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Competition in New Zealand Industries: Measurement and Evidence

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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 New Zealand.

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Abstract

Competition works alongside other factors to determine the performance of economies. Understanding the degree of competition within and across industries is an important step towards understanding the functioning of the economy. In this exploratory paper, we discuss several measures of competition applied in the academic literature. In particular, we consider a recently developed measure - *profit elasticity* - which is designed to overcome the problem other measures have in correctly identifying the intensity of competition. In theory, the profit elasticity measure performs better than more static measures of competition in markets where reallocation is strong and firm entry and exit rates are high. This paper provides the first empirical study of the degree of competition using this measure across a range of industries in New Zealand using firm level data. We find that manufacturing industries are some of the most competitive sectors in New Zealand. We also find that more sectors experienced significant increases in competition intensity, rather than decreases, over the period 2000-2010. Internationally, competition in New Zealand industries appears slightly more intense than Portugal, but less intense than the Netherlands and Finland.

JEL Classification: D4, L1, L5

Keywords: *competition, measurement, profit elasticity, microdata, New Zealand*

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1. Introduction

Competition works alongside other factors to determine the performance of economies. It stimulates managerial effort and company performance (Vickers, 1995), and promotes innovation (Porter, 1990). Competition punishes inefficiency and allocates resources to their best use. As a result of innovation and reallocation of resources to more efficient firms, productivity grows over time.

Understanding competition is critical to developing government policy and regulation to support a dynamic and growing economy. We currently have little or no information on the degree of competition in the majority of the sectors in the New Zealand economy. This study is the first major effort to fill the gap to provide a broad picture of competition across New Zealand industries.[1]

This report introduces a relatively new 'profit elasticity' measure of competition intensity (Boone 2000, 2008a, 2008b) that is designed to be more robust than the conventional measures based on industry structure (e.g. concentration indices) or price-cost margins. Profit elasticity measures the sensitivity of profits to costs. We calculate profit elasticity for over three hundred New Zealand four-digit industries, using firm-level data from the prototype Longitudinal Business Database.

The remainder of this paper is structured as follows: Section 2 provides some background to motivate the study; Section 3 briefly discusses the nature of competition and methods for measuring it, and introduces the profit elasticity model; Section 4 describes our data; Section 5 presents our empirical models and results for New Zealand industries, and compares them with some international studies; and Section 6 summarises the key findings and discusses areas for future research.

[1] Note that this study is distinct from the detailed analyses of clearly-defined individual markets that are the province of competition agencies. These studies require an in-depth examination of the history and context of the market, the nature of costs and production, barriers to entry, technological development, product substitutability etc., and are beyond the scope of this paper. Nevertheless, the measure presented in this paper could be a useful input into such analyses.

2. Background

The policy context for this work can be neatly summed up as the 'New Zealand Paradox' (McCann 2009). New Zealand's policies compare favourably with international best practice in many areas, such as the ease of starting a business and labour and product market regulation. New Zealand has an open economy: tariffs and other protective mechanisms have been all but phased out, and it has established free trade agreements with many key trading partners, such as China and Singapore. Nevertheless, New Zealand has a low level of labour productivity, about 80% of the OECD average (MED *et al.*, 2011). "The mystery is why a country that seems close to best practice in most of the policies that are regarded as the key drivers of growth is nevertheless just an average performer" (OECD, 2003, p. 29).

One potential explanation for this paradox is that, despite best practice policy and regulation, competition is weak in New Zealand. For instance, because of New Zealand's distance from major markets and global producers, firms here are relatively insulated from international competition. At the same time, relatively few firms operate in some domestic markets because of New Zealand's small population dispersed across a number of centres. Gal (2003) argued that small, distant economies suffer from a lack of scale economies, high levels of industrial concentration (for instance, dairying in New Zealand) and high barriers to market entry for international players.[2] One of the costs of distance and small size may be lower levels of competition in the economy.

Technological advances have in some ways reduced the impact of distance (Cairncross, 1997; Coyle, 1997; Keller, 2002; Friedman, 2005; Thompson, 2006; Griffith, Lee & Van Reenen 2007). Yet, despite falling transport costs and advances in communications technology, the economic costs of distance are still considerable. An OECD study estimated that New Zealand and Australia's distance from major trading centres reduces their per capita income by up to 11% (Boulhol, de Serres & Molnar, 2008). The relative cost of distance may even have increased over the last 40 years for simultaneously small and distant economies (Krugman, 1991a, 1991b; McCann, 2009).

Yet, even if New Zealand markets had healthy levels of competition, competition may not always be unambiguously good for growth. For instance, high levels of competition could curtail innovation by competing away the value of innovation to the innovator (e.g. Romer, 1990; Grossman & Helpman, 1991; Aghion & Howitt, 1992). As a result, the relationship between competition and outcomes such as innovation and productivity growth may be non-linear. In markets with already high levels of competition and a wide range of productivity levels across firms, increasing competition may reduce innovation (e.g. Aghion et al., 2005; Polder & Veldhuizen, 2012).

Excessive competition might have particularly strong effects on curtailing innovation in small markets such as New Zealand's, where the potential returns to innovation are lower than in big economies like the US and Europe. Innovation-generating activity often ends in failure. New techniques create new problems to overcome, are impractical, or simply do not work as planned. New products or services may fail to emerge or do not land well with customers. Innovation can be costly in time, effort and money. R&D, retooling production lines, building logistics networks, and creating market awareness can all be expensive. In New Zealand, lower potential returns might compound the effects of high levels of competition on innovation.

Yet whether or not firms in a particular market face a level of competition that inhibits innovation is an empirical question (Polder & Veldhuizen, 2012). Studies of the relationship between competition and innovation often show that a majority of markets in particular countries would perform better with more competition. If competition is generally weak in New

[2] The problems suffered by small, distant economies such as New Zealand are also discussed in Evans and Hughes (2003).

Zealand markets because of its small size and distance, then more competition is likely to stimulate innovation rather than curtail it.[3]

Policy makers and regulators need better measures of competition in New Zealand markets and a firmer understanding of the relationship between competition and innovation in particular markets. This study provides a first step by producing estimates of competition intensity in markets across the New Zealand economy. The following section discusses how to define and measure the intensity of competition.

[3] Another argument, not likely to apply to New Zealand, is that in countries in early stages of development, lower competition (particular from international competitors) protects fledgling industries while they develop scale and capability (Gerschenkron, 1962; Acemoglu, Aghion & Zilibotti, 2003; Crafts, 2004).

3. Measuring competition

Competition is a process of rivalry between parties that strive for something that all cannot obtain or possess (Stigler, 1987; Vickers, 1995). There is a long history of considering and reconsidering the meaning of competition in economics, since at least the 18th century (e.g. David Hume and Adam Smith)[4]. This paper looks at firms competing in or for a market.

A market is typically more competitive when forces prevent firms from exercising market power. A firm has market power if it has the ability to profitably raise prices above marginal costs. Market power is constrained by supply-side responses (the ability to compete on quality or prices, through collusion or strategic interactions), by entry or the threat of entry by other firms, and by demand-side responses of consumers (including the degree of product differentiation and state of consumer preferences).

How then do we measure competition? The empirical industrial organisation literature has used several measures of competition, such as the Herfindahl-Herschman index (HHI) and the price-cost margin (PCM). Both measures, in different ways, attempt to measure the degree of market power that firms in a particular industry enjoy. Yet, these measures do not always perform well in depicting the level or changes in competition in a market (as outlined in sections 3.1 to 3.4).

More recently, Boone and others have introduced a theoretically robust measure of competition – the relative profits difference (RPD) or, equivalently, the profit elasticity (PE). These measures show the relationship between firm-level profits and efficiency in a market; the relationship is stronger in more competitive markets. The RPD and PE measures can be implemented empirically to overcome the problems identified with other measures (Boone, 2000, 2008a, 2008b). We outline the various measures below, considering the advantages and disadvantages of each.

3.1. Concentration indices and the Herfindahl-Herschman Index

Early studies measured competition using the concentration of market share within an industry. The *concentration ratio* and the *HHI* are two of the most common measures. The concentration ratio is the share of an industry or market accounted for by the top firms, e.g. the top 4 or 5 firms[5]. The HHI, the sum of the squares of the market shares for all firms in a particular market, is a non-linear version of the concentration ratio.[6]

The concentration ratio and the HHI are relatively simple to measure in closed economies, requiring just the sales of firms in a market. In an open economy, competition from imports must be taken into account, requiring data on imports of goods and services. Even when available, these are typically recorded according to a product classification (such as the *Harmonized Commodity Description and Coding System*). On the other hand, firm data are classified by the firm's predominant industry (New Zealand uses the *Australian and New Zealand Standard Industrial Classification* - ANZSIC). There is no simple one-to-one match of products to industries. Imports may compete with both goods-producing and retail industries, adding further complexity.

[4] Examples include: Ely (1901), Lerner (1934), Hayek (1948), Stigler (1957), McNulty (1968), Stigler (1987), Vickers (1995), and Boone (2000, 2008a, 2008b).

[5] The *k*-firm concentration ratio in industry *j* is given by: $C_j^k = \sum_{l=1}^{k} Sales_l \Big/ \sum_i Sales_i \qquad i,l \in j$

[6] The HHI in industry *j* is given by $H_j = \sum_i \left(Sales_i \Big/ \sum_l Sales_l \right)^2 \quad i,l \in j$

The concentration ratio and HHI are measures of market *structure*, reflecting a view that firms in highly concentrated markets can exercise market power. The measures are useful in relatively static markets, but do not account well for competition in dynamic markets.

In more dynamic markets, new firms enter and unsuccessful firms exit, while more efficient firms grow at the expense of less efficient ones. Intense competition of this sort may increase concentration as more efficient firms gain market share. This is an important issue. In most economies, around 20% of firms in any given year are either born or die (e.g. MED *et al*., 2011; Devine, Doan, Nunns and Stevens, 2012).

High concentration in a market does not necessarily entail low competition. When firms engage in 'leap-frog' innovation', for instance, a particular firm's dominance (in terms of market share) is likely to be temporary (Romer, 1990; Aghion and Howitt, 1992). Nintendo, and before that Sega and Atari, once dominated the games console market; now Microsoft and Sony lead.

3.2. Price Cost Margin

What economists generally mean when they think of a market with low competition is that firms have the ability to mark up prices well above marginal costs. This allows firms to make 'supernormal profits' at the expense of the consumer and is a reason competition authorities intervene to prevent anti-competitive behaviour.

The PCM (or Lerner index) therefore measures a firm's ability to increase prices above marginal cost.[7] It is straightforward to generate a measure for the whole industry by aggregating up all firms' PCM weighted by each firm's market share.[8] In most circumstances, when competition changes (due to a firm entering the market or more aggressive conduct by firms), it will affect *all* firms' ability to mark-up prices over their marginal cost.

As with the concentration ratio and HHI, the PCM is simple to calculate in a closed economy. However, data on the costs of foreign firms that compete in the domestic economy are seldom available. The PCM is primarily a firm-level measure of market power. If import competition reduces the market power of domestic firms, this should be accurately reflected in a lower level firm-level PCM.

Yet, once we allow for heterogeneity within the market, an aggregated industry-level PCM may not accurately reflect competitive conditions (section 3.3). If competition forces less efficient firms with the highest costs and the lowest mark-up out of the market, the average PCM of the remainder may well be *higher*. What is true for the firm is not always true for the industry as a whole.

3.3. Competition, reallocation and selection

Traditional measures often assume that firms within industries are identical with respect to productivity. However, firms are not all identical, and there is often considerable heterogeneity in productivity between firms. A key finding emerging from firm or plant-level datasets is that there is a large variation in firm performance, even within narrowly defined industries (Bartelsman and Doms, 2000; Syverson, 2004). It is not unusual to find that firms in the top decile of the industry productivity distribution are many times more productive than those in the lowest decile. There are a number of explanations for this, ranging from the use of different production or management techniques and technology, to how hard staff are working.

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[7] More usually, the PCM is measured using average costs, because marginal costs are difficult to observe (e.g. Nickell, 1996; Stevens, 2009).

[8] That is, $PCM_j = \sum_{i \in j} \left(\frac{p_i - c_i}{p_i} \times s_i \right)$, where *s* is the firm's market share: $s_i = Sales_i \Big/ \sum_l Sales_l$

Competition can affect a more productive firm differently than its less productive counterparts. Consider an industry where firms have some market power and can charge a mark-up over marginal costs because their products or services are not identical. Most markets are differentiated in some way that consumers value. Even products that *look* identical may vary in other aspects, such as their proximity to consumers.

Firms are also not identical in terms of the efficiency of their operations. There is heterogeneity in efficiency and, hence, costs. More efficient firms have higher profits and profit margins than less efficient firms.

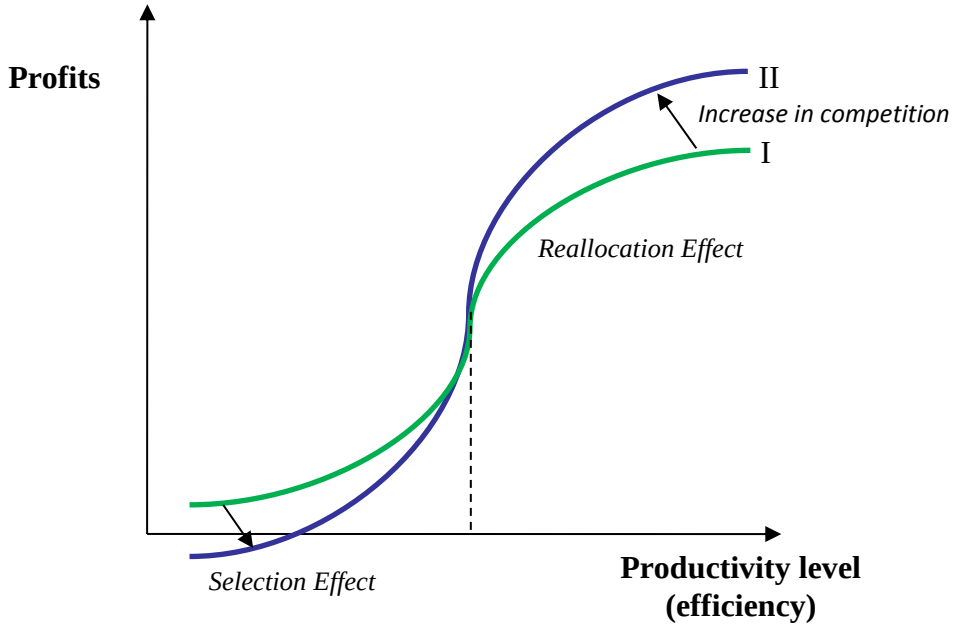
Assume, for simplicity's sake, that increased competition affects all firms' prices in a similar way (i.e. when a new competitor enters the market, all firms have to lower their prices to compete and this does not change the rankings of prices). This will lead to the mark-ups of all firms to fall. Beyond the impact on each individual firm's mark-up, an increase in competition is likely to have two broader effects: a *reallocation* effect and a *selection* effect.

- The ***reallocation effect*** is the reallocation of output between firms in a competitive market. More efficient firms are better able to weather economic storms. When competition increases, market share is reallocated from less efficient firms to more efficient firms, as the former are less able to reduce margins and remain profitable.
- The ***selection effect*** is when inefficient firms leave the market. As competition increases, the least efficient firms become unprofitable and are forced to exit. The remaining firms – those with higher price cost margins – will increase their output to service the customers of the less-efficient firms who exit.

The reallocation and selection effects are demonstrated in Figure 1, which shows the relationship between changes in competition and firm profits for firms with different levels of productivity/efficiency. There is a positive relationship between profits and productivity – more productive firms are more profitable, other things remaining the same.

The initial level of competition is demonstrated by curve I. The slope reflects the intensity of competition and a steeper slope indicates fiercer competition. The effect of an increase in competition is to increase the slope and rotate the curve anticlockwise (from I to II). The rotation of the curve demonstrates both the reallocation and selection effects. With fiercer competition, more efficient and productive firms increase their profits relative to less efficient firms and increase their market share. Firms with low productivity experience a fall in profits relative to more efficient firms and lose market share. When the least productive firms' profits drop below zero, they exit the market. This is the selection effect.

Figure 1: Profit-productivity Curve



Reallocation and selection mean that, even if competition reduces profit margins for all firms, more efficient firms increase their profits relative to less efficient firms. This is both because the percentage change in the profit margins of more efficient firms is relatively smaller than for less efficient firms, and also because more efficient firms increase their market share. As a result, traditional measures of competition, such as the HHI and the PCM, may not accurately reflect the degree of competition in a market (section 3.4).

3.4. Firm heterogeneity and traditional competition measures

More efficient firms have a higher PCM in markets with heterogeneous firms. When competition becomes fiercer, more efficient firms are able to use their cost advantage to increase their market share. At the same time, the least efficient firms, those with the lowest PCM may be forced out of the market. As a result of both reallocation and selection effects, increased competition can result in an *increase* in industry PCM. Moreover, reallocation and selection can also *increase* concentration. Hence concentration measures like the HHI can also rise when competition increases.

Thus both the PCM and HHI may incorrectly measure a change in the level of competition. Mismeasurement will likely be a particular problem in dynamic markets with high rates of firm entry and exit, and of reallocation of market share amongst incumbents.

3.5. Relative profits difference and profit elasticity

Boone (2000, 2008a, 2008b) presents a new measure of competition, based on the sensitivity of profits to firms' efficiency. The *Relative Profit Difference* (RPD) captures the insight that more efficient firms are able to exploit their cost advantage over inefficient firms. As competition rises, the profits of more efficient firms will become relatively larger than those of less efficient firms, even if profits fall for all firms.

Consider a market with two firms making a profit defined as $\pi(\eta)$ with different levels of efficiency, η, where $\eta' > \eta$. The RPD is the ratio of the profits of the more efficient to the less efficient firm and is given by:

(1) $$RPD = \frac{\pi(\eta')}{\pi(\eta)}$$

If competition increases, for example through another firm entering the market, the RPD will increase. The profits of the more efficient firm will decrease by less than the profits of the less efficient firm. This results in the share of profits in the market being reallocated from the less efficient firm (η) to the more efficient firm (η').

The RPD measure is a two-way comparison of firms. For each pair of firms, an increase in competition will always result in the more efficient firm becoming relatively more profitable. Griffith et al. (2005) extended this concept to a more general, industry-wide measure of competition, the *profit elasticity* (PE). The PE measures the sensitivity of profits to changes in marginal cost.[9]

The PE for industry *j* is typically calculated by regressing firms' profits *(π)* on their average variable costs (*avc*):

(2) $$PE_{ij} : \ln(\pi_{ij}) = \alpha + \beta_j \ln(avc_{ij}) + \varepsilon_{ij}$$

where profit equals gross output of firm *i,* (y_i) less total variable cost (tvc_i) (labour costs and intermediate consumption), and average variable costs are equal to total variable cost (tvc_i) divided by gross output (y_i). That is:

(3) $$PE_{ij} : \ln(y_{ij} - tvc_{ij}) = \alpha + \beta_j \ln\left(\frac{tvc_{ij}}{y_{ij}}\right) + \varepsilon_{ij}$$

The β coefficient (sometimes known as the Boone Indicator) estimates the elasticity of profits to changes in cost. The β is expected to be *negative*, indicating that as average costs increase, profits of the firm will decrease. In a more competitive market, β will be more negative, indicating that firms' profits are more sensitive to changes in their average costs.

Boone (2000) discusses two key advantages of this measure. First, the PE is, in theory, monotonic with competition. As competition increases, the negative relationship between average cost and profit becomes stronger. The PE, unlike the HHI and PCM, is robust to the ambiguity of the reallocation effect, as competition will always affect relative profits of all firms in the same direction regardless of the distribution of efficiency across firms (Boone, 2008b).

Second, the PE can be derived from the same data as the PCM (and the HHI). This means that it is as robust to missing firm observations as the PCM. Data-related assumptions for the PE (such as using average costs as a proxy for marginal costs) are no more restrictive than for the PCM.

As with any model, estimating the PE requires assumptions (Creusen et al., 2006a and 2006b). First, the theory assumes that ranking firms on their marginal costs is equivalent to ranking them on their efficiency. This does not seem unduly restrictive.

Second, because of data availability issues, researchers usually use average variable costs rather than marginal costs to calculate the PE. Griffith et al. (2005) show that there is a one-to-one increasing relationship between marginal costs and average variable costs, under the assumption that more efficient firms have higher cost margins. However, in practice some firms might choose to sacrifice

[9] Hay and Liu (1997) used the sensitivity of firms' market share to costs as a conceptually similar measure of competition.

profit margins for market share, which would violate this assumption (van Leuvensteijn et al., 2011).[10]

Third, and related to the second point, while the PE allows for heterogeneity in terms of products and efficiency, it does assume that firms with the same level of efficiency will respond in the same way to any change in competition. Put another way, this means that each firm faces the same competitive environment as another firm with the same level of efficiency.[11] This enables the model to allow for firm heterogeneity, but still to be analytically tractable.

Fourth, the theory behind the PE implies that, in equilibrium, the most efficient firms will have the largest market share. Empirical evidence shows that, in practice, some smaller firms are more efficient than larger firms for extended periods of time, at least in some markets (Schiersch & Schmidt-Ehmcke, 2010). More generally the direction of the relationships among firm scale, profits, market share and marginal costs is uncertain. For instance, larger firms with already high profits might be able to negotiate lower input costs.

To deal with these issues, researchers adopt a number of strategies. Some researchers control for firm scale and/or include firm level fixed effects when panel data is available.[12] Fixed effects control for time-invariant unobserved differences between firms that could influence the observed relationship between costs and profits. A few studies use techniques to control for multi-directional causality or 'endogeneity'.[13]

This study estimates equation (3) using firm level fixed effects and controlling for firm scale. Future research could investigate whether controlling for endogeneity produces significantly different estimates of the PE.[14]

The PE shares with other measures of competition the problem of defining the relevant market (Boone, 2000). The measure is, however, in some respects less sensitive to this than alternatives.

Consider an industry where the national market is made up of two distinct (but identical) markets, each with four equal-sized firms accounting for half of the market. The four-firm concentration ratio for the industry when calculated for the whole country would be only 25%. In this case, the concentration ratio measure would overestimate the degree of competition in the market considerably. Because the sensitivity of profits to costs is the same in each market, the PE in this case would correctly measure the degree of competition, despite the geographic extent of the market being incorrectly specified.

In general, the PE represents a (weighted) average of the constituent markets. It does not rely on industries having the same geographic extent to make them comparable.

Yet the theory underlying the PE implies that firms in a market compete on substitutable products. The measure will perform better when markets are defined narrowly (in terms of industrial classification) rather than broadly (Boone, 2008a).

One final issue arises from the fact that equation (3) is estimated using natural logarithms to deal with the non-linear relationship between profits and costs, and to allow the coefficient β to be

[10] Where richer data on firms is available, researchers sometimes first estimate marginal costs from a cost function (e.g. van Leuvensteijn et al., 2011; Ansari, 2012; Delis, 2012; Tabak et al., 2012; Kick & Prieto, 2013; van Leuvensteijn et al., 2013; Kar & Swain, 2014; Xu et al., 2013).

[11] Boone (2008) provides a theoretical example where this condition does not hold.

[12] Shciersch & Schmidt-Ehmcke, (2010); Peroni & Gomes Ferreira, (2011); Ansari, (2012); Polder & Veldhuizen, (2012); Heyman, Svaleryd & Vlachos, (2013); Köhler, (2014); Parsons & de Vanssay, (2014); Schaek & Cihák, (2014); World Bank Group, (2014); Nguyen, de Vanssay & Parsons, (2015).

[13] van Leuvensteijn et al., (2011); van Leuvensteijn et al., (2013); Xu et al., (2013); Kar & Swain, (2014); Schaek & Cihák, (2014).

[14] Tabak et al. (2012) found that endogeneity was mostly not an issue for estimates of the PE for banking markets in Latin America.

interpreted as an elasticity. This approach removes all negative and zero-profit/mark-up firms from the sample used for estimation. Firms clearly cannot maintain negative profits or mark-ups for sustained periods. Nevertheless, this may create a sample selection issue if the propensity to dip in and out of negative profits is greater in some industries than others in a way that is related to competition.

This paper uses one measure of competition, PE, to look at a range of evidence on competition in New Zealand – across industries, within industries over time, and within selected industries across countries. Different measures of competition reflect different aspects of competition. Therefore, ideally a range of competition measures would be used for assessing competition in a single industry.

4. Data and estimation

This study uses data from Statistics New Zealand's Longitudinal Business Database (LBD) (part of the Integrated Data Infrastructure) to estimate a version of equation (3). The LBD is built on the Longitudinal Business Frame, which integrates different data sources such as firms' financial accounts (IR10) and Goods and Services Tax Returns (GST) provided by the Inland Revenue Department (IRD); and survey data such as the Annual Enterprise Survey (AES). Appendix A1 provides more detail.

4.1. Annual Enterprise Survey

The study uses the AES as the primary source of information on firms' profits and costs. The AES has been running since 1986 and covers around 90 per cent of New Zealand's gross domestic product (GDP).[15] In 2010 the AES had a population of 445,215 enterprises,[16] of which 18,394 were surveyed directly in the AES and 3,648 through other surveys. The AES uses IRD tax data for a further 302,235 enterprises. We use all AES surveys between 2000 and 2010.

The AES provides measures of total gross output and intermediate consumption. In the AES, total gross output includes sales of goods manufactured, income from services provided, gross income from renting and leasing of land and buildings, management fees (also includes sales of goods purchased for resale in the manufacturing, wholesale and retail sectors).[17]

Intermediate costs are purchases of materials, either for use by the enterprise itself or on a commission basis. Purchases include fuel and power, renting and leasing of land and buildings, telecommunication charges, business insurance premiums, management fees, payments for work done by others on the enterprise's own materials, and accident insurance premiums.[18]

4.2. Linked Employer-Employee Database

Statistics NZ's Linked Employer-Employee Database (LEED) uses information from tax and statistical sources to construct a record of paid jobs. Since April 1999, all employers in New Zealand are required to file an employer monthly schedule (EMS) with IRD. The EMS lists a firm's employees paid during that month, their earnings and the tax deducted at source.[19] We use all the available data on pay-as-you-earn (PAYE) employee jobs in New Zealand during the eleven March-years from April 1999 to March 2010.

[15] Statistics New Zealand (2008). The AES does not survey residential property operators, central government and justice, foreign government representation, religious services, private households employing staff and undifferentiated goods- and service-producing activities of households for own use.

[16] If an enterprise has more than one accounting division then statistics are collected for each division.

[17] Gross output excludes income from interest, dividends and donations; government grants and subsidies; non-operating income (e.g. sales on capital assets, exchange rate gains).

[18] Intermediate costs exclude commission paid to self-employed agents (finance and insurance, and property and business services sectors), indirect taxes (e.g. excise duties, land tax, road user charges, license fees and rates, fringe benefit tax and the energy resource levy – mining industry only), depreciation, non-operating expenses (e.g. losses from writing off bad debts, sales of capital assets below book value etc.).

[19] The EMS covers both employees (for whom firms deduct Pay-As-You-Earn tax) and some of the self-employed (for whom firms deduct withholding tax).

4.3. Analysis Sample

We define markets as 4-digit industries according to the 1996 ANZSIC classification[20]. We choose this narrow classification level so that firms are likely to be competing on products that are close substitutes.[21] Four-digit industries generally have a sufficient number of firms to make estimation of statistically significant relationships possible. Yet many studies use 3-digit (Griffith et al., 2005; Maliranta et al., 2007; Amador and Soares, 2012) or even 2-digit industries (for example, as Peroni & Gomes-Ferreira, 2011).[22]

It would be preferable to define markets according to products/services and geographic extent. These issues are of prime importance in studies of individual markets. Unfortunately, this kind of information is not available for the majority of markets.

Box 1 provides examples of 2-, 3-, and 4-digit industries to illustrate the different levels of disaggregation.

[20] We used the ANZSIC 1996 classification because the backwards classification to the ANZSIC 2006 coding for the LBD database is less robust in the years up to 2005.

[21] Boone (2008) recommends using data at the 4- or 5-digit level in the industry classification.

[22] Studies of competition in banking are able to define markets narrowly, by using publicly available data on banks financial performance and balance sheets, rather than the less-detailed data held by national statistical agencies whose release is subject to confidentiality rules (van Leuvensteijn et al., 2011; Ansari, 2012; Delis 2012; Tabak et al., 2012; Kick & Prieto, 2013; van Leuvensteijn et al., 2013; Xu et al., 2013; Schaeck & Cihák, 2014). Parsons and de Vanssay (2013) and Nguyen et al. (2015) use similar data to investigate competition in the Japanese beer and tyre industries respectively.

Box 1 The ANZSIC system

The ANZSIC system is a hierarchical system for classifying firms to industries based on their predominant activity. The classification has four levels: *Division* (1-digit), *Subdivision* (2-digit), *Group* (3-digit) and *Class* (4-digit). An example of the construction industry is shown below. Generally in this paper, when we refer to industry, we are referring to 4-digit industry class. We also use the 1-digit industry division to aggregate results and refer to this as a 'sector'.

1-digit	*2-digit*	*3-digit*	*4-digit*	*Description*
E				**Construction**
	E41			General Construction
		E411		Building Construction
			E4111	House Construction
			E4112	Residential Building Construction n.e.c.
			E4113	Non-Residential Building Construction
		E412		Non-Building Construction
			E4121	Road and Bridge Construction
			E4122	Non-Building Construction n.e.c.
	E42			Construction Trade Services
		E421		Site Preparation Services
			E4210	Site Preparation Services
		E422		Building Structure Services
			E4221	Concreting Services
			E4222	Bricklaying Services
			E4223	Roofing Services
			E4224	Structural Steel Erection Services
		E423		Installation Trade Services
			E4231	Plumbing Services
			E4232	Electrical Services
			E4233	Air Conditioning and Heating Services
			E4234	Fire and Security System Services
		E424		Building Completion Services
			E4241	Plastering and Ceiling Services
			E4242	Carpentry Services
			E4243	Tiling and Carpeting Services
			E4244	Painting and Decorating Services
			E4245	Glazing Services
		E425		Other Construction Services
			E4251	Landscaping Services
			E4259	Construction Services n.e.c.

Notes

- *n.e.c. = Not elsewhere classified*

The sample includes all operating firms from 2000 to 2010, with the following exceptions:

- Some 4-digit industries have been excluded or combined with other nearby industries, where there are insufficient observations to obtain meaningful regression results or in order to protect confidentiality.[23 & 24]
- To estimate equation (3) in logarithms we drop observations with negative or missing sales[25] and those with negative or missing intermediate costs or employee earnings.
- We exclude the mining sector because it contributes less than one percent to total gross value added (GVA); and electricity supply, education, health and community services, cultural and recreation services and personal and other services because the public sector is a major employer or regulator in these industries.

The final dataset includes 1,418,343 observations from 2000 to 2010. It comprises 384,012 individual firms and each firm has an average of 3.7 observations. There are a total of 309 markets (out of a total of 366 represented in the AES), which represents 87.4 percent of GVA and 90 percent of employment in the original AES sample.[26]

4.4. Model and variable specification

4.4.1. Estimation of the price elasticity

For our main results, we use a modified profit elasticity estimation model introduced by Boone (2007):

(4) $$\ln(profit_{ijt}) = \alpha_{ij} + \delta_{jt} + \beta_j \ln(avc_{ijt}) + \lambda_j \ln(emp_{ijt}) + \varepsilon_{ij}$$

where *i, j* and *t* index firm, industry and year, respectively.

Because the underlying model relates profits to efficiency, and scale may influence efficiency, we control for scale effects, using a term for numbers of employees (following, for instance, Peroni and Gomes-Ferreira, 2011; Köhler, 2014). We include firm-level fixed effects to control for unobserved heterogeneity across firms that may be correlated with efficiency (α_{ij}). Allowing for fixed effects and the impact of scale will make comparisons between industries of price elasticities more robust.

We use logarithms to normalise the distribution of profits ($profit_{ijt}$), average variable costs (avc_{ijt}) and employment (emp_{ijt}) across firms[27]. A set of year dummies has been included to control for macro conditions (δ_{jt}).

We calculate total variable costs as the sum of intermediate consumption costs (from the AES) and employment costs (from monthly earnings in the LEED data, excluding working proprietors' earnings taken from profits). Average variable costs are total variable cost divided by gross output (from the AES). Profits are gross output less total variable costs.

[23] It is often industries with a small number of dominant players that are of most interest in studying competition. However, the focus of this study is the degree of competition across the New Zealand economy and not the study of specific markets.

[24] The 4-digit industries that were combined are all in the manufacturing sector, for example, milk and cream processing was combined with ice cream manufacturing and other diary manufacturing.

[25] Firms with a missing industry code were also excluded

[26] For more information on data cleaning, see the Appendix A1.3

[27] In their analysis of price elasticity for Portugal, Amador and Soares (2012) experimented with a log-log and semi-log version of the PE model, used cross-section and panel data regressions (including firm-level fixed effects and random effects) and controlled for sample selection caused by firms with negative profits being excluded. They found that the results from the different robustness tests did not change their main conclusions. This was confirmed by our exploratory analysis with the New Zealand data.

Employment is an average of twelve monthly employment head counts (calculated as 'rolling mean employment' or RME). Using RME removes seasonal fluctuations from the employment measure. Yet using head counts rather than full-time equivalent (FTE) employment as a proxy for firm scale introduces a source of measurement error (Schiersch & Schmidt-Ehmcke, 2010). Measurement error is likely to make estimates of the PE less precise (and possibly biased) if there is a systematic relationship between the PE measure and an industry's propensity to employ people full-time. Fabling and Maré (2015) have recently developed a method to estimate FTE employment from LEED data. Future refinements of the approach in the current study could investigate using this measure.

Appendix A1 provides further detail on variable definition and sources.

4.4.2. Testing for changes in the price elasticity over time

To test whether estimated changes in the PE over time are statistically significant, we use the following regression equation:

(5) $$\ln(profit_{ijt}) = \alpha_{ij} + \delta_{jt} + (\beta_j + \varpi_j t)*\ln(avc_{ijt}) + \lambda_j \ln(emp_{ijt}) + \varepsilon_{ij}$$

where *i, j* and *t* index firm, industry and year respectively. The regression model is similar to equation (4), except that it includes a time trend (*t*). A positive ϖ_j indicates a reduction in competition intensity within industry *j*. Conversely, a negative ϖ_j indicates an increase.

4.4.3. International comparisons

We use different data restrictions, estimation specifications and industry levels to compare estimates of the PE in New Zealand with those from the Netherlands, Finland and Portugal. Appendix A2 provides further detail.

5. Results

In this section we outline the results of our empirical models of profit elasticity. Our analysis has three aspects – the basic estimation of the degree of competition, an examination of changes over time, and an international comparison. In section 5.1 we estimate our main model of profit elasticity for 309 4-digit industries between 2000 and 2010. In section 5.2 we examine whether competition has increased or decreased over the period by augmenting our main model with a time trend interaction on the profit elasticity parameter. Finally, in section 5.3 we compare our results with those from three European studies – Finland, the Netherlands and Portugal – where we can estimate similar models.

5.1. Competition levels in New Zealand Industries, 2000 - 2010

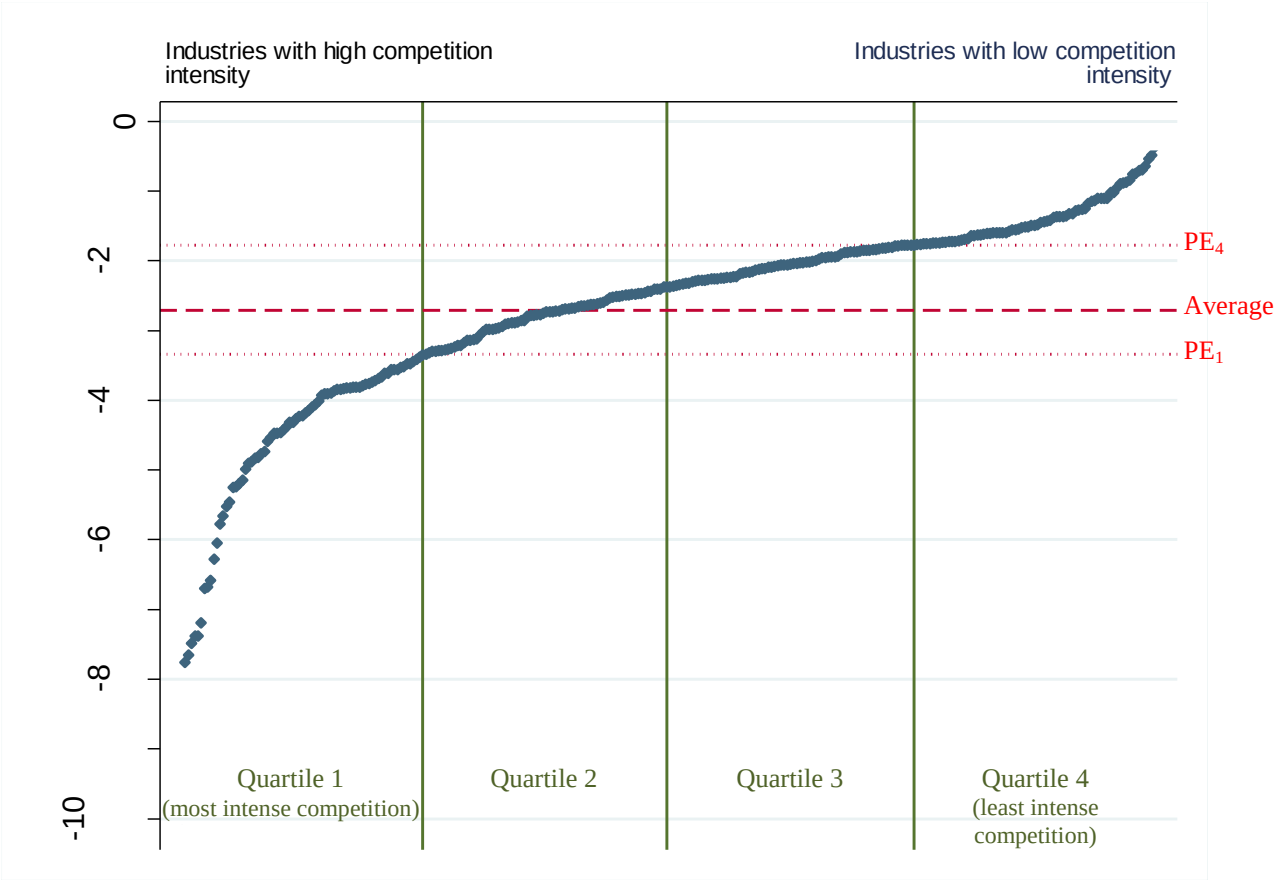
The results for estimating equation (4) for 309 4-digit industries over the 2000-2010 period are summarised in Figure 2 and Table 1 below. Figure 2 plots the average PE for each 4-digit industry for the period. The estimated PE is depicted on the vertical axis (where a more negative PE score connotes more intense competition). The industries have been ranked in ascending order from the most to least competitive industry (from left to right on the horizontal axis).

As predicted by theory, our estimates of the PE are negative in all 4-digit industries analysed (and nearly all are statistically significant at the 1% level).[28] The PE scores range from -0.33 (the least competitive market) to -10.17 (the most competitive market). The (unweighted) mean profit elasticity is -2.72 (represented by the dashed line in the figure).

The green vertical lines in Figure 2 divide the industries into quartiles according to their PE. Quartile 1 contains the most competitive industries, i.e. the one quarter of industries that have a PE score that is greater (more negative) than PE_1 (-3.34). Quartile 4 contains the least competitive industries, i.e. the one-quarter of firms that have a PE that is smaller (less negative) than PE_4 (-1.77). We shall discuss these groups in more detail in section 5.1.2 below (Table 2 and Table 3).

[28] The PE in 301 out of 309 4-digit industries was statistically significantly different from zero.

Figure 2 Profit elasticity levels across 4-digit industries in the period 2000-10



Notes:

- *Chart shows our estimates of profit elasticity for each of the 309 4-digit industries in our sample, ordered from most to least negative*
- *Red dashed line shows the unweighted average price elasticity across all industries*
- *PE_1 = profit elasticity at the top of Quartile 1 (the most competitive quartile) = -3.34*
- *PE_4 = profit elasticity at the bottom of Quartile 4 (the least competitive quartile) = -1.77*

5.1.1. Profit elasticity by sector division

In Table 1, we summarise the PEs for broad industry groups. The ANZSIC 1996 1-digit divisions have been used to group the individual 4-digit industries. In what follows we shall call these 1-digit divisions 'sectors'. They are listed in the first column of the table. Column 2 contains the number of 4-digit industries in each 1-digit sector. Column 3 contains the (unweighted) average PE for the 4-digit industries in each sector. The final column contains the GVA weighted average PE for the 4-digit industries in the sector (we describe this in more detail below).

Table 1 ranks the 1-digit sector divisions from the most competitive to the least competitive in terms of their unweighted average PE. The *Manufacturing* sector has the highest average competition intensity, with an average PE of -3.50, followed by the *Construction* sector with a PE of -2.99. These in turn are closely followed by the *Hospitality* (*Accommodation, Café and Hotel*) and *Transport and Storage* sectors, which both have very similar unweighted PE scores (-2.91 and -2.90 respectively). The *Finance and Insurance* and *Wholesale Trade* sectors have the lowest competition intensity. Both have an average PE of -1.78.

Table 1 Profit elasticity levels by sector (2000-2010)

Sector (1-digit 1996 ANZSIC)	4-digit industries (*N*)	PE (unweighted)	PE (weighted by GVA)
Manufacturing	109	-3.50	-3.20
Construction	21	-2.99	-3.44
Hospitality	3	-2.91	-2.69
Transport & Storage	22	-2.90	-2.59
Communications Services	3	-2.63	-3.87
Retail	38	-2.46	-2.39
Agriculture, Forestry & Fishing	33	-2.17	-1.42
Property & Business	30	-2.00	-1.82
Wholesale Trade	40	-1.78	-1.66
Finance & Insurance	10	-1.78	-1.54
Total	**309**	**-2.72**	**-2.36**

Notes:

- *1-digit sectors ordered by unweighted average PE score*
- *N denotes the number of 4-digit industries in the 1-digit sector*
- *PE for each sector is the unweighted average of 4-digit industries contained therein*
- *PE (GVA) for each sector is the average of 4-digit industries weighted by their share in total GVA*

Column 3 of Table 1 places equal weighting on all 4-digit industries. Because both the 1-digit sectors and their constituent 4-digit industries vary greatly in size, the unweighted aggregate PE scores may hide some of the story. These simple aggregates do not necessarily reflect the contribution of each sector to the competitiveness of the economy. If we weight sectors by their share in overall economic activity,[29] a slightly different story emerges. The GVA-weighted PE scores are shown in the final column of Table 1. The overall average GVA-weighted PE is -2.36, slightly lower than the unweighted average of -2.72, which suggests that competition intensity is slightly lower in larger sectors (although the difference is small). In most sectors (8 out of the 10 1-digit sectors in Table 1) the GVA-weighted PE is less negative than the unweighted one, which indicates a lower measured intensity of competition. Most of the differences are relatively small, with the exception of *Agriculture, Forestry and Fishing* (where the competition intensity is lower when we weight the PEs of the constituent 4-digit industries) and *Communications Services* and *Construction* (where competition intensity is higher).

5.1.2. Most and least competitive industries by sector

There is also considerable variation in profit elasticities *within* some of the 1-digit sector divisions. For example, the average 4-digit industry in the *Manufacturing* sector is relatively competitive, but the sector includes 4-digit industries that are some of the most and least competitive markets in New Zealand.

[29] Measured by shares in GVA.

We can get a perspective on the intensity of competition within these aggregate 1-digit sectors by looking at how the 4-digit industries within them stack up in the overall distribution. In Figure 2 above we divided up the 4-digit industries into four quartiles, from most intense (Quartile 1) to least intense (Quartile 4) competition. In Table 2 and Table 3, we examine which industries make up the most and least competitive industries in the economy.

Table 2 examines what portion of the 4-digit industries in each of the ten 1-digit sectors can be found among the top and bottom quarter of industries in terms of price elasticity. The third and fifth columns show the number of 4-digit industries from that sector that appear in the most competitive quartile (Quartile 1) and least competitive quartile (Quartile 4) (N_1 and N_4, respectively). In order to consider their contribution to the overall performance of the economy, we weight each 4-digit industry by their share in gross value added. The fourth and sixth columns in Table 2 show the proportion of gross value added produced in the sector that comes from 4-digit industries that are in the most and least competitive quartiles, respectively.

Table 2 High and low PE 4-digit industries, by 1-digit sector (2000-2010)

		Industries appearing in…			
		most competitive industries (Quartile 1)		*least competitive industries (Quartile 4)*	
Sector (1-digit 1996 ANZSIC)	**4-digit industries** N	N_1	GVA_1	N_4	GVA_4
Manufacturing	109	49	39.9%	15	19.3%
Construction	21	9	60.3%	2	0.7%
Hospitality	3	1	44.9%	1	50.3%
Transport & Storage	22	8	37.0%	4	17.8%
Communications Services	3	1	82.4%	1	4.8%
Retail	38	6	22.1%	8	16.0%
Agriculture, Forestry & Fishing	33	2	1.6%	10	71.4%
Property & Business	30	2	0.9%	11	47.6%
Wholesale Trade	40	0	0.0%	18	59.5%
Finance & Insurance	10	0	0.0%	7	94.8%
Total	**309**	**78**	**28.9%**	**77**	**38.2**

Notes:

- *1-digit sectors ordered by the average PE*
- *N denotes the number of 4-digit industries in the 1-digit sectors*
- N_1 = *number of 4-digit industries from sector in quartile 1 (most competitive industries)*
- N_4 = *number of 4-digit industries from sector in quartile 4 (least competitive industries)*
- GVA_1 and GVA_4 denote the percentage of GVA that is accounted for by 4-digit industries in the most and least competitive quartiles, respectively

The *Manufacturing* and *Construction* sectors have 44.9 (i.e. 49 out of 109) and 42.9 percent of their 4-digit industries in the most competitive quartile, respectively. For the *Construction* sector, the share of GVA in the most competitive quartile is over half (60.3 percent). The *Hospitality* and *Communications Services* sectors only have three 4-digit industries, but both have their largest

industries (*Cafes and Restaurants*, and *Telecommunications Services*, respectively) in the most competitive quartile. These industries account for 44.9 and 82.4 percent of their GVA, respectively.

We can also look at which sectors the most- and least- competitive industries come from. In Table 3 we show the proportion of 4-digit industries in the most and least competitive quartiles that come from each 1-digit sector. We calculate these percentages in terms of raw industry numbers and of GVA.

The *Manufacturing* sector accounts for nearly two-thirds (62.8 percent) of the 4-digit industries that are ranked in the most competitive quartile. However, because the industries are smaller on average, the *Manufacturing* sector only accounts for 43.4% of GVA in Quartile 1. The concentration of manufacturing among the most competitive industries has also been found in other countries. In their study of Portugal, Amador and Soares (2012) found that 88 percent of industries in the most competitive quartile were from Portugal's manufacturing sector.

Table 3 Breakdown of most and least competitive industries, by sector (2000-2010)

	Most competitive (Quartile 1)		***Least competitive (Quartile 4)***	
Sector (1-digit 1996 ANZSIC)	4-digit industries	GVA	4-digit industries	GVA
Manufacturing	62.8%	43.4%	19.5%	11.1%
Construction	11.5%	20.1%	2.6%	0.2%
Hospitality	1.3%	6.1%	1.3%	2.8%
Transport & Storage	10.3%	7.3%	5.2%	2.4%
Communications Services	1.3%	13.7%	1.3%	0.6%
Retail	7.7%	7.9%	10.4%	4.1%
Agriculture, Forestry & Fishing	2.6%	0.8%	13.0%	15.5%
Property & Business	2.6%	0.7%	14.3%	20.3%
Wholesale Trade	0.0%	0.0%	23.4%	19.3%
Finance & Insurance	0.0%	0.0%	9.1%	23.8%
Total	**100%**	**100%**	**100%**	**100%**

Notes:

- *1-digit sectors ordered by average PE*
- *Columns 2 and 4 depict the percentage of all 4-digit industries in the most and least competitive industries in economy (Quartile 1 and 4,) that come from the relevant 1-digit sector*
- *Columns 3 and 5 depict the breakdown of GVA that comes from 4-digit industries from the relevant 1-digit sector*

5.1.3. Patterns of competition in New Zealand industries

In summary, there is considerable variation across the New Zealand economy in the degree of competition. Whilst there are big differences between sectors with the highest intensity of competition (*Manufacturing*, *Construction* and *Communications Services*) and those with the lowest intensity (*Agriculture, Forestry and Fishing*, *Finance and Insurance* and *Wholesale Trade*), there is also considerable variation in the degree of competition of industries *within* sectors. No matter what the average measured degree of competition of the sectors as a whole, each sector contains industries

that are numbered among the least competitive 25 percent of industries in New Zealand. Conversely, all but two of the sectors contain industries that are in the most competitive quartile of industries in the economy. This suggests that whatever the explanation for differences in the degree of competition, the explanation is unlikely to be simple.

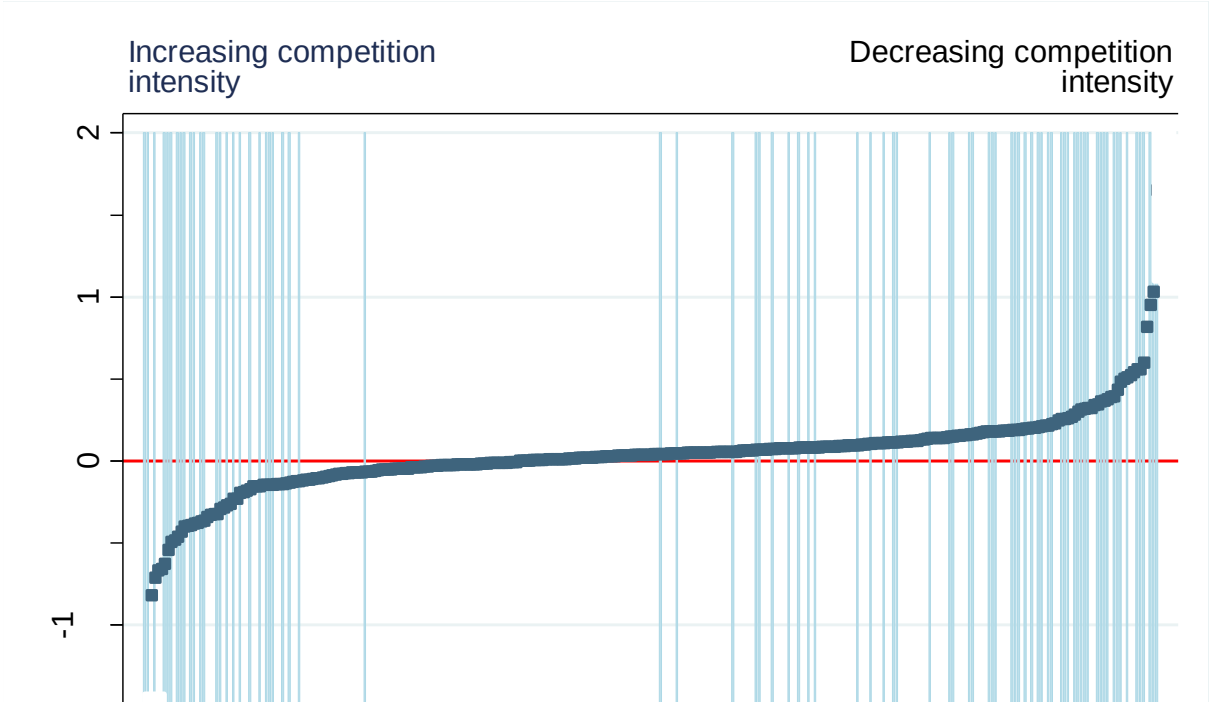
5.2. Trends in competition in New Zealand Industries, 2000 - 2010

This section examines how competition intensity has changed over the period 2000-2010, based on estimating equation (5).

Figure 3 plots the PE time trend for the period 2000 to 2010 for each 4-digit industry. Again, the industries have been ranked in ascending order, from left to right on the horizontal axis, by the time trend. Dots below zero on the vertical axis are 4-digit industries that experienced an increase in competition (to the left of the figure) and dots above zero are 4-digit industries that experienced a reduction in competition intensity (to the right of the figure). The light blue lines indicate in which 4-digit industries the time trend is statistically significant from zero.

The majority of 4-digit industries did not experience a change in profit elasticity. Only 81 out of 309 (26.2 percent) of markets experienced a change in profit elasticity that was statistically significant (at the 5 percent level) between 2000 and 2010. These markets accounted for about a third (36.2 percent) of GVA. Most of the 4-digit industries (54 out of 81) with a statistically significant change in profit elasticity experienced an increase in competition intensity (the estimated time trend was negative), compared with 27 markets that experienced a decrease in competition.

Figure 3 Profit elasticity trends across 4-digit industries in the period 2000 to 2010

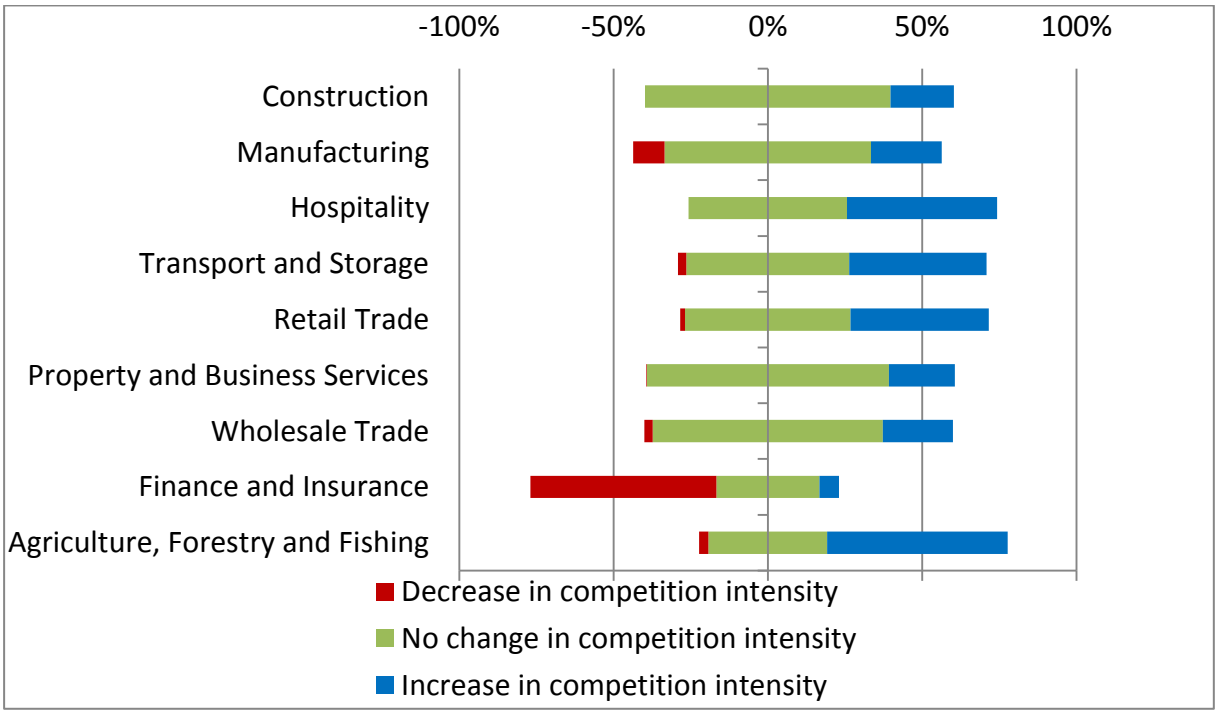


5.2.1. Changes in competition by sector

Figure 4 examines how the changes in the intensity of competition vary across sector. The figure plots the proportion of a sector's GVA that was in 4-digit industries that experienced a statistically significant increase or reduction in competition intensity. The red bars to the left of zero measure the share of the 1-digit sector's GVA produced by 4-digit industries that experienced a reduction in

competition intensity. The blue bars to the right measure the share of GVA in industries where competition intensity increased. The green bar depicts the share of GVA in industries where there was no (statistically significant) change in the PE. The *Communications Services* sector has been excluded from the graph because none of its three 4-digit industries experienced a significant change in competition intensity.

Figure 4 Profit elasticity trends by sector in the period 2000 to 2010



As can be seen from Figure 4, the *Hospitality*, *Transport and Storage*, *Retail Trade*, *Finance and Insurance*, and *Agriculture, Forestry and Fishing* sectors experienced greater than average change in competition intensity of between 44.5 percent and 60.3 percent of GVA. All sectors, with the exception of *Finance and Insurance*, experienced a net increase in competition intensity. In the *Finance and Insurance* sector, 60.3 percent of GVA was in industries that experienced a decrease in competition intensity, compared with 6.3 percent in industries that experienced an increase in competition.

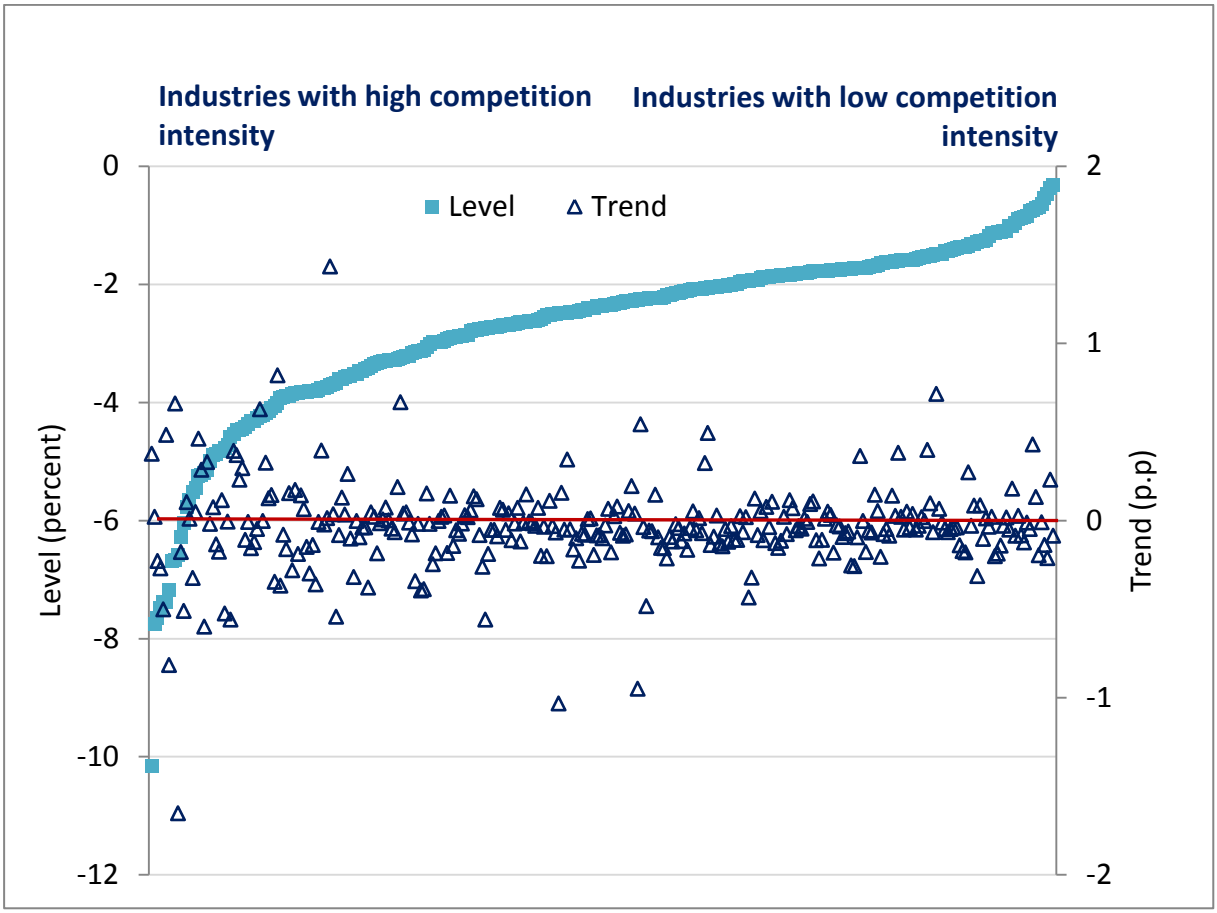
The relatively large changes in competition intensity in the *Finance and Insurance* sector (a decrease) and the *Agriculture, Forestry and Fishing* sector (an increase) were driven by a single industry within each of these sectors. The *Banking* industry was the only industry where competition decreased in the *Finance and Insurance* sector, and the *Dairy* industry accounted for most of the increase in competition intensity in the *Agriculture, Forestry and Fishing* sector in terms of GVA share (66 percent). The same is also true for the *Hospitality* sector where the *Cafes and Restaurants* industry experienced an increase in competition intensity.

By combining PE levels and trends it is possible to explore whether a reduction in competition intensity is occurring within the least competitive industries, which if true would paint a more negative picture of competition in New Zealand. The analysis could also help identify regression toward the mean, (meaning that extreme PE scores are closer to the average PE scores in subsequent years).[30]

[30] Measurement error is one cause of regression toward the mean.

Figure 5, plots the time trend (right hand axis) and the mean PE (left hand axis) for each 4-digit industry over the period 2000 to 2010.

Figure 5 Profit elasticity levels and trends in the period 2000 to 2010



The 4-digit industries have been ranked on the horizontal axis by their PE, from most to least competitive. Observations above (below) zero on the time trend (right hand) axis indicate a reduction (increase) in competition intensity.

Figure 5 does not show evidence of regression toward the mean. Some industries with relatively high competition intensity experienced a reduction in competition levels, while others saw competition intensity increase. The same is true among industries with relatively low competition intensity. If there was regression toward the mean, we would expect to see a negative relationship between the profit elasticity levels and the time trend.

Why has competition intensity increased across the economy? The study period from 2000 to 2010 was characterised by strong economic growth at the beginning and a recession at the end of the period. It is possible that competition may increase as incumbent firms fight hard to retain their share of the market as the overall market shrinks. On the other hand, falling demand may reduce the number of new competitors wishing to enter the market, which may make it easier for incumbent firms to retain their customers.

The determinants and implications of the levels and changes in competition are important questions. This paper takes a first step in measuring levels and changes in competition intensity, which will enable more systematic study of questions involving the role of competition in the evolution of the economy.

5.3. International comparisons

How does competition in New Zealand industries compare with other countries? We identified three countries with comparable data – Finland, the Netherlands and Portugal. Finland has a similar population to New Zealand, but its GDP per capita is larger. The Netherlands has a higher population than New Zealand and one of the highest GDP per capita in the OECD. Finally, Portugal has a higher population than New Zealand but its GDP per capita is a bit lower. Because of their proximity to other European markets Finland, the Netherlands and Portugal are all more open to competition from imports than New Zealand.

To facilitate comparisons, we took an approach which was as similar as possible to the other country studies in terms of industry definitions, the population of firms chosen, specification of the regression model and the definition of variables.

Creusen et al. (2006), provide PEs for 119 3-digit industries in the Netherlands, of which 80 are comparable to New Zealand 3-digit industries. The authors of Maliranta, Pajarinen, Rouvinen, and Yla-Anttila (2007) provided the data for Finland and the authors of Amador and Soares (2012) provided the data for Portugal. The data for Finland and Portugal contain 133 and 85 (respectively) 3-digit industries comparable to New Zealand industries.

We match the industries in the three comparison countries to 3-digit industries in New Zealand, using the 1996 ANZSIC industry classification system. We have used a similar method to each country's study to select a comparable set of firms (e.g. firm size) and have used the same regression model[31] and time periods to estimate profit elasticities for the New Zealand 3-digit industries.[32,33]

The New Zealand PEs reported in this section do not represent our best estimate for that particular industry. Their purpose is to facilitate comparisons with the corresponding industry in the comparison country.

Table 4 reports PEs in the manufacturing and services industries for New Zealand and each of the three comparison countries. The last column shows the number of industries where competition is more intensive in New Zealand than in the comparison country. The number in brackets is the number of industries where the PE is statistically different between New Zealand and the comparison country.[34]

Only 14 of 66 New Zealand manufacturing industries have more intensive competition than their Finnish counterparts. However, these differences may not be significantly different from zero and should be treated with caution. Only 5 of 67 New Zealand service industries have more intensive competition than their Finnish counterparts.

[31] The Netherlands, Finland and Portugal used a Log-log fixed effect model using 2001, 2000–2004 and 2005–2009 data respectively.

[32] ANZSIC 1996 has 163 3-digit industries. The comparison excludes 'Government administration and defence', 'Not elsewhere included', 'Agriculture, forestry and fishing', and 'Electricity and gas supply', leaving 133 3-digit industries.

[33] Appendix A2 provides details of methods and data cleaning for each country comparison.

[34] The Finland and Netherland's data did not contain standard errors for the PE estimates. We applied the NZ standard errors to each industry for these two countries to test how sensitive the differences may be to confidence intervals. It is possible that using the NZ standard errors results in more insignificant differences because, particularly in the Netherlands, SEs may be smaller because their industries are likely to contain more observations.

Table 4 Profit elasticity levels by county

Country	Number of Industries compared	*Profit Elasticity*		NZ markets more competitive
		Comparison country	New Zealand	
Finland				
Manufacturing	66	-10.12	-7.28	14(0)
Services	67	-9.37	-3.47	5(1)
Netherlands				
Manufacturing	39	-6.76	-3.76	11(0)
Services	41	-2.15	-2.32	25(9)
Portugal				
Manufacturing	39	-3.03	-3.07	22(15)
Services	46	-1.73	-2.15	31(31)

Manufacturing industries in the Netherlands also mostly have more intensive competition than in New Zealand. However the number of service industries where one or the other country has more intensive competition is more evenly matched.

New Zealand manufacturing industries (with an average PE of -3.07) exhibit a similar intensity of competition to those in Portugal (with an average PE of -3.03). A majority (22 of 39) of manufacturing industries in New Zealand have more intensive competition than comparable industries in Portugal. The difference is statistically significant in 15 of the 22. All of the New Zealand services industries were more competitive than their Portuguese counterparts, and all the differences were statistically significant.

It is difficult to draw any general conclusions about differences in competition intensity between the three countries. Portugal has more than twice the population of New Zealand and is close to European markets. Having more producers and consumers should make competition more intense in Portugal than in New Zealand, but our estimates show otherwise. Finland is similar in size and appears to have more industries subject to intense competition than New Zealand.

In general, levels of competition are loosely correlated with GDP per capita. Finland and the Netherlands are richer and their firms face more intense competition than New Zealand in a majority of industries. Competition is slightly more intense and per capital GDP slightly higher in New Zealand than in Portugal. Differences among countries in the intensity of competition are likely to be explained by a number of factors including product and labour market regulation, proximity to international markets, openness to trade and the role that domestic industries play in international supply chains.

6. Summary and future research

This paper uses a new measure of competition intensity, profit elasticity, to describe competition levels and trends across sectors in the New Zealand economy. PE is theoretically robust to reallocation and selection effects that can otherwise confound more traditional measures of competition, such as concentration indices (e.g., the HHI) and the PCM. The paper also compares PEs for selected industries in New Zealand with those in Finland, the Netherlands and Portugal.

The ranking of 4-digit industries by their PE showed that, as in other countries such as the Netherlands and Portugal, industries in the *Manufacturing* sector were some of the most competitive. The *Finance and Insurance* and *Agriculture, Forestry and Fishing* sectors had their largest industry (*Banking* and *Dairy*, respectively) among the least competitive industries.

The *Communications Services* sector had the highest levels of competition intensity with a GVA-weighted PE of -3.87, followed by the *Construction* (-3.44) and *Manufacturing* (-3.20) sector. The 1-digit sectors with the lowest competition intensity were *Agriculture, Forestry & Fishing* (-1.42), *Finance and Insurance* (-1.54), and *Wholesale Trade* (-1.66).

The majority of industries did not experience a change in competition intensity between 2000 and 2010. Competition intensity changed in around a quarter of 4-digit industries, or just over a third of industries by GVA. Most of the industries that experienced a statistically significant change in competition intensity showed increases in intensity rather than decreases. There was no clear relationship between the level of competition in an industry and whether or not that industry experienced an increase or decrease in competition intensity. Changes in the level of competition (positive or negative) were spread across industries at all competition levels.

The nature of the link between competition and other changes, such as firm births or exits, and whether the observed changes are associated with the economic cycle, are topics for future investigation. Preliminary work has also looked at the dispersion of productivity in New Zealand (Devine, Doan & Stevens, 2012). This could be extended to explore the role of competition and firm entry and exit in driving productivity growth in New Zealand businesses and industries.

While manufacturing industries are often the most competitive within economies, the manufacturing sector in New Zealand seems to face less competition than in some other countries. A careful comparison of 3-digit manufacturing sectors shows that competition intensity was higher in the Finnish and Netherlands manufacturing sectors and slightly lower in Portugal, than in New Zealand.

PE scores would be a useful addition to the suite of measures used to monitor the performance of New Zealand industries. We have estimated PE using a method that accounts for time-invariant differences between firms (and hence industries) and the effects of scale. Further work could refine the PE measure, for instance by controlling for firm scale using an FTE measure of employment, and testing for endogeneity of profits to efficiency.

More work is also needed, through comparisons of PE scores across industries and countries, and over time, to validate the robustness of PE as an empirical measure of competition (van Leuvensteijn et. al, 2011). A few studies already look at whether changes in PE correspond to what might be expected with enforcement of competition policy (e.g., Schiersch & Schmidt-Ehmcke, 2010; Clougherty et al., 2015) or economic liberalisation (Delis, 2012).

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A1 Data Appendix

The source of our data is the LBD. The full LBD is described in more detail in Fabling, Grimes, Sanderson and Stevens (2008) and Fabling (2009).

A1.1 Data

Annual Enterprise Survey (AES)

The Annual Enterprise Survey (AES) is Statistics New Zealand's primary data source for the production of National Accounts, providing the benchmark for estimating value added. The survey covers all large firms, with a stratified sample for smaller firms, and has industry specific questions in order to accurately measure aggregated GDP.

Linked Employer-Employee Data (LEED)

Linked Employer-Employee Data (LEED) is constructed by Statistics New Zealand from IRD PAYE returns for employees. LEED variables are aggregated to the firm level for confidentiality reasons. Researchers generally assume that missing employment data implies zero employees, on the grounds that personal income tax non-compliance is negligible in the population of firms that comply with mandatory GST. Variables available include counts of employers (on an annual firm level basis) and employees (on a monthly plant level basis). Summary characteristics are available by gender, and age-band breakdowns, tenure distributions of employees and summary measures of wage distribution within the firm. The LEED provides data on wages and salaries.

Employees

Employment is measured using an average of twelve monthly PAYE employee counts in the year. These monthly employee counts are taken as of the 15th of each month. This number excludes working proprietors and is known as Rolling Mean Employment (RME).

Working proprietors

The working proprietor count is the number of self-employed persons who were paid taxable income during the tax year (at any time). In LEED, a working proprietor is assumed to be a person who (i) operates his or her own economic enterprise or engages independently in a profession or trade, and (ii) receives income from self-employment from which tax is deducted.
From tax data, there are five ways that people can be identified as earning self-employment income from a firm:

- Through the IR3 individual income tax form for individuals who earn income that is not taxed at source. This shows they are a sole trader working for themselves.
- Through the IR348 employer monthly schedule, which shows that withholding payments were paid on their behalf - either by a firm they own, or as an independent contractor.
- Through the IR348, showing they were paid a PAYE tax-deducted salary by a firm they own.
- Through the IR20 annual partnership tax form, which reports the distribution of income earned by partnerships to their partners, or the IR7 partnership income tax return, showing they were paid a partnership income by a partnership they own.
- Through the IR4S annual company tax return, showing they were paid a shareholder salary by a company they own. The IR4S reports the distribution of income from companies to shareholders for work performed (known as shareholder-salaries).

It is not possible to determine whether the reported self-employment income involves labour input. For example, shareholder salaries can be paid to owner-shareholders who were not actively involved in running the business. Yet the income data does provide some relevant information (a very small payment is unlikely to reflect a full-year, full-time labour input).

A1.1 Variables and Sources

Variable	Source	Comments
Gross Output (gross sales)	Annual Enterprise Survey	NZ$ (constant, March 2011), output PPI used
Intermediate Consumption	Annual Enterprise Survey	NZ$ (constant, March 2011), input PPI used
Employment costs	Monthly earnings, LEED (*lbf_leed_wages_salary_amt*).	NZ$ (constant, March 2011), CPI used This does not include entrepreneurship earnings such as profits, dividends.

Notes:

- *We adjusted the measurement unit ($) for monthly earnings from LEED to be the same as the AES data. Data used in this paper were deflated to March 2011 dollars. We use the Producer Price Index to deflate sales and purchases and the CPI to deflate monthly earnings.*

A1.2 Selection of analysis sample

We dropped firms in the following categories:

+ Firms without an ANZSIC 1996 code
+ Firms in sector M (Government Administration and Defence)
+ Firms in sector Q97 (Private Households Employing Staff)
+ Firms in sector R (Not elsewhere included - rest of the world)
+ Firms without the business type 1996 code[35]
+ Firms without an institutional sector 1996 code

[35] Business type is the legal status of an enterprise. More detail can be found at http://www.stats.govt.nz/surveys_and_methods/methods/classifications-and-standards/classification-related-stats-standards/business-type/definition.aspx

A2 International comparison – data cleaning and model choices

A2.1 The Netherlands

The Netherlands profit elasticity data is from Creusen *el al.* (2006). We apply the same data restrictions in this paper to the New Zealand data by removing firms with:

- no turnover and/or no employment
- negative value added
- turnover less than labour costs
- identical output and employment data in two consecutive years
- large changes in output (VA and sales) and employment.

The Netherlands data excludes the agriculture, forestry and fishing industry; banking and insurance; government administration and public utilities; and health care industries.

The Netherlands paper uses a firm-level database of 119 3-digit industries from 1993 to 2001. However, the paper only reported profit elasticities for 2001. Profit elasticities were estimated using a fixed effects log-log model. For the New Zealand data we used the following model:

$$\ln profit = \alpha + \beta_1 year2000 * \ln cost + \beta_2 year2001 * \ln cost + \beta_3 year2002 * \ln cost + \varepsilon$$

A2.2 Finland

The Finnish profit elasticities come from Maliranta *et al*. (2007). We apply the same data restrictions in this paper to the New Zealand data by removing firms:

- in the agriculture, fishing, forestry; and mining and quarrying industries
- in the public administration, defence and education, membership organisations, extra-territorial organisations and firms where the industry is unknown.
- with less than 5 employees
- with unreliable or partial information, such as on turnover, employment;
- with negative value add and firms where turnover is less than its labour costs.

The Finnish study uses a log-log fixed effect model for each 3-digit industry and for each year from 1994 to 2004, following Griffith et al*.,* (2005). We are able to compare profit elasticities for New Zealand and Finland for the years 2000 to 2004. For the New Zealand data we used the following model:

$$\ln profit = \alpha + \beta_1 year2000 * \ln cost + \beta_2 year2001 * \ln cost + \beta_3 year2002 * \ln cost + \beta_4 year2002 * \ln cost + \beta_5 year2005 * \ln cost + \varepsilon$$

Profit elasticities for each industry and year in Finland have not been published and were provided by the authors.

A2.3 Portugal

The Portuguese profit elasticities come from Amador and Soares (2012). We apply their data restrictions to the New Zealand data by removing firms:

- in the finance and insurance services, government administration and defence, compulsory social security, agriculture, hunting and forestry, mining and quarrying, education, health and social work and community, social and personal service industries
- with zero or missing sales or variable costs and negative profits
- in 3-digit industries with fewer than 5 firms in any year

The authors provided profit elasticities for the period from 2005 to 2009. The profit elasticities were calculated using a log-log fixed effects model with year dummies as follows:

$$\ln profit = \alpha + \beta_1 \ln cost + \beta_2 year2005 + \beta_3 year2006 + \beta_4 year2007 + \beta_5 year2008 + \beta_6 year2009 + \varepsilon$$

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