The Productivity and Competition Nexus in New Zealand[1]

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Preliminary Results: Please do not quote

Abstract

Using a panel dataset of 19,836 manufacturing firms from the prototype Longitudinal Business Database spanning the years 2000-09, this paper offers the first evidence on the nexus between productivity and competition in New Zealand. Two measures of competition are used: the Lerner index (LI) and the profit elasticity (PE) indicator. Productivity is computed allowing for imperfect competition. We uncover an inverted "U" shaped relationship between productivity and LI. In other words, at low levels of competition the there is a positive relationship between competition and productivity. But at high levels of competition, Schumpeterian effects dominate. The relationship between productivity and PE is also parabolic, but the curve faces upwards. The PE indicator appears to correct for the reallocation effects of competition. The upward facing curve indicates that in stagnant markets, innovation is dis-incentivised but in markets with risk of market share reallocation, as competition intensifies, firms strive to become more productive. The PE and LI are measures are complimentary in explaining the nexus between competition and productivity.

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I. Introduction

Understanding the relationship between competition and productivity is critical to developing government policy and regulation to support a dynamic and growing economy (Devine, Doan, Iyer, Mok, & Stevens, 2011a). Based on certain constructs of competition, several studies have found that there exists an inverted "U" shaped relationship between competition and productivity (e.g., Aghion, Bloom, Blundell, Griffith & Howitt, 2005; Nickell, 1996). The interpretation of this relationship is that while at low levels of competition the "competition effect" dominates leading to a positive relationship between competition and productivity, at high levels of competition the "Schumpeterian effect" dominates leading to a negative effect (see, Aghion et al., 2005). In the context of testing the inverted "U" propositions in Aghion et al. (2005), studies have found that the results are not consistent across alternative constructs of competition (e.g., Aiginger & Falk, 2005; Tingvall & Poldahl, 2006).

In any case, it would be unreasonable to expect different constructs of competition to relate similarly to productivity, given that each of the constructs were designed to reveal a different facet of the concept of competition. Yet, each of these constructs is independently identified to capture the complex concept of competition. It is unsurprising that nailing the relationship of competition and productivity has been an elusive task.

Recently, empirical literature on competition has increasingly recognised that most traditional constructs of competition are non-monotone to the underlying concept of competition, resulting in misleading interpretations (Boone, 2000; Boone 2008; Braila, Rayp, & Sanyal, 2010; Creusen, Minne, & van der Wiel, 2006). Commonly, competition has been measured in a “direct” manner focusing on certain facet of competition; common examples include concentration ratio, mark-up or market share. These direct measures are invariably non-monotone. In other words, they may in some cases incorrectly show competition to have decreased (increased), when in fact competition may have increased (decreased) (Boone, 2000; Boone 2008; Braila et al., 2010; Creusen, et al., 2006). As an illustration, consider a construct of competition based on industry concentration. If an industry is newly liberalized and market competition intensifies, the concentration ratio might increase or decrease, rather than unambiguously increasing. On the one hand, there may be more firms in the market simply because of the liberalization. Conversely, there might be market appropriation by the low marginal cost firms and a consequent exit of inefficient firms leading to a fall in the concentration ratio (Braila, et al., 2010). Furthermore, there is also an implicit and somewhat unreasonable assumption in the computation of direct measures of competition that all firms in the industry are homogenous in their cost structures.

Following Boone (2000), Creusen, et al. (2006) and Braila, et al. (2010) observe that intensified competition will invariably be associated with two things. First is that the profits of the least efficient firm active in the market reduces: selection effect of competition. Second is that the profit of a more efficient firm rises relative to the profit of a less efficient firm: reallocation effect of competition. The reallocation effect is more readily understood based on the premise that fiercer competition induces efficient firms to exploit their efficiency advantage and push aside less efficient firms (Creusen, et al., 2006). It is precisely because the reallocation effects are not appropriately accounted that direct measures of competition become non-monotone. Empirical evidence suggests that reallocation effects of competition explain most of the changes in productivity growth (e.g., Baldwin & Gu, 2006; Barnes & Haskel, 2000; Disney, Haskel & Heden, 2003; Scarpetta, Hemmings, Tressel, & Woo, 2002).

It follows, therefore, that applying a monotone measure of competition is critical in evaluating the competition and productivity nexus. Also, in this paper given that nature of the data, we are not able to disentangle the effects of competing to gain market share (competition in the market) from the effects of competing to supply a market (competition for the market). In any case, both these effects are not mutually exclusive. However, what this does mean is that the competition construct applied in the analysis should be suitable to pick up both forms of competition.

Regressing profits on marginal cost, Boone (2000) observes that the resulting profit elasticity (PE) coefficient is a reasonable and monotone "indirect" indicator of market competition. It should be apparent that the PE indicator[3]emphasises the impact of marginal costs (efficiency levels) on profits and reveals the differences between firms in terms of their efficiency levels. Revisiting the example of the newly liberalised industry, it is easy to see that the PE indicator appropriately captures the reallocation effect of more efficient firms gaining higher relative profits at the expense of inefficient firms. Since the PE is able to pick up changes in market shares, it is able to account for the effects of both competition in the market and for the market. Based on the theoretical merits of the PE indicator as well as the indicator's increasing acceptance in the policy world (e.g., Braila, et al., 2010; Creusen, et al., 2006), this paper uses PE as one of the main competition constructs in investigating the competition and productivity nexus.

We also apply another measure of competition: the Lerner index (LI) that is, mark-up.[4] Among direct measures, we chose LI owing to its application in several seminal studies

[3] The PE indicator is also known as the Boone indicator and the Relative Profit Measure.
[4] Also known as the Price Cost Margin.

that examine the effects of competition on productivity and innovation (e.g., Aghion, et al., 2005; Griffith, Harrison, & Simpson, 2006; Nickell, 1996). Underlying the LI is a straightforward interpretation of competition. If a firm has more market power it would be able to charge a higher mark-up. On the other hand, if there are many competitors in a market characterised by a low level of demand, then competition forces the firms to reduce their mark-up. At the extreme, in perfect competition prices are equal to marginal cost.

We observe that the differences between LI and PE are more likely to be marked in industries where low costs and high costs firms (i.e., differing levels of efficiencies) operate together. For these industries, it has been argued that LI measures might be misleading because they are non-monotone (Braila, et al., 2010). A unique attribute of the PE indicator relative to other competition measures is that, by considering firm specific marginal costs, it does not assume homogeneity of cost structure across all firms in the industry. It follows there from that while direct measures of competition are exclusively about pricing, the PE indicator is able to model the strategic interaction between pricing and cost structures (Braila, et al., 2010).

Klette and Griliches (1996) observe that imperfect competition has not only - potentially - an impact on productivity dispersion, it also introduces biases and errors into conventional estimates of productivity. Examining the effects of competition on productivity, when the latter is based on an unreasonable assumption of perfect competition is difficult to justify. In response to the observation in Klette and Griliches, Martin (2008) developed a novel control function approach to productivity estimation that is able to explicitly take into account imperfect competition. In addition, the Martin approach provides for a flexible production technology allows non-constant returns to scale and addresses the endogeneity of factor inputs problem. In this paper, we compute measures of productivity following the approach in Martin.

The analysis in this paper is set in the New Zealand (NZ) context. Motivated by the lack of policy relevant information on the degree of competition in the majority of the sectors of the NZ economy, the Ministry of Economic Development, the Treasury, the Commerce Commission and the Ministry of Foreign Affairs and Trade have jointly embarked on a research project with funding from the Cross Departmental Research Pool. The objective of this project is to determine the nature, extent and impact of competition in the NZ economy. The present paper is a preliminary version of the second of a suite of three papers undertaken as a part of this research project. The other two papers look at the measurement and evidence on competition (Devine, et al., 2011a) and dynamics of competition in New Zealand industries (Devine, et al., 2011b).

This paper, more generally the project itself, is facilitated by the availability of suitable and high quality firm level data in the NZ context. The primary source for the analysis is the prototype Longitudinal Business Database (LBD). The LBD contains a broad range of variables from a number of tax, administrative and survey sources. We derive the data from the following sources from within the LBD: the Annual Enterprise Survey (AES), Business Activity Indicator (smoothed GST returns), financial accounts (IR10), company tax returns (IR4) and Pay as you earn (PAYE) returns. Further, we retrieve demographic information pertaining to firms from the Longitudinal Business Frame (LBF) which has been defined as the spine of the LBD (Fabling, Grimes, Sanderson, & Stevens, 2008).[5] An

[5] A detailed discussion of the LBD is available in Fabling (2009) and Statistics NZ (2007).

unbalanced panel dataset of nearly 19,836 firms spanning the years 2000-09 is applied. All the firms in the LBF were included in the original dataset[6] thereby giving confidence that the study captures the NZ manufacturing economy comprehensively.

The LBD is essentially a firm-level dataset, with firms classified according to sector by economic activity rather than product or service. Driven by this, our primary focus for definitions of 'the market' will relate to standard industrial definitions (i.e. the Australian and New Zealand Standard Industrial Classification, or ANZSIC). This is the standard for analyses such as this (see, for e.g., Braila, et al., 2010; Creusen, et al., 2006). This issue cannot be resolved given the nature of the data, but should be borne in mind when interpreting the results. Also, our analysis is restricted by the confidentiality issues around the data that are upheld by the data guardian, Statistics New Zealand. Information based on very small industries and/or those that are dominated by very few firms cannot be released.

The remainder of the paper is organised as follows. The next section briefly reviews the literature on the nexus between competition and productivity, while emphasising the choice of the competition measures applied in this paper. Section 3 discuses the econometric methodology and presents the model specification. Section 4 briefly describes the data. The results are reported in Section 5. The last section concludes.

[6] The final dataset was "filtered". Firms with no or negative turnover/intermediate consumption/value added/capital/employment were dropped. Despite that, the data are reasonably representative of the productive NZ business economy. Econometric analyses of the nature undertaken would not have been possible without filtering the data.

II. Review of the literature

Anecdotal evidence, especially studies that compare productivities of industries pre- and post-deregulation, find that competition contributes significantly to productivity growth. For example, the Australian Productivity Commission (APC) (2005) found that the Australian economy benefitted extensively from increased competition resulting from deregulation of the infrastructure sector. Post deregulation, the average real prices in the electricity sector fell by 19% during the early 1990s, reductions in rail freight rates ranged from 8% for wheat, to as much as 42% for coal traffic and real port charges fell by up to 50% during the 1990s. APC modelling indicates that these price changes have boosted Australia's GDP by 2.5% or $20 billion, and the average household's income by $7000 per year. Several other studies analysing the productivity effects of deregulation also find competition to be growth enhancing (e.g., Boylaud, 2000; Gort & Sung, 1999; Nicoletti & Scarpetta, 2005).

More formal econometric modelling, premised in the endogenous growth literature, suggests that the relationship competition and productivity may be non-linear, characterized by an inverted "U" shaped relationship (Aghion, et. al., 2005; Nickell, 1996). This implies that with both very high and very low levels of competition might be bad for productivity growth. However, this thesis is not without opposition (e.g., Aiginger & Falk, 2005; Levin, Cohen, & Mowery, 1985; Tingvall & Poldahl, 2006). Even while accepting that the inverted "U" shaped relationship might hold, Boone (2001) notes that "basically anything can happen".

It is reasonably straightforward to see why competition may be conducive to productivity growth. Competition potentially contributes to productivity via within firms effects, between firm effects and innovation.

Within firm effects represent the x-efficiency factors. An increase in competition forces firms to "trim the fat" and become more efficient. Firms might take a wide range of measures to move closer to the best practice frontier, these measures may include more efficient assimilation of available technology, organizational restructuring and downsizing. United Kingdom's Office of Fair Trading (OFT) (2007) argues that entry of new firms as well as thereat of entry is an incentive enough for existing firms to up their efficiency levels. As listed in OFT, there is extensive empirical evidence on the x-efficiency enhancing effects of competition. For example, using management survey practice data from 732 medium sized manufacturing firms in the United States (US), United Kingdom (UK), France and Germany, Bloom and van Reenen (2006) conclude that poor management practices are more prevalent when competition is weak. Bloom and van Reenen find that there is long tail of firms having "surprisingly bad management practices" and that these firms are heavily concentrated amongst firms in the low competition sample. This can be taken to imply that competition might be penalizing inefficiency. Nickell, Nicolitsas and Dryden (1997) view competition as a form of pressure (or disciplining device) on managers. In their study of 580 manufacturing firms in the UK, Nickell et al. find evidence of competition influencing x-efficiency. Nickell et al. further observe that the effect of competition on x-efficiency is somewhat substitutable with other disciplining devices such as financial pressure and dominant shareholders. Reporting on economies in transition, Djankov and Murrell (2002) also report that competition intensifies the pressure on firms to lower costs. We identify lower costs to be indicative of higher productivity.

Within firm effects of competition on productivity might be non-linear. For example, Caves and Barton (1990) and Green and Mayes (1991) find that technical inefficiency creeps into the production process at high as well as low levels of competition. Schmidt (1997) explains the inverted "U" shaped relationship suggesting that at high levels of competition, firms' profits – and so managerial incentives - will be reduced to such an extent that it can lead to less managerial effort.

Creusen, et al. (2006) and Braila, et al. (2010) observe that intensified competition will invariably be associated with reallocation of market share. More intense competition induces efficient firms to exploit their efficiency advantage and push aside less efficient firms (Creusen, et al., 2006). As a consequence, the market share of the more efficient firms increases, while the less efficient firms lose market share and might even exit. This process has been termed as "market sorting". Haskel (2000), in a study of 158,000 manufacturing firms in the United Kingdom, illustrates the market sorting processes. He notes that almost 45% of manufacturing plants who start at the top of the productivity distribution are still there or one quintile lower a decade later. Nearly 50% had actually exited, having moved down the productivity distribution. Haskel also found that over 70% of manufacturing plants starting at the bottom of the productivity distribution exit within a decade. Most of the remainder are still at the bottom ten years later. Less than 1% per of plants starting at the bottom ever make it to the top.20. In an ongoing study, part of the same project as the current paper, Devine et al., (2011b) find the prevalence of market sorting in NZ. Specifically, Devine et al., find efficient firms are able to appropriate market share from the relatively inefficient ones.

The empirical evidence appears to suggest the aggregate effects of reallocation effects of competition on productivity are significant in magnitude. For example, applying a sample of 10 OECD countries, Scarpetta, Hemmings, Tressel and Woo (2002) find that reallocation accounts for between 20 and 40% of total productivity growth for varying time periods in the 1980s and 1990s. Barnes and Haskel (2000) in a survey of UK manufacturing firms find that reallocation effect accounts for 33% of productivity growth.

Indeed, comparing the within firm (x-efficiency) and between firm (reallocation) effects, most studies tend to find that reallocation dominates. Baldwin and Gu (2006), using a sample of Canadian manufacturing firms spanning the period 1979–99, attribute 70% of productivity growth to reallocation of market share between firms. Baldwin and Gu contend that studies that find large x-efficiency effects have inadvertently captured the effects of market share reallocation in their within firm estimates. Likewise, Disney, Haskel and Heden (2003) analysing UK manufacturing firms over the period 1980–92 report that reallocation accounts for roughly half of labour productivity growth, and 80 to 90% of multi-factor productivity (MFP) growth with over half of the MFP growth being attributable to firm entry and exit.

Although the literature suggests that reallocation effects could be the most important facet of competition in the context of explaining productivity, most empirical models examining the competition and productivity nexus use constructs of competition that do not effectively account for reallocation effects. Using the PE indicator (Boone, 2000) to measure competition would enable better modelling of the effects of competition on productivity. The PE indicator is briefly discussed in the introduction and comprehensively described in Devine et al., (2011a).

Moving on from efficiency, we direct our attention to technological progress[7], a result of innovations. Boyle and Evans (2007) emphasise that innovative activity and research and development (R&D) advances are critical for productivity growth. There exists extensive literature on the role of R&D/innovation on productivity growth. For example, Cameron (2003) finds that 1% increase in R&D by UK manufacturing firms raised productivity by 0.2 to 0.3% in the 1980s. Looking at an earlier period, Griliches (1980) finds that a 1% increase in R&D raised productivity growth by 0.07%. There exists evidence of R&D induced productivity growth even in the case of NZ. To cite one recent example, applying data from the LBD spanning the period 2000-08, Iyer, Stevens and Tang (2011) find that firms that undertake R&D enjoy a productivity premium of about 7%.

There exists a large body of studies that theoretically posit and empirically demonstrate that the relationship between innovation and productivity is non-linear (e.g., Aghion, et al., 2005; Nickell, 1996). Competition is generally thought to act as a spur to innovation – not only incentivising organisations to create new and improved things to do and new and improved ways to do them, but also incentivising firms to adopt the best practices of others (Stevens, 2009). However, innovation is often a costly activity and so requires the prospect of rents in order to be undertaken. Thus, it may be that in some sectors competition impedes innovation and growth. Up to a certain point, increased competition stimulates more innovation as firms try to escape competition. Beyond that point, Schumpeterian effects dominate, as post-innovation rents are competed away (Stevens, 2009). Aghion, et al. (2005) describe the intuition underlying the inverted "U" shaped curve thus:

[7] Productivity growth can be decomposed into two mutually exclusive and exhaustive components: technological progress and efficiency changes.

Innovation incentives depend not so much upon post innovation rents, as in previous endogenous growth models where all innovations are made by outsiders, but upon the *difference* between *post innovation* and *pre innovation* rents of incumbent firms. In this case, more competition may foster innovation and growth, because it may reduce a firm's pre innovation rents by more than it reduces its post innovation rents. In other words, competition may increase the incremental profits from innovating, and thereby encourage R&D investments aimed at "escaping competition." This should be particularly true in sectors where incumbent firms are operating at similar technological levels; in these "neck-and-neck" sectors, pre innovation rents should be especially reduced by product market competition. On the other hand, in sectors where innovations are made by laggard firms with already low initial profits, product market competition will mainly affect post innovation rents, and therefore the Schumpeterian effect of competition should dominate. The essence of the inverted-U relationship between competition and innovation is that the fraction of sectors with neck-and-neck competitors is itself endogenous, and depends upon equilibrium innovation intensities in the different types of sectors. More specifically, when competition is low, a larger equilibrium fraction of sectors involve neck-and-neck competing incumbents, so that overall the escape-competition effect is more likely to dominate the Schumpeterian effect. On the other hand, when competition is high, the Schumpeterian effect is more likely to dominate, because a larger fraction of sectors in equilibrium have innovation being performed by laggard firms with low initial profits. (Aghion, et al., 2005, p. 701).

Empirical evidence on the inverted "U" relationship between competition and innovation has been mixed. Lin, Cohen and Mowery (1985) initially found a statistically significant inverted "U" relationship between market concentration and both R&D intensity and the rate at which innovations were introduced. However, the significance of these relationships was greatly reduced when technological opportunity and appropriability into account. This finding suggests that whatever relationship may exist between concentration and R&D across an entire economy is largely overwhelmed by the differences among individual industries with respect to technological opportunities, demand, and the appropriability of inventions. Hashmi (2011) finds support for the inverted "U" relationship but does not observe a more positive relationship between R&D and competition in the neck-and-neck industries, as is theorized in Agion et al., (2005). Tingvall and Poldahl (2006), on the other hand, find support for the existence of an inverted "U" relationship when applying the Herfindahl index as the construct of competition but not when using the price cost margin (or LI) measure. Likewise, Aiginger and Falk (2005) also do not find evidence of an inverted "U" shaped relationship when applying the LI measure of competition. In discussing their findings, Aiginger and Falk question the use of LI as a measure of competition. Indeed, this question has precedence in Boone (2000). Boone also reported that the price cost margin (or LI) is inadequate and suggested the application of the PE indicator.

Summarising the literature review, we find that competition is generally regarded as a critical determinant of productivity. Competition is thought to impact on productivity in three ways: Spurring an increase in x-efficiency, reallocating market shares in favour of more efficient firms and, encouraging innovation. Among these, reallocation effects are particularly important and are less conducive to being captured by traditional measures of competition. The newly developed PE indicator is able to account for reallocation effects is receiving wide spread acceptance in the literature. Moreover, the PE indicator is able to account for both competition in the market and for the market. There are string theoretical arguments suggesting that competition and productivity are non-linearly related, although the empirical evidence is mixed.

III. MODEL SPECIFICATION AND ECONOMETRIC METHOD

The econometric modelling in this paper follows a two-step procedure: In the first step, measures of multi-factor productivity (MFP) are estimated; in the second, MFP is regressed against a vector of variables that includes those relating competition (i.e., the Lerner index [LI] and the PE indicator [PE]).

Phase 1: Computing Multi-factor Productivity (MFP)

MFP is estimated as the residual of a Cobb-Douglas production function and is specified as:

$$\begin{aligned} \ln(GO_{it}) = \theta_0 + \theta_l[\ln(L_{it}) - \ln(\overline{L_t})] + \theta_m[\ln(M_{it}) - \ln(\overline{M_t})] \\ + \theta_k[\ln(K_{it}) - \ln(\overline{K_t})] + \delta_t + \delta_j + \varepsilon_{it} \end{aligned} \qquad (2)$$

where GO_{it} is the gross output of firm *i* at time *t*, and θ_l , θ_m and θ_k are the estimated coefficients of mean adjusted labour, intermediate consumption and capital respectively. δ_t represents year dummies while δ_j represents industry dummies

Specifically, as noted in the introduction to the paper, we apply the productivity estimation method developed in Martin (2008). This approach to estimation allows for imperfect competition (Dixit-Stiglitz market structure), non-constant returns to scale and factor input endogeneity. Gross profits measured as gross output minus the cost of intermediate inputs and wages is used as the proxy for the unobservable productivity shock.

Phase 2: MFP Regressions[8]

The following model is estimated:

$$\ln(MFP_{ijt}) = \varphi_0 + \varphi_1 EX_{ijt} + \varphi_2 FDI_{ijt} + \varphi_3 R\&D_{ijt} + \beta_1 AGE_{ijt} + \beta_2 RSIZE_{ijt} + \beta_3 MSHARE_{ijt} + \beta_4 COMP_{jt} + \beta_4 COMP_{jt}^2 + \delta_t + \delta_j + \varepsilon_{ijt} \quad (2)$$

where,

MFP_{ijt} : Multi-factor productivity of firm *i* from industry *j* at time *t*.

EX_{ijt} : A dummy variable capturing if the firm is an exporter. Firms that first exported at time *t* are treated as non-exporters in all previous years and as exporters in all future years.

FDI_{ijt} : A dummy variable capturing if the firm is foreign owned.

$R\&D_{ijt}$: A dummy variable capturing if the firm is an R&D performer.

AGE_{ijt} : Years since birth of firm.

[8] An important assumption of the production function regression is that the error term is independently and identically distributed (iid). The credibility of the second stage MFP regressions which use such an error term from the first stage regressions as the dependent variable is circumspect. We acknowledge that the MFP measure obtained from the procedure we apply in this paper confronts this iid econometric issue.

$RSIZE_{ijt}$: Employment in firm *i* relative to average employment of industry *j* at time *t*.

$MSHARE_{ijt}$: Gross output firm *i* relative to total gross output of industry *j* at time *t*.

$COMP_{jt}$: Measurement of competition in industry *j* at time *t*. It is recalled that two measures of competition are applied: the Lerners index (LI) and the profit elasticity indicator (PE).[9]

δ_t : Year dummies.

δ_j : Industry dummies.

The above equations have a firm level variable on the LHS and several industry level variables on the RHS. Moulton (1990) demonstrates that regressions of micro units on variables aggregated at the industry level produce standard errors that are biased downwards, giving raise to the possibility of spurious significance. To address this issue, we correct the standard errors to allow for intra-industry correlation, relaxing the usual requirement that the observations be independent. That is, the observations are independent across industries but not necessarily within industries. The data sources of the variables are detailed in Data Appendix.

Second stage regressions on MFP can also be estimated using a variety of methods such as pooled OLS, between effects, fixed effects, random effects and GMM. Pooled OLS is not applied since it is outperformed by the other methods. GMM is not used due to the lack of

[9] LI and PE values for this paper are taken from Devine, et al., (2011a).

suitable instruments. Fixed effects are also not a reasonable option in our view. The fixed effects method "time differences" the variables; as a consequence, nearly time invariant[10] variables such as the FDI dummy, the R&D dummy or the export propensity dummy will exit the regression model. The option was, therefore, to use either the pooled regression (POLS) model or the random effects (RE) model. It is not clear which of the two methods is more preferable. Therefore, for robustness we use both.

We estimate two variants of the specified model, one using the PE measure of competition and the other using the LI measure. Since two estimation methods are used (POLS and RE), we have four sets of regression results which are denoted as: POLS-PE, RE – PE, POLS-LI and RE-LI. All four regressions are repeated after excluding the market share variable to identify if the results are sensitive to the inclusion of the *MSHARE* variable.

IV. DATA

The dataset is drawn from the LBD. Generally speaking, the LBD has been built primarily around government administered data collections and stands out for both its comprehensive coverage of firms and the variety of variables captured. The breadth of data in the LBD enables significant advances to be made in many areas of microeconomic analysis, including export spillovers. For the present analysis, an unbalanced panel dataset of 19,836 manufacturing firms spanning the years 2000-09 is extracted from the LBD.

[10] These binary variables are nearly time invariant in the sense that if a non-exporter in year *t* becomes an exporter at time *t+1*, the export propensity dummy is not totally time invariant.

In measuring competition, markets are proxied using industries defined at the ANZSIC 4 digit level. Industry classifications may not accurately represent markets. However, the low aggregation (ANZSIC 4 digit level) alleviates this concern somewhat. In any case, this approach is the standard for analyses such as this (see, for e.g., Braila, et al., 2010; Creusen, et al., 2006). As noted previously, while this issue cannot be resolved given the nature of the data, it should be borne in mind when interpreting the results.

Detailed description of the data sources and construction of the variables are presented in the Appendix.

The manufacturing economy is classified into nine industry groups based on the ANZSIC 2 digit level (see, table 1).

Table 1: Manufacturing Industries at the 2 digit Level

Industry Notation	Industry Description
C21	Food, Beverage and Tobacco Manufacturing
C22	Textile, Clothing, Footwear, Leather Manufacturing
C23	Wood & Paper Product Manufacturing
C24	Printing, Publishing and Recorded Media
C25	Petrol, Coal, Chemical & Assoc Prod Manufacturing
C26	Non-Metallic Mineral Product Manufacturing
C27	Metal Product Manufacturing
C28	Machinery and Equipment Manufacturing
C29	Other Manufacturing

From the first stage of the empirical modelling, we derive estimates of MFP (see, table 2). Unweighted and weighted estimates of MFP are presented in Table 2 by ANZSIZ 2 digit levels. It is recalled that industry dummies in the second stage regressions are at the ANZSIC 2 digit level of aggregation.

Table 2: Multi-factor Productivity Estimates

MFP (unweighted)				
Ind	**Mean**	**Std. Err.**	**95% Conf. Interval**	
C21	14.1203	0.0039	14.1126	14.1280
C22	12.9241	0.0029	12.9183	12.9300
C23	13.4854	0.0031	13.4792	13.4916
C24	13.3456	0.0027	13.3401	13.3511
C25	14.1804	0.0035	14.1735	14.1872
C26	13.3156	0.0055	13.3048	13.3264
C27	13.7391	0.0019	13.7352	13.7430
C28	13.4946	0.0010	13.4926	13.4967
C29	13.0504	0.0022	13.0460	13.0547

MFP (weighted)				
Ind	**Mean**	**Std. Err.**	**95% Conf. Interval**	
C21	1.9168	0.1566	1.6098	2.2238
C22	1.5077	0.0543	1.4012	1.6141
C23	1.3052	0.0750	1.1581	1.4523
C24	1.6093	0.0906	1.4315	1.7870
C25	2.4542	0.1383	2.1831	2.7253
C26	4.8939	0.4947	3.9242	5.8636
C27	0.9253	0.0540	0.8194	1.0312
C28	0.6014	0.0224	0.5573	0.6454
C29	1.1393	0.0274	1.0855	1.1930

The estimates of weighted MFP are reasonable with Non-Metallic Mineral Product Manufacturing registering the highest levels of MFP. Based on the composition of the Non-Metallic Mineral Product Manufacturing industry in NZ, this result should not come as a surprise. The Petroleum related industries and food and beverages group come next, which are also reasonable. At the end of the distribution are the machinery and equipment manufacturing firms and metal manufacturing firms. This finding is not as intuitive. It may be worthwhile to examine the robustness of the MFP estimates. It is planned to benchmark the estimates from the Martin (2008) method with those obtained using fixed effects regressions and the Levinsohn and Petrin (2003) (LP) procedure. Recently, Iyer et al. (2011) compute MFP using both fixed effects regression and the LP procedure using the same data source; the authors reported that the estimates were markedly similar.

IV. Econometric Results and Discussion

The paper now turns to the MFP regression results based on equation (2). The results are reported in Table 3. Industry and year dummies are suppressed for brevity.

Table 3: Regression Results

Variables	POLS-LI	RE-LI	POLS-PE	RE-PE
Competition	0.4271	2.8720	-0.0285	-0.0234
	(3.85)***	(4.10)***	(14.21)***	(3.24)***
Competition squared	-1.4125	-3.0138	0.0046	0.0015
	(3.99)***	(1.27)	(12.10)***	(3.14)***
FDI	0.1848	0.0579	0.1821	0.0593
	(32.59)***	(1.08)	(32.99)***	(1.11)
R&D	0.0651	-0.0110	0.0658	-0.0114
	(19.29)***	(0.36)	(19.59)***	(0.37)
Export	0.1474	0.0539	0.1465	0.0542
	(72.19)***	(1.53)	(72.27)***	(1.56)
Firm's age	0.0041	0.0134	0.0041	0.0134
	(61.90)***	(11.48)***	(62.26)***	(11.53)***
Firm's size (relative to industry)	1.1442	2.6645	1.1154	2.6994
	(9.24)***	(5.02)***	(9.07)***	(5.07)***
Firm's market share	6.6426	0.7578	6.7423	0.7496
	(6.03)***	(1.77)*	(6.12)***	(1.74)*
Constant	13.9237	13.0757	13.9715	13.3883
	(1739.30)***	(70.51)***	(3232.33)***	(77.62)***
Observations	95,229	96,516	95,229	96,516
R-squared	0.77		0.77	

Robust t statistics in parentheses; Significant at 10%; ** Significant at 5%; *** significant at 1%*

There are four sets of results, depending on whether PE or LI measures are used as the competition construct, and whether POLS or RE estimators are used in the regressions. For instance, in column 2, POLS-LI denotes that the results are based on the POLS estimator and the LI measure of competition. That the results across the regressions are by and large consistent is an evidence of robustness. Some additional models have also been estimated.

For example, all the estimations were repeated using lag values of variables (excepting *AGE*) in the explanatory vector. The results were quantitatively and qualitative similar. Likewise, we also observe that dropping the *MSHARE* variable did not alter the results much. The estimations were sensitive to the exclusion of the second order term of competition. In fact, the results were much less meaningful when a linear relationship between competition and productivity was imposed. This lends confidence that the specification used is reasonable.[11] Results from alternative specifications are available on request and will also be included in the occasional paper that will follow.

The coefficients of competition (both first order and second order) are of primary interest and this is where the differences between the regressions are most noticeable as well. There is clear evidence of the first order LI measure being positively and significantly associated with productivity. The second order LI measure is negatively signed but is statistically significant only in the POLS estimation. By and large, it is reasonable to conclude there is evidence of an inverted "U" shaped relationship between competition and productivity if the LI construct is applied. This means that in NZ manufacturing at low levels of competition higher mark-up is associated with higher levels of productivity. However, as competition intensifies, the productivity competition association turns negative. This can be attributed to either reduced managerial effort (Schmidt, 1997) and/or the "Schumpeterian effect", that is, as reduced monopoly rents from innovation which might discourage R&D investment (Aghion et al., 2005). In terms of magnitude, according to the POLS-LI estimation, a one percentage point increase in mark-up on average is associated with a firm productivity increase of 0.43%. This result holds till a certain inflection point after which the

[11] Results from alternative specifications are available on request and will also be included in the occasional paper that will follow.

association between the two variables is reversed; the threshold is at 15% mark-up.[12] In other words, if the average mark-up in an industry exceeds 15%, either managerial effort may diminish or Schumpeterian effects may take over. However, below 15%, competition might be productivity enhancing.

The relationship between productivity and the PE indicator of competition is also parabolic but the curve, when plotted, faces upwards. This means that at low levels of PE, when PE increases, productivity decreases. After the inflection point, the relationship is reversed and higher PE is associated with higher productivity. Does this result contradict the results obtained using the LI measures? Both measures are designed to reflect on different facets of competition. Therefore, a comparison is not strictly meaningful. However, the result is complimentary. It is recalled that PE is simply the responsiveness of profits to average costs. The upward facing parabolic relationship simply suggests that where firms are not intensely competing to serve the market, higher responsiveness of profits to changes cost is associated with reduction in productivity. This result is intuitive. In stagnant markets, there is less incentive for firms to innovate if small increases in costs results in large decreases in profits. Equivalently, if the market is stagnant and firms are not competing intensely for market share, the realisation that a small reduction in R&D expenses will result in large increase in profits will be a disincentive to innovate. However, as the completion for the market rises, the threat of market share reallocation to more efficient firms is likely to spur firms to innovate as well as to increase x-efficiency.

[12] This is the point where the first derivative of the regression function is zero. For the 2nd order polynomial, this value is the coefficient of the linear term divided by -2 times the value of the coefficient of the squared term.

The FDI dummy variable is positive and highly significant across all four regressions. The magnitudes of its coefficient are also very comparable across the PE and LI based models. For instance, the result from the POLS-PE estimation indicates that a foreign owned firm is 20% (=[exp(0.18-1] x 100) more productive than a domestic firm.[13] There are also a statistically significant, positive productivity premium associated with R&D performers and exporters respectively. The productivity premium associated with being an exporter is a tad lower to being a foreign owned firms according to the POLS estimations, but almost the same according to the RE estimations. Based on the POLS-PE estimation, the productivity premium associated with exporting is roughly 16%. The productivity premium associated R&D is statistically significant across all regressions, but is much smaller than that the FDI and exporter premium. As an example, the premium associated with being an R&D performer based on the POLS-PE estimation is 7%.

Regarding the other variables in the explanatory vector, the effect of firm size (*RSIZE*) is expectedly significant and positive. A one percentage point increase in relative size increases the productivity of an average firm by about 1.12% (POLS-PE estimation). This magnitude is reasonably large. Consistent with the results on relative size, we also find statistically significant coefficients of market share in all four regressions. It is recalled that alternative regressions were conducted excluding the market share variable and the other coefficients were robust to the change in model specification. Lastly, we find a positive and statistically significant effect on the *AGE* variable. This result is expected. An older firm, on average, is more likely to be productive than a new entrant. Older firms that were inefficient would have exited the market and not be included in our dataset.

[13] Recall that the variables themselves are binary and the dependent variable is in natural logarithms.

In summary, we find that productivity and the LI do have an inverted "U" shape relationship. But the parabolic shape is reversed when the PE indicator of competition is uses instead of LI. This is not a contradiction. Both results have a sound theoretical reasoning. Other control variables included in the model such as foreign ownership, exporting, R&D, market share, age and relative size are appropriately signed and are of reasonable magnitude.

The empirical model in the paper requires refining and results from this paper needs robustness checks before policy implications of the findings are discussed.

V. Conclusions

Applying a panel dataset of 19,836 manufacturing firms from the prototype Longitudinal Business Database spanning the years 2000-09, this paper documented the nexus between competition and productivity in NZ manufacturing. The study applied two constructs of completion: the traditional LI measure and the recently developed PE indicator. It has been argued that the PE indicator is theoretically superior. Some of the theoretical merits of the PE indicator were discussed; notably that it is monotone, able to account for varying cost structures, appropriate captures reallocation effects of competition. Modelling productivity on both LI and PE, using POLS and RE methods we find that the relationship between competition and productivity is non-linear, specifically parabolic. With LI, our finding falls in line with the inverted "U" proposition. This means that in NZ manufacturing at low levels of competition higher mark-up is associated with higher levels of productivity. However, as competition intensifies, the productivity competition association turns negative. This can be attributed to either reduced managerial effort and/or the loss of post-innovation rents in a Schumpeterian sense. With PE we find that the parabolic curve is upward facing. This suggests that if the firms are not competing intensely for market share, innovation is dis-incentivised. However, as the completion for the market rises, the threat of market share reallocation to more efficient firms spurs firms to innovate as well as to increase x-efficiency. The empirical model controlled for several other variables, all of which were of reasonable magnitude and were appropriately signed.

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DATA APPENDIX: VARIABLES AND DATA SOURCES

Variable Acronym	Variable Name	Data Sources
Firms		Economically active enterprise are defined as enterprises that meet at least one of the following criteria in a particular year: • Linked Employer Employee Data (LEED) rolling mean employment (RME) greater than zero • GST sales greater than zero • GST purchases greater than zero • IR10 total income greater than zero • IR10 total expenditure greater than zero • IR10 total fixed assets greater than zero. As mentioned in the text, firms are not always single legal entities. Where firms are components of a group, the group aggregates are used to measure the variables rather than the firm (i.e., legal entity) specific data.
GO	Gross Output	Gross output variable derived from the Annual Enterprise Survey (AES). Adjusted to constant 2009Q1 dollars using industry sub-division specific deflators. Where gross output was not available in the AES or was based on tax data, it was replaced with a derived gross output from the Business Activity Indicator (BAI). The derivation is simply sales from BAI. The production function includes a level dummy to capture the difference in sources. It has been worked out that the difference in the two sources is essentially one of levels.
K	Capital	Derived as the summation of depreciation and cost of capital charge for owned assets. Data from AES and BAI (depending on the source of data for value added). Adjusted to constant 2009Q1 dollars using asset specific deflators.
L	Labour	Rolling mean employment from LBF, plus working proprietors from LEED.
M	Intermediate consumption	Intermediate consumption variable derived from the Annual Enterprise Survey (AES). Adjusted to constant 2009Q1 dollars using industry sub-division specific deflators. Where intermediate consumption was not available in the AES or was based on tax data, it was replaced with a derived value added from the Business Activity Indicator (BAI). The derivation is simply purchases (from BAI).
FDI	FDI Dummy	Constructed as a binary variable: foreign owned and non-foreign owned; data from LBF and IR4 (company tax returns).
EX	Exporter Dummy	Constructed as a binary variable: Exporter of goods and/or service and Non-Exporters. Goods exports are derived from CUSTOMS and services exporters are derived from International Trade in Services & Royalties Survey.
R&D	R&D Dummy	Constructed as a binary variable: R&D performers and R&D non-performers; data from IR10.
AGE	Age of the firm	Extracted from the LBF, as current year +1 – year of birth
RSIZE	Relative Size	Constructed using data on firm and industry Labour. See text for formula.
MSHARE	Market Share	Constructed using data on firm and industry gross output. See text for formula.

*Gross profit is used as a proxy variable for unobserved productivity shocks based on the Martin (2008) approach. Data comes from AES and the BAI and IR10. Gross profit is derived as Gross output – intermediate consumption – wages.