Decomposition of New Zealand firm productivity, 2001-2008

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The results in this paper are not official statistics, they have been created for research purposes from the Integrated Data Infrastructure prototype (IDI) managed by Statistics NZ. The opinions, findings, recommendations and conclusions expressed in this paper are those of the author(s). Statistics NZ, the Ministry of Economic Development, NZ and The Treasury, NZ take no responsibility for any omissions or errors in the information contained here.

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Abstract

In this paper we decompose labour productivity growth in the New Zealand industries. Using the prototype Longitudinal Business Database (LBD), we measure the firm productivity growth and break it down to see what composes the growth. Our analysis has three parts. First, we decompose labour productivity growth across industries using Olley and Pakes decomposition method (1996) with an extension to include exit and entry (Melitz and Palonec, 2009). The productivity growth is aggregated to one-digit level industry (1996 ANZSIC classification) using employment shares as weights, and to economy level using one-digit industry market shares as weights. Second, we examine reallocation effects of labour input and output in order to provide an insight into effects of firm dynamics.

JEL Classification: D40, D22, D24

Keywords: competition, firm entry and exit, productivity decomposition

Table of Contents

List of Figures

List of Tables

1. Introduction

High productivity is the key determinant of economic growth and the improvement of living standards. Despite a favourable business environment, New Zealand's current productivity performance is low and has deteriorated in comparison to many developed economies (New Zealand Treasury, 2008). GDP or output of an economy is a function of labour utilisation and labour productivity. The relatively high labour utilisation in New Zealand (MED, 2011) indicates the widened gap in terms of GDP per capita between New Zealand and other OECD countries can be attributed to lower labour productivity.

When seeking to understand these issues, studies tend to focus on the aggregate level of productivity for an economy or industries. However, that approach may mask the underlying engine of productivity growth because within each industry or economy every single firm is treated the same way. In order to understand where productivity growth comes from in New Zealand, in this paper we decompose labour productivity growth into components that capture effects of firm dynamics and examine input and output reallocation effects which resulting from competition.

Devine, Doan, Iyer, Mok and Stevens (2012) show there is an association between competition and industry dynamics via selection and reallocation effects. Industry dynamics from firm entry, expansion, shrinking and exit influence firm and industry performance and productivity growth is driven by these factors. Labour productivity growth may come through a number of channels. Firms can expand market shares and gain productivity, but firms may also enlarge their market shares at the expense of productivity, growing on pain. The death of less productive firms reallocates resources to more productive and newly entering firms. Whilst the expansion of surviving firms and entry of new firms is good news for employees, firm exiting or shrinking are not necessary bad for economy if the released labour force would be better used by elsewhere. However, policymakers looking at reducing unemployment rates may prefer to know how many net jobs created by this dynamic process and which group of firms play a key role in the process.

Firm productivity growth is a result of the dynamic process. Firm productivity is always dispersed even within a narrowly-defined areas of economic activity level e.g. branches within the same line of business (Griffith, Haskel and Neely, 2006). The

least productive firms in the bottom decile of New Zealand firms produced less than one tenth of the top decile of firms (Devine, Doan, Kris, Mok and Stevens, 2011b). Therefore, the contribution of firms to productivity growth at different points of the productivity distribution is expected to be considerably different. This motivates us to investigate how various groups of firms' contribution to aggregate productivity growth. Such decomposition provides insight into the contributions of firm dynamics which is influenced by market competition.

Our analysis has two parts. First, we measure firm labour productivity growth and decompose the growth across industries. The aim of this part is to answer the question 'what are the contributions to labour productivity growth of within-firm improvement, cross-firm reallocation, firm entry and exit?' Because of the size of our database, we are able to decompose aggregate movements down to the 4-digit industry (using the 1996 ANZSIC). We summarise our results at the aggregate level of sixteen one-digit industries. Second, we consider input and output reallocation effects in order to provide visible evidence on effects of the firm dynamics.

The remaining of the paper is structured as follows. In the next section we provide some background for the paper. In section 3 we briefly describe our data sources and provide definitions. In section 4, we present the decomposition results. Reallocation effects on input and output are presented in section 5. Section 6 summarizes findings and concludes.

2. Literature background and decomposition methods

2.1. Firm dynamics and productivity growth

Competition is believed to reduce slack and promote efficiency, to weed out the less efficient firms and promote (or discourage) innovation. Authors such as Nickell (1996) divide the impacts of competition into improvements of performance in static (efficiency change) terms (e.g. through managerial effort) and those in the dynamic context (e.g. through innovation or technical change).[1] The efficiency change moves

[1] Tirole (1997), considering the strategic interaction of firms in a game-theoretic industrial organisation framework, classifies the instruments with which firms to compete in a market according to the speed at which they can be altered. In the short run, firms compete by altering their price, advertising and sales effort. In the medium term firms can change their cost structures and product characteristics (within given cost and production sets – technology, in economics parlance). Finally, in the long run, the product characteristics and the cost structures themselves (i.e. shift the frontier of the production and cost sets) can be changed through research and development and other investments (p. 205).

firm's production toward the frontier, while the technical change shifts the frontier outward.

Competition tends to adversely affect the profits of less-efficient firms by more than it does to more-efficient firms. Competition therefore results in resource reallocation both inputs and output within industries. Expansion of more productive firms, shrinking of less productive firms, entry of new firms, and exiting of obsolete or poor performing firms are elements of the competition process and contribute to industry productivity growth. The process of "born and being destroyed", a key element of a battle called "creative destruction" plays an important role as a driver of productivity growth (OECD, 2003).

If the price of inefficiency in competitive markets is the death of inefficient firms, we would expect to see more firm exits in more competitive markets. On the one hand, new firms might have higher productivity growth than incumbents, either because they have some innovation that has caused them to enter market or because they need to be more productive in order to overcome the costs of entry. On the other hand, entering firms may have lower productivity because of their inexperience in producing and competing in the market. Once firms enter the market they can improve their efficiency through experiencing 'learning-by-doing' (Jovanovic, 1982). Those new entrants that manage to survive are likely to enter with lower productivity than the incumbents and tend to grow quickly, achieving high productivity.

Firm dynamics is believed to foster economic growth (Aghion and Howitt, 1992; Foster, Haltiwanger, and Krizan, 1998; Bartelsman and Doms, 2000). There are some reasons to advocate this belief. First, the process of 'learning by doing', firms may enter a market without full information about their potential profitability. After entering the market firms start to learn about its own profitability based on information they obtain during their business operation. If firms stay in the market longer, they then will make decision to expand, contract or exit the market. This process of learning is called *passive learning* (Jovanovic, 1982). Another learning process called *active learning* (Ericson and Pakes, 1995) is that firms actively explore their market conditions to invest in order to survive and enhance their profitability under competitive pressure. The profitability of firms changes over time because of their own investment and actions from their rivals. If a firm succeeds, it grows, accumulates assets and experience; otherwise it will shrink or exit. Firm dynamics is

a process of filtering and selecting. There can be many potential entrants to a market, but only more efficient firms can enter and survive the filtering or selection process. This forces firms to improve their productivity to survive and grow, and hence it results in economic growth.

The 'creative destruction' or firm dynamics may be explained in another way. New capital embodies new technology. New firms may take advantage to use new technologies while the existing firms need to costly re-equip new technologies and/or change production process. Overall growth is associated with the displacement of less efficient incumbent firms by the new productive and innovative firms. Productivity growth is believed to be led by new entrants (Bartelsman, Scarpetta and Schivardi, 2003). However, this is not always the case because amongst the existing firms those have better resources e.g. existing market shares, accumulated physical and human capital may find easier to compete with newcomers who are empirically examined to be smaller and less efficient (e.g. Devine *et al.,* 2012). Under more competitive pressure both from existing rivals and new entrants, incumbents may be forced to increase their performance and expand their market shares to stay ahead of the game. Consequently productivity growth may come from incumbent firms.

2.2. Labour productivity growth decomposition

In this sub-section, we summarize some widely-used methods of productivity growth decomposition, providing greater details on the method that is believed to be less biased than the others.

a. Bailey, Hulten and Campbell (1992) approach

This seminal decomposition method provides the foundation for many widely-cited methods such as Griliches and Regev (1995), Foster, Haltiwanger and Krizan (2001, 2008).

The change of aggregate productivity growth is decomposed as follows:

$$\Delta LP_{j,t} = LP_{j,t} - LP_{j,t-1} = \sum_{i \in cont} S_{i,t-1}(LP_{i,t} - LP_{i,t-1}) + \sum_{i \in cont}(S_{i\,t} - S_{i,t-1})LP_{i,t} + \sum_{i \in entry} S_{i,t} LP_{i,t} - \sum_{i \in exit} S_{i,t-1} LP_{i,\,t-1} \quad (1)$$

where $LP_{j,t} = \sum_{i \in j} S_{ijt} LP_{ijt}$; S_{ijt} and LP_{ijt} denote the market share and the productivity of firm i in an industry j in period t. The *cont, exit* and *entry* represent continuing, exiting and entering firms.

The first (within) term captures productivity improvement of surviving firms weighted by market (or employment) shares of initial period t-1. The second (between) term captures the reallocation effect of market shares between surviving firms weighted by period t productivity indices. The remaining terms measure contributions of entering and exiting firms. From equation (1) the contributions by entering and exiting firms are positive and negative respectively since they are treated to have the same productivity level as the surviving firms. In reality, entering and exiting firms are likely to have lower productivity relative to surviving firms leading to biased productivity of each component. Moreover, entering and exiting firms' productivity indices are weighted by overall market shares. This exacerbates the bias because of using common weights over time where they should be different.

b. Griliches and Regev (1995)

One can overcome the problem with Bailey *et al* (1992) by comparing productivity of each group of firms with a reference level of productivity. Griliches and Regev (1995) (hereinafter called GR) do this by comparing them with the unweighted mean of industry productivity (reference productivity).

$$\Delta LP_{j,t} = \sum_{i \in cont} \overline{S}_i (LP_{i,t} - LP_{i,t-1}) + \sum_{i \in cont} (S_{i,t} - S_{i,t-1})(\overline{LP}_i - \overline{LP}_j) + \sum_{i \in entry} S_{i,t} (LP_{i,t} - \overline{LP}_j) - \sum_{i \in exit} S_{i,t-1} (LP_{i,t-1} - \overline{LP}_j) \quad (2)$$

where $\overline{S}_i = (S_{i,t-1} + S_{i,t})/2$; $\overline{LP}_i = (LP_{i,t-1} + LP_{i,t})/2$; $\overline{LP}_j = (LP_{j,t-1} + LP_{j,t})/2$

Note that LP_j and market share are estimated for all types of firms, that is, no restriction is posed any type of firms.

Because entering and exiting firms are now compared to the average firm in its industry, it is possible for contribution of entering (exiting) firms to have a positive or negative impact on aggregate productivity growth. Instead of treating all types of firms the same in terms of productivity as in Bailey et al (1992), entering and exiting firms' productivity is compared to industry reference productivity.

The contribution of entrants is positive only if entering firms' aggregate productivity in period t exceeds (unweighted) industry aggregate productivity for all active firms (including entrants). Likewise, contribution of exiters is negative only if exiting firms'

aggregate productivity in period t-1 exceeds (unweighted) industry aggregate productivity for all active firms (including exiters).

If entrants and exiters have lower productivity than the (unweighted) industry aggregate productivity, the equation (2) shows a negative contribution by entry firms and a positive contribution of exiting firms in productivity growth. The expanding more productive firms or shrinking unproductive firms is good for industry productivity. In contrast, expanding unproductive firms or shrinking more productive firms is bad; the contribution of those firms is not good for growth, but something to be calculated. Nevertheless, it can be argued that this method does not correctly measure the impact of firm entry and exit on overall productivity growth because the reference productivity includes the entering and exiting firms' productivity. This could lead to underestimate (or overestimate) of the impact of entering and exiting firm productivity with their shares. The bias is not completely removed since the reference productivity includes the (lower) productivity of entrants and exiters in its computation of contributions of all groups of firms and using the overall market shares.

c. Foster, Haltiwanger and Krizan (2001, 2008)

An alternative approach is Foster, Haltiwanger and Krizan (2001, 2008) (hereinafter called FHK) as follows:

$$\Delta LP_{j,t} = \sum_{i \in Cont} S_{i,t-1}(LP_{i,t} - LP_{i,t-1}) + \sum_{i \in Cont} (S_{i,t} - S_{i,t-1})(LP_{i,_{t-1}} - LP_{j,t-1}) + \sum_{i \in Cont} (S_{i,t} - S_{i,t-1})(LP_{i,t} - LP_{i,t-1}) + \sum_{i \in entry} S_{i,t}(LP_{i,t} - LP_{j,t-1}) - \sum_{i \in exit} S_{i,t-1}(LP_{i,t-1} - LP_{j,t-1}) \quad (3)$$

Like the GR decomposition, LP_j and market share is computed for overall or all groups of firms.

Reallocation of market shares between surviving firms is captured in "*between*" and "*cross"* components. The s*econd term* is positive only if firms that have higher productivity than the industry initial aggregate productivity expand their market shares, or only if firms that have lower productivity than the industry initial aggregate productivity reduce their market shares. The *third term* is positive only if both firm market shares and productivity move in the same direction.

The *fourth* and *fifth* components are the contributions of entrants and exiters. The ontribution of entrants is positive only if entering firms' productivity exceeds the period t-1 industry aggregate productivity for all active firms (including entrant firms).

The contribution of exiters is negative if exiting firms' aggregate productivity exceeds the period t-1 industry aggregate productivity for all active firms (including exiters). The signs of contributions by entry and exit are similar to that of GR method but the reference productivity is different.

Like GR, the FHK method does not completely remove the bias as it uses inappropriate reference productivity (including entrants and exiters' productivity in the reference productivity- LP_j) in estimating contributions of entering and exiting firms (Melitz and Polanec, 2009). The weights used for exiters and entrants are the overall market shares as that of the surviving firms in the initial period (FHK) or the time average of market shares as that of the surviving firms (GR). Therefore, the improper weights exacerbate the bias. Both RG and FHK methods mix contributions of different groups of firms (entering – exiting – surviving).

In summary, these three method variations yield biased measures of the contributions of entrants and exiters due to inappropriate reference productivity and sharing the common weights with the surviving firms.

d. From Olley and Pakes (1996) to Melitz and Polanec (2009)

Olley and Pakes (1996), hereinafter called OP, shows that when the level of industry productivity is measured by the weighted average of firm-level productivity, it can be decomposed into the unweighted average of the productivity of firms and a covariance between market shares and productivity as follows.

$$LP_t = \overline{LP}_t + \sum_i (S_{i,t} - \overline{S}_t)(LP_{i,t} - \overline{LP}_t) = \overline{LP}_t + \mathrm{cov}(S_{i,t}, LP_{i,t}) \qquad (4)$$

where

$\overline{LP}_t = \frac{1}{n}\sum_{i \in j}^{n} LP_{i,t}$ is unweighted firm productivity mean; and

$\overline{S}_t = \frac{1}{n}\sum_{i \in j}^{n} S_{i,t}$ is the mean of market share in year t

The weighted industry productivity consists of unweighted average productivity and the covariance, which is called allocative efficiency (Olley & Pakes, 1996).

The within-industry covariance between market size and productivity is of particular interest to economists. The smaller this covariance term is, the smaller the share of

resources that gets allocated to the most productive firms. Changes in the covariance term may be due to policy (Hyytinen, Ilmakunnas & Maliranta, 2010). In particular, OP(1996) argue that the deregulation of the U.S. telecommunications equipment industry may have increased the covariance term by increasing the allocation of resources to the most productive firms. Similarly, Bartlesman et al. (2009) argue that a low covariance term represents for misallocation of resources, lack of competing, and market distortions, and believe that the variation in the covariance explains an important fraction of the cross-country differences in productivity.

The OP decomposition is cross-sectional and static. It does not consider the contributions of firm dynamics, exit and entry. Melitz and Polanec (2009) extended the OP decomposition to allow for entry and exit. This decomposition is called dynamic Olley-Pakes decomposition (DOPD).

For any group (*g*) of firms at any period we have

$$LP_{j,t} = \sum_{g \in G} S_{g,t} LP_{g,t}, \ \sum_{g \in G} S_{g,t} = 1 \tag{5}$$

Period 1: $$LP_{j,1} = S_{cont,1} LP_{cont,1} + S_{exit,1} LP_{exit,1} \tag{6}$$

Period 2: $$LP_{j,2} = S_{cont,2} LP_{cont,2} + S_{entry,2} LP_{entry,2} \tag{7}$$

For any group of firms in three groups (survivors/entrants/exiters), using equation (4) we have:

$$LP_{g,t} = \overline{LP}_{g,t} + \sum_{i \in j; j \in g} (S_{ig,t} - \overline{S}_{jg,t})(LP_{ig,t} - \overline{LP}_{jg,t}) \tag{8}$$

Combining (6), (7) and (8) we get:

$$\Delta LP_{j,t} = [\Delta \overline{LP}_{cont} + \Delta \mathrm{cov}_{cont}] + S_{entry,2}(LP_{entry,2} - LP_{cont,2}) + S_{exit,1}(LP_{\mathrm{cont},1} - LP_{exit,1}) \tag{9}$$

where

$$\Delta \overline{LP}_{cont} = [\overline{LP}_{cont,2} - \overline{LP}_{cont,1}]$$

$$\Delta \mathrm{cov}_{cont} = \sum_{i \in cont} [(S_{i,2} - \overline{S}_2)(LP_{i,2} - \overline{LP}_2) - (S_{i,1} - \overline{S}_1)(LP_{i,1} - \overline{LP}_1)]$$

where S and LP in equation (9) are aggregate market share and productivity of group g (surviving, entering and exiting firms).

The sum of the first two terms (within the square bracket) of equation (9) is the contribution of the surviving firm group. It is positive if aggregate productivity of these firms increases over time. The first is productivity improvement (within effect), and the second is the reallocation effect. The third term is the contribution of entry firm group. It is negative only if aggregate productivity of the entry firms is lower than that of the

surviving firms in period 2. The contribution to the aggregate productivity growth of exiting firms is positive if aggregate productivity of exiting firms is lower than the aggregate productivity of surviving firms in period 1.

The main differences between the DOPD method with others we described above is that the contributions of entering and exiting firms were estimated using the productivity level of the surviving firm group as the reference productivity rather than industry aggregate productivity of all firms in initial period (FHK) or unweighted time average productivity of all firms (GR). Both FHK and GR include entrants and exiters in the reference productivity, and share the overall market shares. In the meantime, each firm in three firm groups for the DOPD share the common market share within its group.

The second difference is that DOPD defines reallocation only when covariance (between market share and productivity) increases, rather than the contribution of the change in productivity distribution from reallocation for survivors by fixing weights as GR and FHK do. In other words, the covariance is a cross product of changes in market share and productivity without fixing weights.

Both FHK and GR yield biased measures of contributions of all three groups of firms. The size and direction of biases depend on features of firm dynamics (Melitz & Polanec, 2009). A contribution of surviving firms can be underestimated or overestimated depending on relationship between aggregate productivities of different groups of firms and market shares of entrants and exiters. For an industry where surviving firms have a productivity advantage over entering and exiting firms, imposing a common weight for all three groups of firms will result in downward-biased contribution for surviving firms and upward-biased contribution of entering firms in FHK and GR. For exiting firms, FHK yields downward biased contribution while the GR decomposition yields upward biased contribution (Melitz & Polanec, 2009). Melitz and Polanec also argue that the level of bias increases with the speed of surviving firms' productivity improvement and their productivity advantages over the entering and exiting firms. The bias will also become larger with longer periods as more firms enter and exit the market.

The size of different components of aggregate productivity decomposition depends not only on choice of methods of decomposition, but also on way one defines exit

and entry, the choice of productivity measures (actual value of LP or LP in logarithm) and weights. Choice of weights depends on the measure of productivity. It is common to use the weights that correspond to the measure of productivity, typically employment share is used as weights for LP, and VA share for TFP.

3. Data and labour productivity definition

The data used in this study comes from the prototype Longitudinal Business Database (LBD). The LBD is built around the Longitudinal Business Frame (LBF) (Seyb, 2003). To this is attached, among other things, AES, Goods and Services Tax (GST) returns, financial accounts (IR10) and aggregated Pay-As-You-Earn (PAYE) returns all provided by the Inland Revenue Department (IRD). The full prototype LBD is described in more detail in Fabling, Grimes, Sanderson and Stevens (2008) and Fabling (2009).

The dataset for this paper is derived mainly from Linked Employer-Employee Database (LEED) and Business Activity Indicator (BAI) datasets. The Annual Enterprise Survey data supplements if the data (value added) for labour productivity computation from BAI is missing. The firms are linked, starting in 2000 and continuing through to 2009. We have corrected for the discontinuity in firm identifiers based on the employment continuity rules (see Fabling, 2011).

Because of the need to identify entering and exiting firms, we lose 2 years from the data, one at the beginning and another at the end of the period. Therefore, our analysis relates to the period from 2001 to 2008.

Productivity definition

We measure labour productivity using data from the Business Activity Indicator (BAI) database of GST returns, Financial Accounts from Inland Revenue and the Linked Employer-Employee Database (LEED). Value added is calculated as gross output less intermediate consumption, and is deflated using the producer price index and materials deflators at the 2-digit ANZSIC level.

Our measure of labour input is made up of two components: employees and working proprietors.[2] Our measure of employees is rolling mean employment (RME), defined

[2] To be succinct, from this point onward, we use the term employment to mean total labour input, i.e. it includes both employees and working proprietors.

as an average of twelve monthly PAYE employee counts in the year. This takes into account part-year working, but not variations in hours worked (such as the difference between full-time and part-time workers). Our measure of working proprietors also comes from the LEED, it is a count of the number of self-employed persons who are paid taxable income during the tax year. This is based on a number of IRD forms and is calculated on a March year-end basis. For more information on the calculation of the variables used in this paper see Devine *et al.* (2011a and 2012).

This paper focuses on labour productivity (LP) for simplicity and uses value added (VA) as output, so LP of firm i in year t can be computed as $LP_{it}=VA_{it}/Labour_{it}$.

4. Labour productivity growth decomposition

4.1. Firm classification

Our classification of firms is based on a simple criterion: the contribution of a firm to measured industry productivity in the year.[3] Therefore, a firm that contributes in period 1, but not in period 2, is an exiter. A firm that contributes in period 2, but not in period 1, is an entrant. The remainder are continuers.[4] Note that we have not used the terms 'birth' or 'creation', 'death' or 'cease'. These are subsets of the entrant and exiter categories. A firm enters an industry when it contributes to the measured productivity of the industry in period 2, but not in period 1. There are a number of reasons why this may be the case such as firms skipped one or some years, firms switched to other industries, firms have no either data for computing labour productivity (false births, false deaths), for more detail of firm classification see Appendix 1 and Devine *et al*. (2012).

Because in another paper (Devine *et al*, 2012) shows that the rate of industry shifting to another 1-digit industry is negligible. The DOPD method typically looks over a period of time rather than a point of time, so exit, entry and continuing firms are defined for the whole period. In our point of view, skippers and jumpers are not new to the business world. We therefore classify entry including true births and false births, exit including true deaths and false deaths, and continuing firms as the residuals including jumpers and skippers.

[3] Our firm identification is based on data structure that is presented in Appendix 1 at the end of this paper.
[4] These are also called 'stayers', e.g. Baily *et al.* (1992)

4.2. Estimation results

Using the strategy of firm identification as earlier noted, we now implement the productivity growth decomposition for New Zealand industries over the period 2001 to 2008 using the dynamic Olley and Pakes with entry and exit of Melitz and Polanec (2009) as we have outlined above is believed to be least biased amongst these widely-used methods.

Note that value added in this study is a real measure of output that is adjusted for 2-digit industry producer price indices. For labour input, to avoid overestimation of labour input half of number of working proprietors in the first and last year of firm life for entering and exiting firms respectively are used to estimate total labour input. This is because the count of working proprietors is annual data, while employee count is monthly average data.

We compute the contribution by each group of firms over a period between 2001 (base year) and a certain year. Therefore, exit and entry are defined for each period between two years. A firm is defined as an entrant in its first year and in all subsequent years during the considered period. In the same manner, a firm is defined as an exiter in its last year and any preceding years backward during the considered period. The residual of firm population during a particular period are continuers.

Table 1 provides components of the decomposition in the middle columns and total change in the last column which represents the change of aggregate productivity index between a particular year and the base year of 2001. The decomposition is made between 2001 and all subsequent years until 2008. Longer periods allow us to examine how each group of firms contribute in the aggregate productivity growth.

Using the log of labour productivity as a productivity index over the period 2001-2008, we observe that aggregate labour productivity increased by 0.1826 of which 0.1398 is contributed by surviving firms, -0.0704 is contributed by entering firms and 0.1132 is accounted for by exiting firms. On average the annual total change in the aggregate productivity index is 0.0228 log points.

Table 1: Labour productivity growth decomposition (LP in log), 2001-2008

Year	Surviving firms			Entering firms	Exiting firms	Total[5] change
	Change in weighted productivity	Change in unweighted productivity	Change in covariance	Weighted productivity difference Ent. vs. Sur	Weighted productivity difference Sur. vs. Ext	
2002	0.0383	0.0244	0.0139	-0.0122	0.0201	0.0462
2003	0.0597	0.0467	0.0130	-0.0181	0.0326	0.0742
2004	0.1217	0.0857	0.0360	-0.0516	0.0522	0.1223
2005	0.1340	0.0947	0.0394	-0.0611	0.0642	0.1371
2006	0.1379	0.0776	0.0603	-0.0495	0.0812	0.1696
2007	0.1282	0.0590	0.0692	-0.0661	0.1009	0.1630
2008	0.1398	0.0624	0.0774	-0.0704	0.1132	0.1826
Average	0.0175	0.0078	0.0097	-0.0088	0.0141	0.0228

Notes: The industry aggregate productivity growth is calculated with labour input shares as weights, while the aggregate productivity growth for whole economy is calculated using VA shares of 1-digit industries as weights (see Appendix 2). Weights are estimated separately for each group of firms (survivors, entrants, exiters). The reference year for computation of the change of aggregate productivity index is 2001.

Entering and exiting firms are less productive than surviving firms. The contribution of entering firms is negative, while the contribution of exiting firms is positive. This is consistent with the evidence found in Devine *et al* (2012) even we look at a longer period of 8 years that may allow for more reliable measures of entering and exiting firms' contributions.

Entering firms reduce aggregate industry productivity as these firms in the initial years of their life are often less productive than the average firms. It is interesting that in countries where market entry barriers are higher, entering firms tend to have higher productivity growth than incumbents while countries such as Germany, the US where market entry barriers are low, entering firms are more likely to have lower productivity growth hence have a negative contribution to aggregate productivity index (Bartelsman et al, 2009).[6] According to OECD (2011), New Zealand is one of the countries having the lowest administrative and business start-up costs and most favourable business environment indicating New Zealand is likely to be similar to the US and Germany.

Exiting firms' contribution in aggregate productivity index is positive because the exiters are often least productive firms. What we found here very well accords with

[5] The growth can be estimated by taking anti-log of the "Total" and then computing the change between two subsequent years, but for simplicity the growth approximates the change in "Total" because "Total" that is in logarithm approximates the exponent of "Total" when the "Total" is small.

[6] New entrants might charge a low price to gain entrance into the market which is reflected in the low VA. Nevertheless, this effect is hard to disentangle in the absence of reliable price data.

that of most countries, including OECD economies (Bartelsman, Haltiwanger & Scarpetta, 2005).

The contributions of entering and exiting firms are fairly significant if we look at the contributions in a longer time frame. This accords with observed firm dynamics in NZ. NZ economy has a relatively high churn rate and high proportion of small firms relative to other OCED countries (OCED, 2008; MED, 2010). Smaller firms are less likely to survive long (MED, 2010), suggesting that more entering and exiting firms in the business population leads to larger contributions of these firms in the aggregate productivity index in relation with other OECD countries.

Over a longer period the absolute contributions by entering and exiting firms rose faster than that of the surviving firms (Figure 1) as number of entering and exiting increases with longer time periods as noted above. The relatively high values of entering and exiting components may imply that the churn rate is high and/or the gap between aggregate productivity of entering and exiting firms and that of surviving firms is large.[7] Recall that the entering and exiting productivity contributions are estimated using surviving firms' productivity as a reference. Moreover, the increase in aggregate productivity index caused by exit of exiting firms is much higher than the decrease in the aggregate productivity caused by the entry of entering firms, this implies that entering firms are more productive than the exiting firms unless exiting firms are larger than entering firms and/or the exiting rate is higher than entering rate. However, NZ data does not support this assumption because there are positive contributions in employment (market share) and firm turnover by net entry (see Devine *et al*, 2012).

The contribution of surviving firms to change in aggregate productivity is decomposed into two parts: change in unweighted productivity and change in covariance or reallocation. The firm productivity improvement seems to increase during the first four years then slightly decline, while the contribution of reallocation constantly increased over longer periods and overtook the unweighted productivity index after 7 years (see Figure 1).

[7] The higher churn rate means higher market shares of entering and exiting firms *ceteris paribus*.

Figure 1: Accumulated contributions of surviving, entering and exiting firms over time

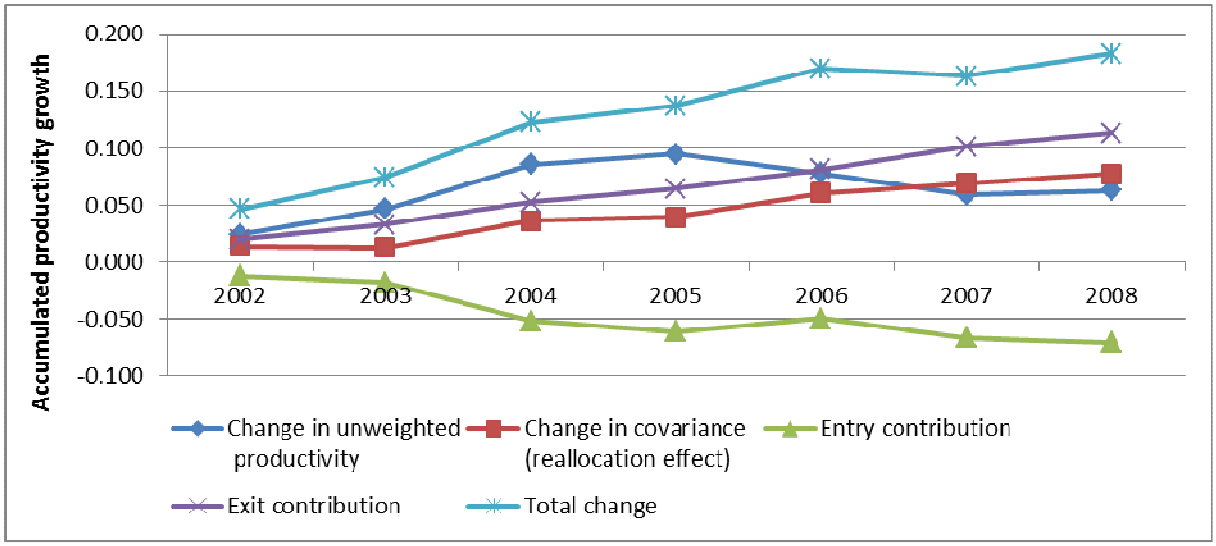

Table 2 reports total change in aggregate productivity indices and its components using log of labour productivity for 16 one-digit industries. The total change shows that all industries have increased productivity over the period.[8] There is a remarkable variation or dispersion in aggregate productivity growth across industries. However, bear in mind that the change in aggregate productivity indices may be attributed to data and also dip and/or fluctuation in reference year or middle-period year data, and potentially to data cleaning i.e. taking logarithm of LP. If there is a shock affecting productivity index of any year including the base year during the period. For example, a large change in aggregate productivity index of mining and quarrying can be the case of data fluctuation which leads to high change in aggregate productivity index.

As expected, for all industries exiting firms have a positive contribution in productivity growth index, while most industries have a negative contribution to the productivity growth except the first three industries of agriculture, fishing and forestry, and mining. The entering firms in these industries seem to have higher productivity growth than surviving firms if we look at a period of 8 years.

As discussed in OP(1996) and Hyytinen, Ilmakunnas and Maliranta (2010), the covariance between market size and productivity is of particular interest, the larger covariance is relative to the firm productivity improvement component, the bigger the share of resources allocated to the most productive firms. This implies that in the

[8] This is computed as Total change from 2001 to 2008.

longer term, competition amongst surviving firms helps reallocate resources to more productive firms.

Table 2: Accumulated productivity growth decomposition from 2001 to 2008

Industry	Survivor Total	Change in unweighted productivity	Chang in covariance (reallocation effect)	Entry contri	Exit contri	Total change
Farm, agricultural services And hunting	-0.025	-0.033	0.008	0.022	0.066	0.064
Fishing, forestry	0.250	0.187	0.063	0.022	0.025	0.298
Mining & quarrying	0.361	0.346	0.015	0.040	0.077	0.480
Manufacturing	0.194	0.069	0.125	-0.006	0.089	0.278
Construction	0.063	0.012	0.051	-0.132	0.143	0.074
Whole sales	0.187	0.144	0.043	-0.072	0.110	0.226
Retail	0.191	0.118	0.073	-0.088	0.116	0.219
Cafe, rest, accommodation	0.068	0.081	-0.013	-0.162	0.128	0.034
Transports & storage	0.130	0.033	0.097	-0.126	0.108	0.113
Post & communications	0.212	0.190	0.022	-0.126	0.103	0.189
Finance and insurance	0.140	-0.092	0.232	-0.139	0.083	0.084
Property & business services	0.089	-0.002	0.091	-0.084	0.195	0.200
Education	0.071	0.068	0.003	-0.007	0.073	0.138
Health & community services	0.265	0.188	0.077	-0.064	0.020	0.221
Cultural & recreational services	0.158	-0.006	0.164	-0.110	0.019	0.068
Personal & other services	0.003	0.035	-0.032	-0.105	0.180	0.078
Economy aggregate	**0.139**	**0.062**	**0.077**	**-0.070**	**0.113**	**0.182**

Notes: This table provides "Total change" for each period and average growth by one-digit industry. The reference year for computation of the change of aggregate productivity index is 2001.

In comparison with other OECD countries reported in Bartelsman *et al*. (2009) which uses a similar method to examine the difference in allocative efficiency across countries by looking at the gap between weighted average productivity and unweighted average productivity index. In our DOPD decomposition, the gap is the covariance term. If the gap is positive, it suggests that resources are allocated to more productive firms. Bear in mind that the covariance is a cross term between the change in productivity and change in market shares, it is positive only if both the changes move in the same direction.

By looking at 8-year period allocative efficiency or reallocation amongst the survivors, we observe that on average the reallocation rate is 55%,[9] of which finance and insurance, property and business services, cultural and recreational services,

[9] This is computed as column 4/column 2 of Table 2.

construction, transport & storage, and manufacturing have higher than average allocative efficiency rate, while mining & quarrying and education have very low allocative efficiency rates.

Taking a five-year difference as in Bartelsman et al. (2009), NZ's gap is about 29.4% for economy and 31% for manufacturing (period 2001-2005) (see Table 3). For manufacturing,[10] we find that NZ's gap is apparently higher than the UK and Argentina, and slightly higher than Finland, Netherlands and France, but much lower than the USA and some Asian emerging economies such as Taiwan, Korea and Indonesia.

Table 3: Allocative efficiency rate of manufacturing

Period	Total productivity growth of survivors	Change in unweighted productivity	Chang in covariance (reallocation effect)	Allocative efficiency (col4/col2)
2004/2001	0.1796	0.1218	0.0578	32%
2005/2001	0.1717	0.1186	0.0530	31%
2006/2001	0.2143	0.1033	0.1110	52%
2007/2001	0.1784	0.0662	0.1122	63%
2008/2001	0.1947	0.0695	0.1252	64%

5. Reallocation effects

It is possible to make a distinction between firms that are 'alive' and 'temporarily inactive'. However, it is difficult to distinguish between true inactivity and data issues, particularly for small firms that may drop below reporting thresholds. Instead of making some arbitrary choice for 'length of inactivity' before reactivation, we consider firms to be born the first time if they are observed undertaking economic activity and to die when we no longer observe economic activity for simplicity and to prevent double-counting. Therefore, in order to examine how firm dynamics affect input and output reallocation we re-define a firm in its first year as an entrant if we observe either output or an input (i.e. one of sales, purchases, or labour input). Similarly, we define a firm in its final year as an exiter if we observe either outputs or inputs.

Thus we define firms that enter, exit and are present in a given year t as follows:

N_t = entering firms are present in year t but not in $t-1$ or any earlier year

C_t = continuing firms are present in both year t and t - 1

[10] Data for economy is not available in Bartelsman et al. (2009) to compare

X_t = exiting firms are present in year t - 1 but not in t or any subsequent year

In Devine *et al* (2012) we show that there is a significant fraction of exiters and entrants in firm population and associated reallocation of labour input and output across these firms and survival ones. To provide an insight into the selection and reallocation effects we employ a method proposed by Davis, Haltiwanger and Schuh (1997). Two dimensions are considered. First, we look at contributions by firms for a particular year when firms entered or exited. Second, we then look at contributions by of exiters and entrants for whole life during the study period.

For the first consideration, firms are defined as 'entrants' in the year they entered market, but as 'continuing firms' in subsequent years. Likewise, firms are defined as 'exiters' in the year they exited, but as 'continuing firms' in the preceding years. The results for this examination are presented in Table 4. The table presents estimates of the gross expansion and contraction rates of labour input and outputs weighted by employment shares. The rates of the input and output expansion (contraction) are measured as weighted average of growth rates of expanding (contracting) firms including contribution of entering (exiting) firms. The expansion rates are 4.97%, 14.02% and 9.64% per year for labour input, VA and sales respectively of which continuing firms account for most. In other words, in the first year entering firms contribute a modest fraction (even a negative contribution in case of VA) of input and output. Similarly, the exiting firms in their last year contribute a little proportion in the contraction rate. The higher expansion rates than contraction rates for all measures resulted in positive net flows.

Table 4: Reallocation of input and output

Gross reallocation	Labour		VA		Sales	
	Rate	Share	Rate	Share	Rate	Share
Expansion rate	4.97	100%	14.02	100%	9.64	100%
Due to entering firms	*0.16*	*3.2%*	*-0.37*	*-2.82%*	*0.20*	*2.1%*
Due to continuing firms	*4.81*	*96.8%*	*14.42*	*102.82%*	*9.43*	*97.9%*
Contraction rate	2.05	100%	9.04	100%	5.35	100%
Due to exiting firms	*0.05*	*2.2%*	*0.36*	*3.97%*	*0.14*	*2.6%*
Due to continuing firms	*2.00*	*97.8%*	*8.68*	*96.0%*	*5.22*	*97.4%*
Net flows	2.92		4.99		4.28	
Excess reallocation	4.10		18.08		10.71	

Note: we removed firms that have zero-labour input and zero-value added in every year of their life during the study period. Net flow is difference between expansion and contraction rate. Excess reallocation is sum of expansion and contraction rates minus net flows.

For the second examination, firms are defined 'entrants' for the year they entered market and for all subsequent years until they either exited or last year of the study period (2008) if the firms still survived. Likewise, firms are defined 'exiters' for the year they exited, and for all preceding years. The remaining are 'continuers'. The story of contributions in input and outputs changes substantially by this consideration.

The rates of gross input and output expansion and contraction are very large over the eight-year horizon (Table 5).[11] Comparing to the base year of 2001, expansion rates are 81%, 219% and 109% for employment, VA and sales. The contraction rates are also high, but smaller than expansion rates, leading to the positive net flows. Looking at a longer time horizon, the contribution of firm turnover is really significant.

Interestingly, the entering firms contribute significantly over the period in terms of employment (48% of gross expansion) but their contributions in VA and sales are disproportional to their employment contribution. This suggests that entering firms are less productive than the continuing firms irrespective of considering over a longer period 2001-2008. This accords well our previous discussion. The contribution of exiting firms in employment contraction is very large, more than half of total job losses during the 8-year span.

Table 5: Reallocation of inputs and output over the period 2001-2008

Gross reallocation	Employment		VA		Sales	
	Count	Ratio	$mil	Ratio	$mil	Ratio
Expansion rate	1,208,800	81%	209,000	219%	400,700	109%
Due to entering firms	585,700	39% (48%)	33,100	35% (16%)	131,000	36% (33%)
Due to continuing firms	623,100	42% (52%)	175,900	184% (84%)	269,700	73% (67%)
Contraction rate	955,075	64%	176,200	185%	287,700	78%
Due to exiting firms	511,375	34% (54%)	26,200	27% (15%)	95,900	26% (33%)
Due to continuing firms	443,700	30% (46%)	150,000	157% (85%)	191,800	52% (67%)
Net flows	253,725	17%	32,800	34%	113,000	31%
Excess reallocation	1,910,151	128%	352,400	369%	575,400	156%
Baseline year 2001	1,492,500	100%	95,500	100%	368,000	100%

Note: Net flow is difference between expansion and contraction rate. Excess reallocation is summation of expansion and contraction rates minus net flows. All the rates are compared to 2001 baseline except percentages in parentheses are shares of each sub-item in their upper level rates.

In contrast, reallocation effects amongst continuing firms are also very large. They contributed 52% in total expansion rate and 46% in contraction rate of employment. Especially, net contribution by continuing firms in total employment growth is more

[11] The expansion and contraction rates are estimated by comparing to the base year 2001.

than 70%, about 179,400 out of 253,725 jobs. The continuing firms also account for 84% of expansion and 85% of contraction rates in VA and about two thirds of expansion and contraction rates in sales. In terms of net contributions in VA and total sales, the continuing firms have contributed to net flows much more than the entrants and exiters, 79% in net VA increase and 69% in net increase in total sales.

The large contributions especially in employment by entering and exiting firms imply that entry and exit are important drivers of firm dynamics and 'creation and destruction' analyses. The contributions by exit and entry are large, but they offset one another, thus the contributions of net flows by these firms are much smaller than the continuing firms. In the meantime, the healthy continuing firms expanded large enough to compensate for the contractions by shrinking incumbent firms and have significant contributions in the net flows.

6. Summary and conclusions

The paper has explored the productivity growth decomposition and reallocation effects by firm dynamics for New Zealand economy for period 2001-2008.

Using the log of labour productivity as a productivity index over the period 2001-2008, we observe that aggregate labour productivity increased by 0.1826 of which 0.1398 is contributed by surviving firms, -0.0704 is contributed by entering firms and 0.1132 is accounted for by exiting firms. On average the annual total change in the aggregate productivity index is 0.0228 log points.

The contribution of entering firms in aggregate productivity index is negative and contribution of exiting firms is positive. This is in line with the literature which typically indicates that entering and exiting firms are likely to be less efficient than surviving counterparts.

The contributions of entering and exiting firms are quite significant if we consider the contributions in a longer time frame. The contribution seems to be higher than OECD countries as a result of a relatively high churn rate and higher proportion of small firms relative to other OCED countries (OCED, 2008; MED, 2010). The smaller firms are more likely to have lower survival rates (MED, 2010).

For the aggregate productivity by surviving firms, the firm productivity improvement seems to increase during the first years, but slightly decline afterwards. In the

meantime, contribution of reallocation effect is positive and constantly increased over longer periods. More importantly, the increasing reallocation or allocative efficiency over longer periods suggests that more resources are allocated to the most productive firms. Some industries such as finance and insurance, property and business services, cultural and recreational services, construction, transport & storage, and manufacturing have high allocative efficiency rates, while mining & quarrying and education have very low allocative efficiency rates.

In comparison with other OECD countries reported in Bartelsman *et al*. (2009) with a five-year productivity difference NZ's allocative efficiency is higher than the UK, and slightly higher than Finland, Netherlands and France, but much lower than the USA and some Asian developing countries such as Taiwan, Korea and Indonesia. This suggest that allocative efficiency in NZ economy is somewhere just above European advanced economies but much less efficient than the most dynamic countries such as the US and fast emerging economies in Asia.

Our decomposition demonstrates that aggregate productivity growth index is mostly driven by firm productivity improvement in very short term, but in a longer term the reallocation and selection play a vital role in the aggregate productivity growth.

Given high rates of churn, it is necessary to examine how much industry dynamics contribute in inputs and output. If we look at a single point of time, in the first year of entering firms or last year of exiting firms their contributions in employment and output are modest, but considering over a longer time span their contributions are huge. This sheds light on evidence of the selection and reallocation effects in inputs and output. The finding suggest that policies aiming at job creation should pay attention to entering and exiting firms as they are very important contributors in job creation and destruction. In contrast, continuing, often are larger entities, play crucial important roles in growing outputs. The time span considered in our study is eight years, fairly long enough to conclude that contributions of entry firms are just more than enough to offset the contractions by exiting firms especially outputs exit, meanwhile the continuing firms are key players in the input and output growth.

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Appendices

Appendix 1: Data structure and firm identification

Continuer in all years

Year	2001	2002	2003	2004	2005	2006	2007	2008
VA	✓	✓	✓	✓	✓	✓	✓	✓
Labour	✓	✓	✓	✓	✓	✓	✓	✓
LP	✓	✓	✓	✓	✓	✓	✓	✓
Industry	C1111	C1111	C1111	C1111	C1111	C1111	C1111	C1111
	C	C	C	C	C	C	C	C

Entrant, then Continuer

Year	2001	2002	2003	2004	2005	2006	2007	2008
VA	×	×	✓	✓	✓	✓	✓	✓
Labour	×	×	✓	✓	✓	✓	✓	✓
LP	×	×	✓	✓	✓	✓	✓	✓
Industry	C1111	C1111	C1111	C1111	C1111	C1111	C1111	C1111
	.	.	**Enter**	C	C	C	C	C

Continuer, then Exiter

Year	2001	2002	2003	2004	2005	2006	2007	2008
VA	✓	✓	✓	✓	✓	×	×	×
Labour	✓	✓	✓	✓	✓	×	×	×
LP	✓	✓	✓	✓	✓	×	×	×
Industry	C1111	C1111	C1111	C1111	C1111	C1111	C1111	C1111
	C	C	C	C	**Exit**	.	.	.

Note: To be able to calculate labour productivity we need to define EXIT (firms doomed to die) in year 2005 instead of 2006.

Entrant, then Continuer, then Exiter

Year	2001	2002	2003	2004	2005	2006	2007	2008
VA	×	×	✓	✓	✓	×	×	×
Labour	×	×	✓	✓	✓	×	×	×
LP	×	×	✓	✓	✓	×	×	×
Industry	C1111	C1111	C1111	C1111	C1111	C1111	C1111	C1111
	.	.	**Enter**	**C**	**Exit**	.	.	.

Note: To be able to calculate labour productivity for EXIT we need to define EXIT (firms doomed to die) in year 2005 instead of 2006.

Skipper

Year	2001	2002	2003	2004	2005	2006	2007	2008
VA	✓	✓	×	✓	✓	✓	✓	✓
Labour	✓	✓	✓	✓	✓	✓	✓	✓
LP	✓	✓	×	✓	✓	✓	✓	✓
Industry	C1111	C1111	C1111	C1111	C1111	C1111	C1111	C1111
	C	**Skip out**	.	**Skip in**	C	C	C	C

Note: To be able to calculate labour productivity for 'Skip out' we need to define 'Skip out' in year 2002 instead of 2003.

Jumper

Year	2001	2002	2003	2004	2005	2006	2007	2008
VA	✓	✓	✓	✓	✓	✓	✓	✓
Labour	✓	✓	✓	✓	✓	✓	✓	✓
LP	✓	✓	✓	✓	✓	✓	✓	✓
Industry	C1111	C1111	C1111	C1211	C1211	C1211	C1211	C1211
Industry 1	C	C	**Jump out**	.	.	.	.	.
Industry 2	.	.	.	**Jump in**	C	C	C	C

False Entrant, then Continuer

Year	2001	2002	2003	2004	2005	2006	2007	2008
VA	×	✓	✓	✓	✓	✓	✓	✓
Labour	×	×	✓	✓	✓	✓	✓	✓
LP	×	×	✓	✓	✓	✓	✓	✓
Industry	C1111	C1111	C1111	C1111	C1111	C1111	C1111	C1111
	.	(actual enter?)	**False enter**	C	C	C	C	C

Continuer, then false Exit

Year	2001	2002	2003	2004	2005	2006	2007	2008
VA	✓	✓	✓	✓	✓	✓	×	×
Labour	✓	✓	✓	✓	✓	×	×	×
LP	✓	✓	✓	✓	✓	×	×	×
Industry	C1111	C1111	C1111	C1111	C1111	C1111	C1111	C1111
	C	C	C	C	**False exit**	(actual exit?)	.	.

Appendix 2: Weight estimation for LP growth aggregation to one-digit industry

Industry	2001 (mil)	2008 (mil)	Average	Weight
Farm, agri services & hunting	9,490	8,850	9,170	0.0920
Fishing, forestry	980	857	918.5	0.0092
Mining & quarrying	90	222	156	0.0016
Manufacturing	15,400	23,200	19,300	0.1937
Construction	6,050	9,410	7,730	0.0776
Whole sales	11,200	16,700	13,950	0.1400
Retail	6,150	8,780	7,465	0.0749
Cafe, rest, accommodation	2,150	2,760	2,455	0.0246
Transports & storage	7,350	8,830	8,090	0.0812
Communication services	2,450	3,270	2,860	0.0287
Finance and insurance	1,710	3,730	2,720	0.0273
Property & business services	14,600	23,100	18,850	0.1891
Education	363	740	551.5	0.0055
Health & community services	2,460	3,900	3,180	0.0319
Cultural & recreational services	1,020	1,120	1,070	0.0107
Personal & other services	1,010	1,380	1,195	0.0120
Overall			**99,661**	**1.0000**

Note: these numbers are different from actual GDP or VA as we removed non-standard firms those have no labour input or those have zero VA in every year of their life and we dropped small-number-observation industries (4-digit level), we used this table to estimate weights ONLY