables 6 to 9) is driven by non-random selection of firms into UFB adoption. That is, either UFB uptake was strongest among firms that would have had higher export propensity regardless of UFB uptake, or early adopters did so as part of a pre-existing strategy to enter export markets. The event study results therefore represent an upper bound of the possible effect of UFB adoption on export entry.[20]

4 Conclusions

This paper explores the relationship between high-speed internet and export entry. The internet promotes international trade by allowing timely transmission of information between parties and thereby reducing search and information frictions. For prod-

basis of population, they range in size from around the size of a city block in densely populated areas to over 2000 square kilometres in remote rural locations. For firms located in the same meshblock as a school, the minimum distance is set to 10 metres. Excluding firms from remote areas from the regressions does not appreciably affect the results.

[20] Indeed, when we re-estimate the model for firms adopting UFB in 2014 and 2016, rather than 2012 and 2014, the relationship between uptake and export entry tends to be more strongly conditional on prior ICT, consistent with the more capable ICT users adopting first.

ucts which can be exported digitally, such as software, digital media, and many professional services, the internet also opens up new export opportunities and reduces transport costs to virtually zero. Recent technological developments, along with a greater acceptance of online communication brought about by the Covid-19 pandemic, provide opportunities for geographically distant countries such as New Zealand to expand and diversify their exporting through greater use of internet-based technologies. In order to benefit from these opportunities, however, firms require access to both a suitably high standard of digital infrastructure and the skills and information needed to exploit the new opportunities.

This paper finds that early adoption of high-speed fibre internet is a predictor of future export entry by New Zealand firms. Controlling for other observable characteristics and looking across export industries as a whole, firms which took up fibre broadband connections in the early stages of the UFB rollout were between 5 and 12 percentage points more likely to enter exporting over the following two years than other (non-fibre) broadband users.

Within this overall sample, we observe differences across industry and firm size groups. Notably, the positive relationship between UFB uptake is observed in (tradable) services industries – industries which have a stronger propensity to deliver their products via internet or telephone – but not in goods-producing or trading industries, suggesting that the value of UFB adoption is conditional on products being transmittable via digital channels.

The rich information on the ICT use in our data enables us to include proxies from firms' capabilities in leveraging the internet and digital tools prior to their adoption of UFB. Among large firms the positive relationship between fibre uptake and exporting is observed with a lag but is not conditional on observable measures of prior ICT capability. In contrast, among smaller services firms we see both a contemporaneous and lagged relationship – recent adopters have a higher probability of exporting in the year they first report using UFB and two years later. Among these firms, the relationship is mediated by existing capabilities – firms are more likely to enter exporting after adopting fibre if they already had an above average level of ICT use and/or were already investing in complementary activities to get more from their ICT. As smaller firms tend to have lower ICT use than large firms, this is consistent with there being a minimum level of capability required to make use of UFB to enhance export potential.

Firms that chose to adopt high-speed internet during the early phase of the UFB rollout may not have done so randomly but instead were likely motivated by the potential benefits of UFB adoption, including its potential in reducing the barriers to exporting. If this is the case, the observed positive relationships between UFB uptake and export entry may be driven at least partly by the self-selection of firms with such advanced foresight. To allow for this possibility, we supplement the predictive model with an instrumental variable analysis using information on firm location relative to the nearest primary or secondary school. This reflects the government prioritisation of schools and hospitals in the early phases of the UFB rollout. While the IV results are consistent with a causal effect running from adoption to export entry, the instruments are not strong enough to draw clear conclusions.

The results presented above suggest that investments in high-speed broadband such as New Zealand's Ultra-Fast Broadband Initiative help to set conditions under which

firms can access a wider international market, but that such opportunities are likely to be unevenly exploited across firms. To the extent that UFB adoption is of particular value to smaller firms and to professional services industries, such initiatives may help to diversify exports away from traditional products and exporters. However, with many small firms having limited ICT capabilities, investments in infrastructure may also be usefully supplemented with measures to enhance firms' digital capabilities.

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Tables

Table 1: Uptake of fibre broadband and reasons given among those not planning to use fibre, 2012 and 2018

	2012	2018
Fibre status		
Has fibre	15.5%	51.8%
Plans to get fibre	27.9%	23.0%
No plans to get fibre	56.6%	25.2%
Reason for no plans to get fibre		
Not available in local area	47.1%	59.1%
Start up costs are too high	8.5%	10.3%
Ongoing connection and usage costs are too high	5.4%	6.1%
Needs met by other technologies	20.4%	18.1%
Not compatible with existing technologies	1.2%	2.8%
None of the above	29.0%	16.2%

Notes: Reasons are reported as a proportion of those firms with no plan to get fibre. Percentages do not sum to 100 as firms may report more than one reason. Reported proportions are based on Stats NZ's imputation and sampling weights in order to represent the population of firms with six or more employees.
Source: Authors' calculations based on BOS ICT module, 2012 and 2018.

Table 2: UFB uptake by export status

	Non-exporters	Exporters
2010	7.6%	16.7%
2012	13.1%	18.9%
2014	19.2%	29.4%
2016	32.6%	41.2%
2018	50.4%	54.3%

Notes: Reported proportions are based on Stats NZ's imputation and sampling weights in order to represent the population of firms with six or more employees.
Source: Authors' calculations based on BOS ICT and Business Operations modules, 2012 and 2018.

Table 3: Digital uptake, 2008 and 2018

	2008	2018
Connection types		
Uses internet	93%	97%
Broadband connection	89%	95%
Fibre connection	9%*	51%
Uses of the Internet		
Finance (on-line banking, payments etc.)	85%	92%
Recruitment	36%	61%
Staff training	20%	48%
Within-firm information sharing	38%	57%
Inter-firms information sharing	33%	45%
Purchasing inputs	63%	85%
Selling products	40%	56%
Has own website	57%	73%
Functions included on the website (conditional on having a website)		
Providing information on products and prices	92%	89%
Customised page or information for repeat customers	32%	34%
Taking orders for firm's products	25%	29%
Receiving online payment	12%	20%
Providing after sales support online	25%	31%
Collecting customer information	21%	25%
Offering privacy or security information	19%	27%

Notes: *Fibre uptake reported for 2010 as question was not asked in 2008. Reported proportions are based on Stats NZ's imputation and sampling weights in order to represent the population of firms with six or more employees.
Source: Authors' calculations based on BOS ICT module, 2008, 2010 and 2018.

Table 4: Principal component loadings

Uses of the internet	
Finance (on-line banking, payments etc.)	0.164
Recruitment	0.434
Staff training	0.488
Within-firm information sharing	0.480
Inter-firms information sharing	0.440
Purchasing inputs	0.351
Eigenvalue	2.216
Proportion explained	0.369
N. firm-year observations	20,130
Functions included on the website	
Providing information on products and prices	0.273
Customised page or information for repeat customers	0.394
Taking orders for firm's products	0.439
Receiving online payment	0.414
Providing after sales support online	0.394
Collecting customer information	0.309
Offering privacy or security information	0.394
Eigenvalue	2.860
Proportion explained	0.408
N. firm-year observations	19,662
Complementary investments	
Changed staff levels or skill mix	0.344
Trained employees	0.318
New work practices	0.349
Restructured the organisation	0.333
New business strategies or mgmt techniques	0.364
Physically relocated activities	0.260
Non-ICT capital investment	0.289
Performed R&D	0.287
Redesigned production and distribution processes	0.323
Production of more ICT-intensive products	0.279
Eigenvalue	3.488
Proportion explained	0.349
N. firm-year observations	19,995

Notes: Principal components estimated separately for each group of characteristics, using the full population of firms with the relevant data available.
Source: Authors' calculations based on BOS ICT module, 2010–2018.

Table 5: Values of principal components by export status, 2008–2018

	Non-exporters		Exporters	
	mean	std dev.	mean	std dev.
Use of ICT				
2008	-0.659	1.489	-0.256	1.399
2010	-0.351	1.535	-0.059	1.408
2012	-0.103	1.505	0.187	1.359
2014	0.028	1.465	0.359	1.338
2016	0.176	1.458	0.489	1.278
2018	0.304	1.438	0.646	1.241
Website functionality				
2008	-0.408	1.486	-0.070	1.519
2010	-0.210	1.588	0.103	1.626
2012	-0.056	1.662	0.177	1.656
2014	0.008	1.700	0.235	1.762
2016	0.068	1.749	0.457	1.752
2018	0.032	1.753	0.516	1.895
Complementary investments				
2008	-0.137	1.812	0.249	1.996
2010	-0.141	1.810	0.125	1.806
2012	-0.095	1.880	0.218	2.022
2014	-0.114	1.777	0.141	1.862
2016	-0.066	1.846	0.172	1.874
2018	-0.055	1.864	0.277	1.944

Notes: Mean and standard deviation of the principal components for current exporters and non-exporters using full population of BOS respondents.
Source: Authors' calculations based on BOS ICT and Business Operations modules, 2010–2018.

Table 6: Estimated coefficients for the predicted probability of export entry (OLS)

	Exports at t					Exports at t+2				
adopts fibre	0.031	0.025	-0.021	-0.007	0.024	0.068***	0.055**	0.113*	0.121*	0.055**
	(0.020)	(0.020)	(0.040)	(0.044)	(0.020)	(0.026)	(0.026)	(0.064)	(0.069)	(0.025)
internet use		(0.012)					-0.004			
		(0.008)					(0.010)			
adopts fibre#internet use		0.025					0.039			
		(0.017)					(0.025)			
has website			-0.007	0.01				0.003	0.001	
			(0.020)	(0.022)				(0.026)	(0.028)	
adopts fibre#has website			0.063	0.044				-0.054	-0.066	
			(0.047)	(0.054)				(0.070)	(0.078)	
website functions				-0.015					0.002	
				(0.009)					(0.014)	
adopts fibre#website functions				0.016					0.008	
				(0.019)					(0.028)	
comp. investments					0.016*					0.001
					(0.009)					(0.011)
adopts fibre#comp. invest.					0.016					0.048*
					(0.021)					(0.025)
Mean dependent variable	0.073	0.073	0.073	0.073	0.073	0.090	0.090	0.090	0.090	0.090
R2	0.074	0.076	0.076	0.077	0.080	0.069	0.072	0.070	0.070	0.076
Adj R2	0.053	0.053	0.052	0.053	0.057	0.042	0.044	0.041	0.040	0.048
N	1,266	1,266	1,266	1,266	1,266	1,047	1,047	1,047	1,047	1,047

Notes: Linear probability model of exporting in year t and year t+2, conditional on being a non-exporter in year t-2. Base year t= 2012 & 2014. Excludes firms which were already using fibre broadband at t-2. Restricted to core exporting industries only: Agriculture, forestry and fishing; Manufacturing; Wholesale trade; Information media and telecommunications; Professional and technical services; and Administrative and support services. Control variables: year dummies, industry dummies, firm characteristics at t-2: ln(employment), capital intensity, MFP, binary indicator of inward foreign direct investment, binary indicator of outward direct investment, binary indicator of R&D activity, local employment density. Definitions and summary statistics for these variables are available in Appendix A. * p<0.10, ** p<0.05, *** p<0.01.
Source: Authors' calculations.

Table 7: Estimated coefficients for the predicted probability of export entry by firm size (OLS)

Large firms ($\geq$ 20 employees)	Exports at t			Exports at t+2		
adopts fibre	0.000	0.015	0.001	0.084**	0.273**	0.086**
	(0.026)	(0.089)	(0.025)	(0.036)	(0.124)	(0.035)
internet use	-0.011			0.020		
	(0.012)			(0.013)		
adopts fibre#internet use	0.006			-0.006		
	(0.022)			(0.036)		
has website		-0.029			0.017	
		(0.037)			(0.047)	
adopts fibre#has website		-0.017			-0.209	
		(0.094)			(0.128)	
comp. investments			0.045***			0.036**
			(0.016)			(0.017)
adopts fibre#comp. invest.			-0.043*			-0.032
			(0.024)			(0.029)
Mean dep var.	0.079	0.079	0.079	0.094	0.094	0.094
R^2	0.144	0.145	0.159	0.120	0.128	0.125
Adj. R^2	0.097	0.098	0.113	0.065	0.074	0.072
N	579	579	579	501	501	501

Small firms (<20 employees)	Exports at t			Exports at t+2		
adopts fibre	0.045	-0.062**	0.040	0.024	0.011	0.019
	(0.032)	(0.025)	(0.031)	(0.037)	(0.063)	(0.034)
internet use	-0.009			-0.019		
	(0.010)			(0.014)		
adopts fibre#internet use	0.052**			0.078**		
	(0.026)			(0.036)		
has website		0.015			0.005	
		(0.025)			(0.035)	
adopts fibre#has website		0.161***			0.052	
		(0.051)			(0.080)	
comp. investments			-0.005			-0.028**
			(0.011)			(0.014)
adopts fibre#comp. invest.			0.070*			0.123***
			(0.035)			(0.043)
Mean dep. var.	0.067	0.067	0.067	0.078	0.078	0.078
R^2	0.072	0.077	0.080	0.078	0.068	0.099
Adj. R^2	0.028	0.033	0.036	0.022	0.011	0.044
N	687	687	687	546	546	546

Notes: See notes to Table 6.
Source: Authors' calculations.

Table 8: Estimated coefficients for the predicted probability of export entry by industry group (OLS)

Goods	Exports at t			Exports at t+2		
adopts fibre	0.012	-0.038	0.010	0.037	0.245	0.036
	(0.037)	(0.087)	(0.034)	(0.046)	(0.185)	(0.040)
internet use	-0.008			-0.015		
	(0.011)			(0.013)		
adopts fibre#internet use	-0.011			0.026		
	(0.026)			(0.044)		
has website		0.011			0.014	
		(0.028)			(0.042)	
adopts fibre#has website		0.047			-0.217	
		(0.095)			(0.188)	
comp. investments			0.021			0.002
			(0.014)			(0.016)
adopts fibre#comp. invest.			-0.033			0.021
			(0.026)			(0.036)
Mean dep. var.	0.086	0.086	0.086	0.113	0.113	0.113
R^2	0.066	0.066	0.069	0.051	0.054	0.050
Adj. R^2	0.038	0.038	0.041	0.017	0.020	0.016
N	690	690	690	579	579	579

Services	Exports at t			Exports at t+2		
adopts fibre	0.073***	0.062	0.069***	0.095***	0.162	0.099***
	(0.028)	(0.095)	(0.027)	(0.035)	(0.114)	(0.036)
internet use	-0.028**			0.009		
	(0.012)			(0.018)		
adopts fibre#internet use	0.057**			0.062**		
	(0.023)			(0.032)		
has website		-0.021			0.037*	
		(0.025)			(0.023)	
adopts fibre#has website		0.018			-0.058	
		(0.100)			(0.122)	
comp. investments			0.018			0.010
			(0.013)			(0.017)
adopts fibre#comp. invest.			0.065*			0.066
			(0.033)			(0.041)
Mean dep. var.	0.054	0.054	0.054	0.064	0.064	0.064
R^2	0.131	0.117	0.165	0.108	0.083	0.117
Adj. R^2	0.103	0.088	0.138	0.071	0.045	0.080
N	408	408	408	330	330	330

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Advanced Services	Exports at t			Exports at t+2		
adopts fibre	0.106***	-0.023	0.104***	0.105**	0.065	0.120***
	(0.036)	(0.047)	(0.035)	(0.042)	(0.047)	(0.045)
internet use	-0.010			0.018		
	(0.011)			(0.029)		
adopts fibre#internet use	0.064**			0.090**		
	(0.026)			(0.042)		
has website		-0.002			0.049	
		(0.025)			(0.033)	
adopts fibre#has website		0.148**			0.065	
		(0.058)			(0.073)	
comp. investments			0.031			0.016
			(0.019)			(0.027)
adopts fibre#comp. invest.			0.058			0.075
			(0.042)			(0.054)
Mean dep. var.	0.062	0.062	0.062	0.076	0.076	0.076
R^2	0.135	0.124	0.183	0.148	0.093	0.141
Adj. R^2	0.090	0.077	0.140	0.093	0.035	0.086
N	240	240	240	198	198	198

Notes: Goods industries = Manufacturing and Wholesale trade; Services = Information Media and Telecommunications; Professional and Technical Services; and Administrative and Support Services; Advanced services = Information Media and Telecommunications; Professional and Technical Services. See also notes to Table 6.
Source: Authors' calculations.

Table 9: Estimated coefficients by industry group and firm size (OLS)

	Services				Advanced Services			
Panel A: Large firms	Exports at t		Exports at t+2		Exports at t		Exports at t+2	
adopts fibre	0.030	0.031	0.076*	0.077*	0.045	0.036	0.062	0.056
	(0.032)	(0.032)	(0.044)	(0.044)	(0.052)	(0.052)	(0.053)	(0.047)
internet use	-0.051***		0.020		-0.064*		0.011	
	(0.016)		(0.019)		(0.036)		(0.035)	
adopts fibre#internet use	0.041		0.005		0.081		0.067	
	(0.029)		(0.038)		(0.051)		(0.065)	
comp. investments		0.031		0.011		0.046		0.005
		(0.024)		(0.019)		(0.055)		(0.039)
adopts fibre#comp. invest.		-0.006		-0.021		-0.055		-0.057
		(0.038)		(0.035)		(0.062)		(0.055)
Mean dep. var.	0.063	0.063	0.048	0.048	0.088	0.088	0.057	0.057
R^2	0.218	0.205	0.110	0.103	0.259	0.247	0.176	0.165
Adj. R^2	0.165	0.152	0.034	0.026	0.162	0.148	0.038	0.026
N	210	210	168	168	105	105	84	84

	Services				Advanced Services			
Panel B: Small firms	Exports at t		Exports at t+2		Exports at t		Exports at t+2	
adopts fibre	0.105**	0.094**	0.097*	0.093*	0.119**	0.115***	0.128**	0.127**
	(0.041)	(0.037)	(0.052)	(0.048)	(0.046)	(0.039)	(0.060)	(0.053)
internet use	-0.014		0.013		-0.002		0.032	
	(0.017)		(0.028)		(0.010)		(0.040)	
adopts fibre#internet use	0.102**		0.115**		0.096**		0.114*	
	(0.040)		(0.053)		(0.040)		(0.059)	
comp. investments		-0.002		0.024		0.013		0.040
		(0.009)		(0.026)		(0.011)		(0.036)
adopts fibre#comp. invest.		0.143***		0.154*		0.139**		0.160*
		(0.050)		(0.080)		(0.053)		(0.095)
Mean dep. var.	0.045	0.045	0.080	0.080	0.043	0.043	0.088	0.088
R^2	0.168	0.263	0.164	0.246	0.226	0.368	0.205	0.313
Adj. R^2	0.110	0.212	0.091	0.180	0.151	0.307	0.111	0.231
N	198	198	162	162	138	138	114	114

Notes: Services = Information Media and Telecommunications; Professional and Technical Services; and Administrative and Support Services; Advanced services = Information Media and Telecommunications; Professional and Technical Services. See also notes to Table 6.
Source: Authors' calculations.

Table 10: Instrumental variable regressions (LIML)

	All firms		High use of ICT
	Exports at t	Exports at t+2	Exports at t
First stage:			
ln(distance to UFB enabled school)	-0.030***	-0.028***	-0.039***
	(0.007)	(0.007)	(0.010)
ln(local emplyment density)	0.008	0.011	0.008
	(0.006)	(0.007)	(0.011)
Second stage:			
adopts fibre	0.267**	0.182	0.294*
	(0.128)	(0.150)	(0.153)
First stage adj. R^2	0.147	0.142	0.152
First stage partial R^2t	0.024	0.023	0.03
IV F-stat (Stock-Yogo critical value)	15.34 (8.680)	11.75 (8.680)	9.029 (8.680)
Anderson-Rubin over-ident. test stat.	1.409	0.505	0.194
P-value	0.235	0.477	0.659
N	1,266	1,047	618

Notes: Limited Information Maximum Likelihood regression for probability of exporting in year t and year t+2, conditional on being a non-exporter in year t-2. Base year t= 2012 & 2014. Excludes firms which were already using fibre broadband at t-2. Restricted to core exporting industries only: Agriculture, forestry and fishing; Manufacturing; Wholesale trade; Information media and telecommunications; Professional and technical services; and Administrative and support services. Control variables: year dummies, industry dummies, firm characteristics at t-2: ln(employment), capital intensity, MFP, binary indicator of inward foreign direct investment, binary indicator of outward direct investment, binary indicator of R&D activity. Instruments: local employment density, log distance to the nearest "UFB-enabled" school. Definitions and summary statistics for all variables are available in Appendix A. Results reported only for regressions which pass tests for relevance and exogeneity of instruments. * p<0.10, ** p<0.05, *** p<0.01.
Source: Authors' calculations.

Appendix A Variable definitions and summary statistics

Table A.1: Variable definitions and sources

Variable	Definition	Source data
Exporter	Binary variable set to 1 if firm reports >1% of sales are exported, 0 otherwise	BOS Module A
Adopts fibre	Binary variable set to 1 if firm reports using fibre-to-the-premise connection in year t but not in year t-2	BOS Module B, ICT
internet use	Principal component capturing the range of activities for which the firm reports using the internet at t-2 (see section 3.2	BOS Module B, ICT
has website	Binary variable set to 1 if the firm reports that they had "a website, homepage or other web presence" at t-2, 0 otherwise.	BOS Module B, ICT
website functions	principal component capturing the range of functions offered on the firm's web presence at t-2	BOS Module B, ICT
complementary investments	principal component capturing the range of activites the firm undertook at t-2 to "get more benefit from its ICT"	BOS Module B, ICT
ln(labour)	Log of firm size as measured by average employment during the year (mean monthly headcount of employees plus adjusted annual count of working proprietors)	Fabling and Maré (2015) Labour tables
Capital-labour intensity	ln(capital services / labour) at $t-2$, where capital services are defined as rental, leasing and rate + depreciation + implied cost of capital for fixed assets as per Fabling and Maré (2019)	Fabling and Maré (2015) Labour tables and Fabling and Maré (2019) Productivity tables
Multi-factor productivity (MFP)	Multifactor productivity as calculated by Fabling and Maré (2019) as the residual from industry-specific gross output translog production function.	Fabling and Maré (2019) Productivity tables
ODI	Binary variable set to 1 if firm reports holding an ownership interest or shareholding in an overseas located business	BOS Module A
FDI	Binary variable set to 1 if firm reports that an individual or business located overseas holds an ownership interest or shareholding	BOS Module A
ln(local employment density)	Log of employment density (employees per square kilometre) in the Area Unit in which the firm is located at t-2. Top 1 percent of employment densities Winsorised to exclude implausible values. For firms with multiple locations, the highest density location is used.	Firm locations from Longitudinal Business Frame combined with employee counts from Fabling and Maré (2015) Labour tables.
ln(UFB school distance)	Log of distance to the nearest school, where that school is in a district where the national UFB rollout had commenced by t.	Firm locations from Longitudinal Business Frame combined with rollout information provided by Crown Infrastructure Partners
ANZSIC06 1-digit industry code	One-digit Australia New Zealand Standard Industrial Classification 2006	Business Operations Survey (from Stats NZ sampling frame)
4-digit industry code	Production function industry, derived from NZSIOC by Fabling and Maré (2019)	Fabling and Maré (2019) Productivity tables

Table A.2: Summary statistics for main analysis sample (export industries)

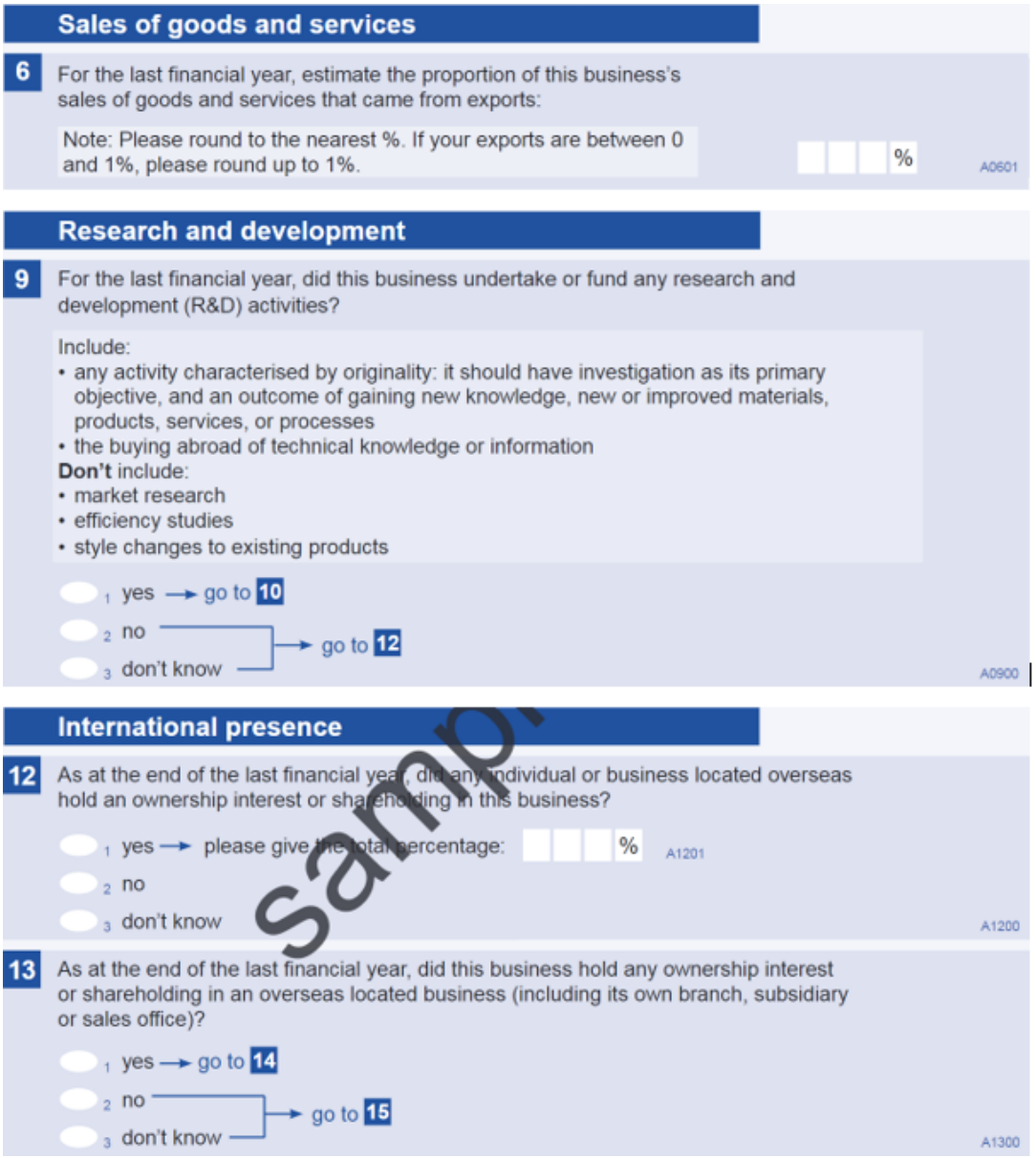
	Outcomes at t		Outcomes at t+2	
	Mean	Std dev	Mean	Std Dev
Has fibre at t	0.221		0.228	
Exports	0.073		0.090	
K/L ratio	9.295	1.196	9.300	1.170
ln(labour)	3.061	1.044	3.103	1.037
ln(local employment density)	6.802	2.587	6.764	2.618
ln(distance to UFB-enabled school)	-0.117	1.959	-0.136	1.918
MFP	0.124	0.292	0.127	0.302
ODI	0.028		0.031	
FDI	0.085		0.084	
Has website	0.742		0.752	
ICT use, web funct., comp. invest.	0	1	0	1
N. observations	1,266		1,047	

Correlation between proxies for ICT capability (Sample: Outcomes at t)				
	ICT use	Has website	Website function	Comp. inves.
ICT use	1			
Has website	0.330	1		
Website function	0.343	0.542	1	
Comp. invest.	0.471	0.237	0.312	1

Notes: Summary statistics for the full population of export industries. Principal components are correlated with each other as they have been estimated independently for each group of variables. The proxy variables used in the regressions are the first principal component for each group, normalised to be mean zero with a standard deviation of one for each regression sample.
Source: Authors' calculations.

Appendix B Survey questions

Figure B.1: Questions on international engagement and R&D (Module A, annual)



Sales of goods and services

6 For the last financial year, estimate the proportion of this business's sales of goods and services that came from exports:

Note: Please round to the nearest %. If your exports are between 0 and 1%, please round up to 1%.

□□□ %

A0601

Research and development

9 For the last financial year, did this business undertake or fund any research and development (R&D) activities?

Include:
- any activity characterised by originality: it should have investigation as its primary objective, and an outcome of gaining new knowledge, new or improved materials, products, services, or processes
- the buying abroad of technical knowledge or information

Don't include:
- market research
- efficiency studies
- style changes to existing products

1 yes → go to **10**
2 no → go to **12**
3 don't know → go to **12**

A0900

International presence

12 As at the end of the last financial year, did any individual or business located overseas hold an ownership interest or shareholding in this business?

1 yes → please give the total percentage: □□□ % A1201
2 no
3 don't know

A1200

13 As at the end of the last financial year, did this business hold any ownership interest or shareholding in an overseas located business (including its own branch, subsidiary or sales office)?

1 yes → go to **14**
2 no → go to **15**
3 don't know → go to **15**

A1300

Figure B.2: Questions on ICT USE (Module B, biennial in even years)

Internet

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

13 How does this business connect to the Internet?

1 both dial-up (ISDN and analog) **and** broadband connections → go to **14**

2 broadband connection only → go to **14**

3 dial-up connection only → go to **17**

or 4 don't know → go to **17** B1300

14 Mark all that apply. What types of broadband Internet connection does this business use?

DSL including ADSL (provided over your copper telephone line) B1401

cable (eg cable plans available in Wellington and Christchurch) B1402

fibre-to-the-premise (fibre optic broadband network) B1403

cellular technology B1404

wireless B1405

satellite B1406

or don't know B1407

15 Mark one oval. When does this business plan to use a fibre-to-the-premise Internet connection?

1 already using

2 within the next 3 months

3 between 3 months to 6 months

4 between 6 months to a year → go to **17**

5 between 1 to 2 years

6 more than 2 years

7 no plans to use fibre-to-the-premise → go to **16** B1500

16 Mark all that apply. Why does this business have no plans to use a fibre-to-the-premise Internet connection?

not available in local area B1601

start up costs are too high B1602

ongoing connection and usage costs are too high B1603

needs met by other technologies B1604

not compatible with existing technologies B1605

none of the above B1606

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

Purchases & sales of goods or services via the Internet

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 → go to **25**
3 don't know → go to **25**

B2100

Web presence

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** B2500
- 2 no → go to **27**

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

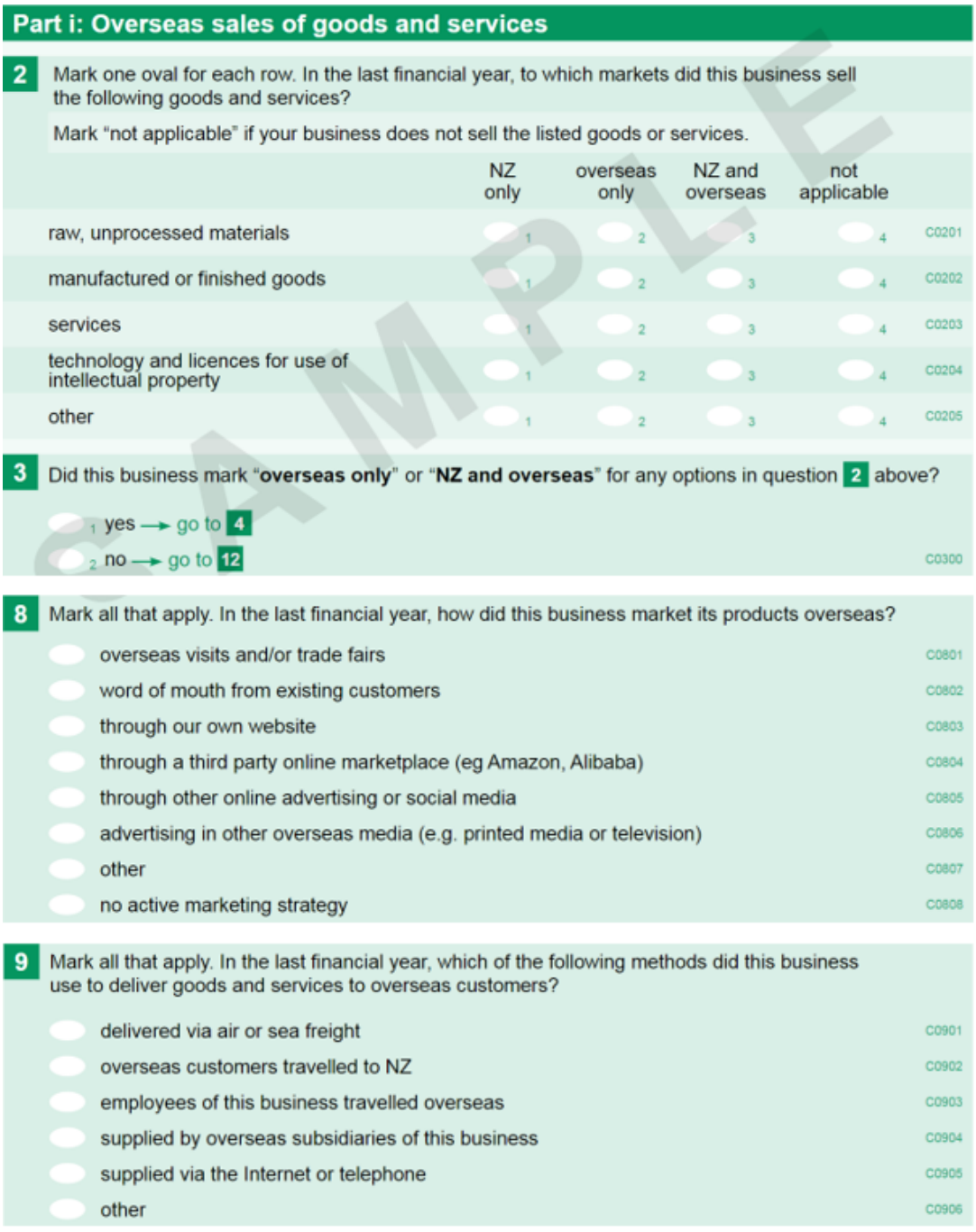
- goods or services information or prices B2601
- facility for collecting customer information on-line B2602
- on-line ordering facility for this business's goods or services B2603
- facility for on-line payment B2604
- provision of on-line after sales support (eg on-line queries, customer feedback)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

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

Figure B.3: Questions on Overseas sales of goods and services (Module C, 2019))



Part i: Overseas sales of goods and services

2 Mark one oval for each row. In the last financial year, to which markets did this business sell the following goods and services?

Mark "not applicable" if your business does not sell the listed goods or services.

	NZ only	overseas only	NZ and overseas	not applicable	
raw, unprocessed materials	1	2	3	4	C0201
manufactured or finished goods	1	2	3	4	C0202
services	1	2	3	4	C0203
technology and licences for use of intellectual property	1	2	3	4	C0204
other	1	2	3	4	C0205

3 Did this business mark "**overseas only**" or "**NZ and overseas**" for any options in question **2** above?

1 yes → go to **4**
2 no → go to **12** C0300

8 Mark all that apply. In the last financial year, how did this business market its products overseas?

- overseas visits and/or trade fairs C0801
- word of mouth from existing customers C0802
- through our own website C0803
- through a third party online marketplace (eg Amazon, Alibaba) C0804
- through other online advertising or social media C0805
- advertising in other overseas media (e.g. printed media or television) C0806
- other C0807
- no active marketing strategy C0808

9 Mark all that apply. In the last financial year, which of the following methods did this business use to deliver goods and services to overseas customers?

- delivered via air or sea freight C0901
- overseas customers travelled to NZ C0902
- employees of this business travelled overseas C0903
- supplied by overseas subsidiaries of this business C0904
- supplied via the Internet or telephone C0905
- other C0906

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