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Abstract

How do choices about personnel practices affect firm performance? To examine this issue we use a unique panel of over 1,500 New Zealand firms, drawn from a diverse range of industries. The panel is constructed around respondents to official surveys of management practices in 2001 and 2005. These surveys ask a wide range of comparable qualitative questions covering organizational practices in the areas of: leadership, planning, customer and supplier relations, human resource management (HRM), quality and process monitoring, benchmarking, and innovation. To this panel, we attach longitudinal firm performance data, covering the 2000 to 2006 financial years, sourced from the prototype Longitudinal Business Database (LBD). The linked data allow us to examine the effect of HRM-related organizational change on firm productivity and worker outcomes.

JEL classifications: D21, L20, O31

Keywords: human resource management; personnel economics; firm performance; productivity; wages

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DISCLAIMER

This research was undertaken while Richard Fabling was on secondment to Statistics New Zealand. The opinions, findings, recommendations and conclusions expressed in this report are those of the authors. Statistics NZ, the Reserve Bank of New Zealand, Motu and the University of Waikato take no responsibility for any omissions or errors in the information contained here.

Access to the data used in this study was provided by Statistics NZ in accordance with security and confidentiality provisions of the Statistics Act 1975. Only people authorised by the Statistics Act 1975 are allowed to see data about a particular business or organization. The results in this paper have been confidentialised to protect individual businesses from identification.

The results are based in part on tax data supplied by Inland Revenue to Statistics NZ under the Tax Administration Act 1994. This tax data must be used only for statistical purposes, and no individual information is published or disclosed in any other form, or provided back to Inland Revenue for administrative or regulatory purposes. Any person who had access to the unit-record data has certified that they have been shown, have read and have understood section 81 of the Tax Administration Act 1994, which relates to privacy and confidentiality. Any discussion of data limitations or weaknesses is not related to the data's ability to support Inland Revenue's core operational requirements.

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1 Motivation

In this paper we examine the relationship between human resource management (HRM) practices and firm performance. Our main concern is to identify whether changes in work place organization have had – or could in the future have – an important role in explaining productivity growth in the New Zealand economy. We also consider how any prospective productivity gains are shared between workers and owners of capital.

Evidence suggests that adoption of new capital equipment and increases in human capital were important components of US productivity growth over the mid-90s (Abowd *et al.* 2001; Nickell and Nicolitsas 2000). Within that context the importance of personnel practices has been highlighted as having contributed to raising aggregate productivity growth (eg, Black & Lynch 2004), and more specifically, provided a complementary role in the "ICT revolution" (eg, Bresnahan *et al*. 1999; Bartel *et al.* 2007). Furthermore, in the US at least, changes in the relative demand for skills has widened the distribution of earnings "but also is likely to reflect changes in human resources practices" (Lazear and Shaw 2007).

High-performance work practices are generally thought to include compensation practices (including performance pay), training, worker autonomy, hiring policies, teamwork, and job rotation. The personnel economics literature has burgeoned on the back of detailed case studies of individual firms undertaking organizational change (eg, Lazear 2000; Shearer 2004); small-scale comprehensive industry studies (eg, MacDuffie 1995; Ichniowski *et al.* 1997), and broader surveys of HRM practices and firm performance (eg, Black and Lynch 1996; Cappelli and Neumark 2001). This body of work has consistently found connections between the choice to move towards these high-performance practices, better firm performance and/or higher wages for workers (Lazear and Shaw 2007, and Pfeffer 2007 provide recent reviews of the field).

Some studies indicate the importance of differentiating the impact of various workplace practices on increasing total firm rents through increased productivity, and the distribution of those rents between owners and employees (Freeman and Lazear 1995; Lazear 2000). For example, Freeman and Kleiner (2005) follow a US shoe manufacturer that shifted from piece rates to time rates (that is, away from high-performance work practices), and suffered decreasing productivity but increasing profitability. Other recent studies have focussed on worker outcomes, particularly changes in average wages, the within-firm distribution of wages, and staff turnover as potentially being affected by choices of personnel practices (eg, Osterman 2000; Bauer and Bender 2003; Black *et al.* 2004).

The importance of utilising a suite of employee practices has been emphasised in a number of studies (Milgrom and Roberts 1995; MacDuffie 1995; Ichniowski *et al.*1997; Kandel and Lazear, 1992; Kruse *et al.* 2003). Ichniowski and Shaw (2003) discuss complementarities between implementation of incentive schemes and more general HRM innovations. These include the importance of avoiding free-rider behaviour on the part of some employees (in group incentive schemes) and encouraging individuals to expand their horizons to problem-solving across the firm. In the latter case, employees are expected to "multi-task", so employee management and incentive systems need to be more complex relative to systems in traditionally managed firms (Holmstrom and Milgrom, 1994). Further, Black and Lynch (1996, 2001, 2004) find that adoption of individual high performance work practices also have a strong positive association with firm-level productivity.

On the basis of hypotheses from the HRM and personnel economics literature, we seek to test whether the adoption of a suite of "high performance" employee practices has beneficial effects on New Zealand firm performance. We test also whether individual HRM practices have beneficial effects.

Our study deepens the literature in a number of ways, leveraging off the strength of the data that we have available. Firstly, we have a relatively large panel dataset with a four year gap between observations of consistently-measured HRM and other business practices. The four year gap between measurement periods is useful because management practices exhibit strong persistence over time (eg, Black and Lynch 2004; Ichniowski and Shaw 1995). Our data is sourced from official mandatory Statistics New Zealand (SNZ) surveys ensuring response rates of over 80%. Further, compared to other studies, our panel attrition rate is low.

Second, our performance metrics are estimated separately from the management practice survey and are constructed using the universe of firms in the population, so that we can consider more detailed industry production functions and control for inter-industry differences. Such controls are important to our study because we have broad industry coverage, with few exclusions. Our main population restriction relates to firm size, but even in this regard our cut-off of six employees is much lower than most other studies. As such the cross-section estimates, presented in Section 4, can genuinely be interpreted as representing a broad swathe of the New Zealand economy.

Third, our sample surveys have detailed questioning on a wide array of practices outside the area of HRM. It is plausible that arguments about the importance of bundles of HRM practices could also extend to these broader areas of practice. For example, Osterman (1994) finds that adoption of high-performance work practices is closely associated with strategic choices regarding quality and customer service. Our data allows for us to control for such factors directly. These factors also help control for aspects of business operations, such as having high quality managers, traditionally left to firm-fixed effects. Our data allow us to determine the impact of personnel practices in the presence of, and separate from, the adoption of general "good" business practices.

Finally, we consider the effect of business practices on multiple performance metrics, including both firm productivity and worker outcomes. To investigate this latter issue, we make use of Linked Employer-Employee Data (LEED) and consider the impact of organizational change on average wages and the rate of "excess" employee turnover.

The model presented in Section 2 is constructed to guide interpretation of the results that we find across this range of performance metrics. Section 3 briefly outlines the contents of the prototype Longitudinal Business Database (LBD) and our performance metrics in more detail, with a more technical description of the construction of those metrics relegated to Appendix B. Section 4 presents pooled cross-section and panel fixed effects regression results. We find strong evidence that adoption of high-performance work practices is positive for firm productivity and worker compensation. Section 5 concludes by reiterating the strength of the dataset and key findings.

2 Model

Consider a generalised production function incorporating quality differences across firms in each of output[3] and labour (for simplicity, capital is assumed to be homogeneous[4]). Output prices depend on the perceived quality of outputs relative to those of competitors; thus we are dealing with a monopolistically competitive market as in Syverson (2004). We denote quantities of firm i's output, labour input and capital input as Y_i, L_i and K_i respectively; the quality (productivity) of labour as λ_i and the quality of output as ν_i. The efficiency parameter, A_i, is assumed to be a function of a vector of firm characteristics, $A(\mathbf{C}_i)$, where $\mathbf{C}_i$ may include such factors as age and sector, as well as underlying management capability within the firm. We normalise variables so that: $E(A_i) = E(\lambda_i) = E(\nu_i) = 1$; $A_i, \lambda_i, \nu_i > 1$ (<1) indicate superior (inferior) quality relative to the mean across all firms. The generalised production function for each firm is of the form:

$$Y_i.\nu_i = f\{ A_i, L_i.\lambda_i, K_i \} \qquad (1)$$

where the first partial derivative of f{.} with respect to each argument is positive.

The output price (q_i) received by firm i is a function of output quality (ν_i):

$$q_i = q(\nu_i) \qquad \text{where } \partial q/\partial \nu_i > 0 \qquad (2)$$

The quality of labour input is determined by two inter-related influences: the innate quality of workers employed by the firm, denoted S_i; and a vector of human resource practices adopted within the firm, denoted $\mathbf{P}_i$, where $\mathbf{P}_i = (P_{1i}, \dots P_{ji}, \dots P_{Ji})$ with higher values for P_{ji} corresponding to 'higher performance' work practices. Thus:

$$\lambda_i = \lambda(\mathbf{P}_i, S_i) \qquad \text{where } \partial\lambda/\partial P_{ji} \geq 0\ \forall j,\ \partial\lambda/\partial S_i \geq 0 \qquad (3)$$

Further, we assume that S_i is a function of the wage offered by the firm, w_i, (relative to the market average wage, which is suppressed for clarity in the following):

$$S_i = S(w_i) \qquad \text{where } \partial S/\partial w_i \geq 0 \qquad (4)$$

Combining (3) and (4):

$$\lambda_i = \lambda'(\mathbf{P}_i, w_i) \qquad \text{where } \partial\lambda'/\partial P_{ji} \geq 0,\ \partial\lambda'/\partial w_i \geq 0,\ \partial^2\lambda'/\partial w_i \partial P_{ji} \geq 0\ \forall j \qquad (5)$$

The first two partial derivatives in (5) follow naturally from (3) and (4). The third set of partial derivatives is based on findings that high performance work practices are most effective in cases where workers are engaged in activities in which they can utilise personal skills to increase productivity (e.g. through problem solving yielding productivity improvements) (eg, Bresnahan *et al.* 1999). According to these studies, firms with higher quality workers (i.e. with higher S_i and higher w_i) will obtain most benefit from employing certain HRM practices within $\mathbf{P}_i$.

In addition to being important for physical productivity, worker quality and HRM practices may also be important for product quality, ν_i and hence product price, q_i. Thus, in an analogous fashion to (5), we have:

$$q_i = q'(\mathbf{P}_i, w_i) \qquad \text{where } \partial q'/\partial P_{ji} \geq 0,\ \partial q'/\partial w_i \geq 0,\ \partial^2 q'/\partial w_i \partial P_{ji} \geq 0\ \forall j \qquad (6)$$

[3] Output quality may be tangible (eg, products with more features) or intangible (eg, brand names).

[4] Fabling and Grimes (2007a) assumed that the quality of capital also varies across firms; however for the purposes of this paper, the variation in product quality and labour quality is sufficient to establish our results. The results nevertheless also hold for the more complex specification with variable capital quality.

The firm maximises profit, Π_i, through its choices of HRM practices, wage rates and quantities of labour and capital. Profits equal revenue less factor costs paid to employees and owners of capital, and less other costs borne by the firm including costs of implementing HRM practices, h_i:

$$h_i = h(\mathbf{P}_i) \qquad \text{where } \partial h/\partial P_{ji} \geq 0 \ \forall j \tag{7}$$

They also include "employee turnover" costs, i.e. costs of hiring (and severing) workers, denoted m_i. The firm's rate of employee turnover is hypothesized to be reduced through adoption of high performance work practices and also by offering higher than market wages. Thus:

$$m_i = m(\mathbf{P}_i, w_i) \qquad \text{where } \partial m/\partial P_{ji} \leq 0 \ \forall j,\ \partial m/\partial w_i \leq 0 \tag{8}$$

Combining all influences on profitability, firm profits, Π_i, are given by:

$$\Pi_i = q'(\mathbf{P}_i,w_i).f\{A(\mathbf{C}_i),L_i.\lambda'(\mathbf{P}_i,w_i),K_i\} - w_i.L_i - r.K_i - h(\mathbf{P}_i,w_i) - m(\mathbf{P}_i,w_i) \tag{9}$$

Profits are maximised with respect to L_i, K_i, w_i, $\mathbf{P}_i$, taking $\mathbf{C}_i$, r and the functions q′(.), f{.}, A(.), λ′(.), h(.) and m(.) as given.[5]

Given the relationships embedded in the functions, as indicated by the partial derivatives above, we hypothesise that the following reduced form features will hold with respect to the influence of HRM practices on firm outcomes. First, we expect that an increase in (at least some elements of) $\mathbf{P}_i$ will result in higher (multi-factor and labour) productivity, and/or higher product quality (with associated higher output price). Owing to the complementarity between innate worker quality and high performance work practices, we also hypothesise that an increase in $\mathbf{P}_i$ will be associated with a higher average wage for the firm and with higher quality workers. Both the increase in $\mathbf{P}_i$ and the associated increase in w_i will decrease employee turnover. Each of these hypotheses is testable given the longitudinal unit record firm data that we have available.

One complication in testing the impact of particular HRM practices on firm performance is that there is a considerable literature indicating that 'bundles' of high performance work practices are more effective in lifting performance than is the introduction of isolated practices (see Lazear and Shaw 2007 for a good summary). Accordingly, we test both for the impact of individual HRM practices and for bundles of high performance practices. Another complication in testing hypotheses in this field is that the adoption of high performance HRM practices will likely be positively correlated with adoption of other high performance management practices within the firm. For instance, firms with good quality planning processes may be those most likely also to adopt high performance HRM practices. A rigorous analysis must therefore be able to control for the adoption of other general management practices (and firm characteristics) that are separate from, but potentially correlated with, the HRM practices that are being tested. Our data are rich enough to control comprehensively for such general management practices. A third complication is that optimal HRM practices may vary across sectors. For instance, practices that may be most effective in services may differ from those in manufacturing (eg, because objective assessment of individual output may be harder to assess for certain types of tasks). The breadth of our data enables us to test separately for manufacturing firms in addition to our tests on firms that are representative of the entire economy.

[5] We assume that the functional forms are such that an interior solution exists.

3 Data

Our analysis is based around respondents to official SNZ surveys of management practices in both 2001 and 2005 (via the Business Practices Survey and Business Operations Survey respectively). These surveys ask a wide range of comparable qualitative questions covering practices in the areas of: leadership, planning, customer and supplier relations, human resource management, quality and process monitoring, benchmarking, and innovation. Both surveys have broad industry coverage with a low employment size cut-off of six, and are stratified on industry and employment. Excluded industries are Electricity, Gas and Water; Government Administration and Defence; Libraries, Museums and the Arts; Sport and Recreation; and Personal and Other Services.[6] Because both surveys are mandatory, survey response rates are over 80%. The unit of observation is the enterprise (we will use the term firm throughout this paper). While much of the research in the field of personnel economics uses the plant as the unit of observation, in most cases our unit of observation is a single plant. Specifically, only 28% of responses relate to firms with more than one employing plant, of which roughly a third have at least 80% of their employment in a single plant.[7] We use this data in a pooled cross-section with a total of 10,392 responses,[8] and as a panel of 1,530 observations. Table 1 sets out the size of sample by 1-digit (ANZSIC[9]) industry in each year. Of particular note, we have a manufacturing panel of almost 500 firms, allowing us to separately test our findings for that sector.

Our HRM variables cover a wide range of topics and incorporate variables relating to management engagement with staff (CONSULT and VALUES); the level of autonomy granted to non-management employees (SUPPLY_AUTON and QUAL_AUTON); TRAINING; performance measurement and reward (PERF_REVIEWS and PERF_PAY); and the attention management gives to the firm's HRM performance (FIRM_HR_PERF). The precise definition of these variables is listed in Table 2 together with weighted mean responses by year for the population. Each variable is a binary constructed by aggregating qualitative responses so that the positive responses are as close to half the sample as possible. A key point from Table 2 is that most practices have either stable, or declining, incidence rates over the period.

Turning attention to the panel, Table 3 shows the rate of adoption or cessation of practices. Consistent with the aggregate picture, the net change in practices is negative in many cases. Our model suggests that we might expect some bias upwards in our uptake rate in the panel (since adoption is expected to improve firm performance). The other point of note in Table 3 is that there are quite a few transitions in and out of each practice with only 62-80% of firms maintaining consistent individual practices over the four year period. These figures are in the same ballpark as Black and Lynch (2004), who find persistence rates of 66-80% over a three year period for a panel of US manufacturers.

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[6] Electricity, Gas & Water; and Sport & Recreation are included in BOS, but excluded from BPS.

[7] Even if this were not the case, a pragmatic perspective would favour surveying business practices at the firm level, since financial variables are almost exclusively at this (or the tax-reporting) level in New Zealand, the main exception being LEED.

[8] The number of observations goes up markedly in 2005, not primarily because of population changes, but rather as a combination of an increased requirement for statistical accuracy in aggregate outputs, as well as some strata being over-sampled relative to this accuracy requirement.

[9] Australia New Zealand Standard Industry Classification.

To test whether the adoption of a suite of HRM practices affects firm performance, we need to construct a measure that captures how these practices occur together. We do this by performing a principal components analysis on our individual HRM variables, retaining factors with eigenvalues greater than one. Table 4 presents the weights on each of the three principal components that this process generates.[10] We label these variables HRM_GENERAL, HRM_PERF and HRM_AUTON respectively, reflecting the underlying component weights. Individual HRM practices with weights of at least 0.3 are presented in bold in Table 4. HRM_PERF has high weights accorded to individual performance reviews and performance pay; HRM_AUTON has high weights on autonomy to contact suppliers, and to identify problems and suggest improvements to product quality. By contrast, HRM_GENERAL has a wide spread of weights.

In our results section we focus on the three HRM principal components, plus a smaller subset of individual HRM practices, specifically SUPPLY_AUTON, PERF_REVIEWS, PERF_PAY and TRAINING. Prior studies suggest that these practices may be particularly important for firm performance.[11] To control for general business practices, we similarly construct a set of twenty-two principal components (labelled "General Factors") from a set of non-HRM business practices spanning a wide range of topics.[12] Appendix A lists the questions that form the general factors. We do not seek to separately interpret results for these controls, rather only reporting whether these general business factors are jointly significant and the impact their inclusion has on our estimation of the effect of HRM practices on firm performance.

To complement the management survey data, we use longitudinal firm performance data sourced from the prototype Longitudinal Business Database (LBD). The LBD was recently developed by Statistics New Zealand and is largely derived from administrative data held by government departments.[13] The core administrative data on the LBD is linked to the Longitudinal Business Frame (LBF) and this paper makes use of goods and services tax (GST) returns and financial accounts (IR10) provided by the Inland Revenue Department (IRD); and information on employers and employees aggregated to the firm level (sourced from IRD via LEED). Aside from this administrative data, SNZ's Annual Enterprise Survey (AES) is used in the construction of productivity measures. These component elements of the LBD are briefly discussed below.[14]

As its name suggests, the LBF is a by-product of SNZ's sampling frame (the Business Frame, BF) and contains longitudinal information (eg, industry, ownership type, and sector) on a comprehensive population of firms.[15] The BF tracks legal units over time – rather than firms

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[10] These three factors capture 64% of the variation in the underlying variables.

[11] The literature tends to focus on general autonomy of operation of staff, rather than particularly in relation to supplier relationships. We pick SUPPLY_AUTON as a proxy for this broader concept, over QUAL_AUTON because of their relative weights in HRM_AUTON.

[12] The general business factors capture 91% of the variation in the underlying variables.

[13] The principles underlying the construction of the database were subject to international peer review by national statistical office representatives from Australia, the United Kingdom and the United States (see Blanchette, Jarmin and Ritchie 2006).

[14] See Fabling *et al.* (2008) for a more detailed description of the full contents of the LBD.

[15] Because GST data is used to help maintain the BF for small firms, there exists a natural floor (the mandatory GST filing threshold at NZ$40,000 GST sales) below which coverage of the database is limited. While many firms choose to file despite being below this threshold, they are not coded to industry by SNZ unless they have exceeded this level at some point.

– so that there is a certain level of false entry and exit in the firm data.[16] For cross-sectional sampling of firms this presents no issues, however our results rely on our ability to construct a panel. Fortunately, in the LBF, SNZ goes to great effort to repair plant-level links using, among other things, individual worker employment patterns to identify continuing plants (Kelly 2003). The identified plant-level links in turn suggest many candidate firm-level repairs (Fabling 2007). This is the first research paper using New Zealand data that makes use of longitudinal plant identifiers to correct false entry and exit at the firm-level – an approach that yields an additional 84 firms for the panel analysis.[17]

GST data include information on sales and purchases of goods and services. In this paper, we use the Business Activity Indicator (BAI), which is derived from the raw GST data, primarily through the apportionment of group filings to individual firms.[18]

IR10 data is a set of company accounts comprising a statement of financial performance and financial position. Consequently this form contains information on sales (and other income) and purchases, as well as a detailed breakdown of expenditure including depreciation, research and development, and salaries and wages. Balance sheet items include fixed assets (broken into vehicles; plant and machinery; furniture and fittings; land and buildings; and other), liabilities broken into current and term, and shareholders funds.

AES is SNZ's primary data source for the production of National Accounts, and as such is the benchmark dataset for estimation of value-added. The survey is full coverage for large firms with a stratified sample survey for smaller firms. It has industry-specific questions in order to accurately measure gross domestic product.

LEED data is constructed by SNZ using IRD tax data, notably Pay-As-You-Earn (PAYE) returns for employees. To protect the confidentiality of individuals, LEED variables available in the LBD dataset have been aggregated to the firm-level. Variables available in this manner include counts of employers (on an annual basis) and employees (on a monthly basis) with matching data on income gained from employment within the firm.[19] Summary characteristics of individuals also include gender and age breakdowns, tenure distributions of employees,[20] and summary measures of the dispersion of wages within the firm.[21] Accessions and separations are summarised at the firm level and are sourced from data underlying official statistics that adjusts for "transitory" employment.

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[16] For example a partnership that decides to become a limited liability company will be ceased on the BF and a new firm (and unique identifier) issued to the company, despite the lack of any change to activity, location or ownership.

[17] This is a significant proportion of the total panel size, and so it is important to have confidence in the quality of the repaired links. A list of potential repairs was constructed using a rule based on at least one plant moving from a BPS firm to a BOS firm. Because of the small pool of candidates, it was possible to then manually use business name, location, industry, and contact person details, together with analysis of other plant and employment movement to eliminate false positives from the simple match.

[18] GST data is collected on a monthly, bi-monthly or six-monthly basis by IRD, depending on the size of the firm filing, so that BAI processing also temporally apportions down to a monthly frequency. However, since we re-aggregate to the financial year, we unwind this apportionment (IRD recommends that firms choose a GST filing cycle in keeping with their financial year).

[19] All sub-annual data (BAI, LEED employee data) has been annualised to each firm's financial year since BOS responses relate in part to financial years.

[20] We use accessions and separation in this paper, because tenure data is heavily left-censored in early years.

[21] Initially, this paper also looked at whether HRM practices had an effect on the distribution of within-firm wages, however, there was no apparent effect and the results have been dropped. This non-result may be a consequence of the fact that the income distribution in NZ has not changed much over the estimation period (Hyslop and Yahanpath 2006).

This paper focuses on a small number of "performance" variables derivable from the above sources, namely multi-factor productivity (based on a Cobb Douglas production function with potentially non-constant returns to scale); labour productivity; log of the average wage; "excess" employee turnover; and an average "worker fixed effect", measuring worker quality. Figure 1 illustrates how the performance data is linked to business practice data. All performance metrics, aside from employee turnover, are estimated by aggregating over two consecutive years to reduce potential measurement error.[22] Linking of the firm performance data causes us to lose some observations because we require firms to be active in each of the pair of years,[23] and because we do not impute missing data. All performance metrics used in this paper make use of the universe of firms in the economy that meet the population criteria for the survey and have data available. For the productivity variables we make use of all employing firms to estimate industry-specific production functions (over 315,000 observations). For worker-related metrics, we restrict the population to firms with at least six employees as these measures are likely to be particularly noisy at very low employment levels (resulting in roughly 57,000 observations). A detailed explanation of the construction of each of these variables is left to Appendix B.

4 Results

4.1 Estimation approach

In discussing our results, we focus on two sets of estimates – population-weighted pooled cross-sections with industry dummies, and unweighted fixed effects panel estimates.[24] In both cases we estimate models implied by our framework in Section 2 with and without general business factors.[25] In the interpretation, we focus primarily on the whole economy panel results incorporating general business factors, using the HRM principal components as our preferred measure of organizational practices. We concentrate on the principal components measures since these represent bundles of practices (in keeping with the existing literature) and each represents an intuitive grouping. Inclusion of the twenty-two general factors in the equation means that we are controlling for a wide array of non-HRM management practices, some of which may be correlated with the high-performance work practices in our HRM principal components. Thus our test of the importance of HRM practices for firm performance is likely, if anything, to understate the significance of the HRM variables.[26]

The manufacturing sub-sample and individual practice results are used to aid explanation of the HRM principal components, and to make connections to the existing literature which is largely based around manufacturers. Similarly, the cross-section results provide us with some context as to why some changes in practice seem to matter and others do not.

[22] We are restricted to using two years by the absence of employment data prior to 2000.

[23] "Economically active" firms have observed output, purchases of inputs or factors of production, specifically: positive employee count or PAYE salaries and wages; positive BAI sales or purchases; and/or positive IR10 total income, total expenditure or total fixed assets.

[24] We also conduct unweighted OLS on the balanced panel to give us a bridge between interpreting the whole economy OLS results and the panel fixed effects results (ie, to verify that the panel is similar to the whole economy).

[25] We use all available observations in both cases. This means that we estimate the model with general factors on a smaller sample of firms (that is, there are firms that answer all HRM questions but fail to respond to at least one of the general factor index questions). There is no indication that this should introduce any bias into this set of results.

[26] The general factors are generally highly jointly significant in the cross-section estimates, with variable importance in the panel estimates.

To recap Section 2, our model predicts that adoption of high-performance work practices should lead to an increase in productivity, higher average wage for the firm and higher quality workers. Both the improved practices and the associated increase in wages are expected to decrease employee turnover. Overall, our panel results appear consistent with these predictions. Firms that adopt high-performance work practices experience higher growth in productivity, both MFP and labour, and average wages.

Table 6, 8, 10 and 12 contain the estimates from our fixed effects regressions, while Tables 5, 7, 9, 11 and 13 capture the results of the pooled cross-section estimates. There are commonalities to the set-up of the tables. In particular, regressions are replicated with and without general factors, with estimates excluding these factors appearing on the left labelled with "a" and those including them are labelled "b". In the cross-section columns one through three all include HRM principal components and vary in the sample that they are estimated on, namely the full (weighted) population (column "1"); the (unweighted) balanced panel ("2"); and the (weighted) manufacturing sub-population ("3"). Columns four through seven are all estimated on the full (weighted) population, but including specific individual HRM practices rather than our constructed indexes. The fixed effects regressions follow the same numbering convention.[27]

4.2 Firm productivity

Focussing on Column (1b) of Tables 6 and 8, where we include our HRM principal components and control for general business practices, our principal component measuring general HRM practices is significantly positive for both productivity measures. These coefficients are interpreted as the percentage change in relative (to industry average) performance, so that a coefficient of 0.089 suggests improving HRM_GENERAL by 1 will raise relative MFP and labour productivity by 8.9%.

As well as being statistically significant, this effect is also economically significant. If we segment firms in the panel into four quartiles based on their change in HRM_GENERAL, then the quartile of firms with the highest positive change in this index started with relatively low productivity in 2001 (on average). This is what we might expect to see – relatively poor performing firms making large changes to HRM practices in an attempt to close the performance gap – better performing firms see no need to change.[28] However, the gap in average initial MFP between this quartile of firms and the next two quartiles of HRM practice change is only around 3%. While these means levels are not significantly different from each other, it is suggestive of the potential for adoption of high-performance practices to raise productivity above the average. Firms in the high-change quartile raise their index score by at least 0.48, and on average 0.97 implying an MFP increase of 4.4% or 8.9% respectively. Using the principal component factor weights in Table 4, a change in the index of this scale would require the adoption of at least three of our HRM practices.

Perhaps somewhat perplexing, given the strong panel results, is the fact that HRM_GENERAL is not significantly related to multi-factor productivity in the cross-section

[27] That is "a" columns exclude general factors, "b" columns include them; column one and two include HRM principal components and differ in the sample (column one being full economy, and column two manufacturing), while columns three through six look at specific individual practices.

[28] Some work suggests that a performance crisis, raising the potential of plant closure, may be a useful management tool for securing employee agreement to radical reengineering of HRM systems (Ichniowski & Shaw 1995).

(Table 5, columns 1a, 2a, 1b and 2b).[29] We present two pieces of evidence that suggest this might be due to threshold effects (ie, non-linearity in the relationship). Firstly, if we return to our quartile breakdown of changes in HRM_GENERAL, the quartile of firms with the greatest negative change in practices have the lowest initial average MFP. Because of the construction of the index, these firms must have had relatively "good" HRM practices in 2001. Why are they weak performers and why do they stop doing something that should be aiding their performance? Both these observations would occur if the high-performance work practices only worked as a suite. In this case, firms with quite high index scores but not the right combination of practices might sensibly drop these practices as having no apparent benefit.

Our second piece of evidence is presented in the top left panel of Figure 2. This chart shows the result of locally-weighted regressions consistent with Table 6, column (2b) (that is, we have partialled out the effect of change in other HRM principal components and the general business factors). Below average changes in HRM_GENERAL, on average, have no effect on MFP while above average changes have a very strong effect. Rerunning our regression on the subset of firms that chose to improve their HRM practices, the estimated effect of HRM_GENERAL on MFP rises to 17% (significant at the 10% level). While it appears that many firms can reasonably drop their existing practices without a consequent cost on performance, those that get the mix of practices right have the potential to leapfrog their competitors.

4.3 Worker outcomes

Turning to the effect on workers, in the cross-section we find a very strong relationship between having better HRM practices and paying higher average wages (Table 9, column 1(a), 1(b)). In the panel (Table 10), there is consistent evidence that firms that introduce performance pay systems have higher growth in average wages. These results provide a useful context for interpreting the productivity effect. As noted earlier, performance pay might raise firm productivity, but rents are likely to be distributed between workers and owners of capital. Further, increased worker productivity may arise from either sorting of better workers into firms that reward better performance, and/or it may come from existing workers being stimulated to provide more effort (Lazear 2000).

Unfortunately, we do not have a longitudinal measure of worker quality in our dataset. However, we can observe the effect of changes in practices on worker turnover (a prerequisite for a substantial sorting effect). We find that the introduction of better work practices (HRM_GENERAL) reduces employee turnover (Table 12, column (1b)). In particular, adopting performance pay systems reduces turnover rates by roughly 4% (column 5(b)). Of course, this result would be a natural consequence of adopting high-performance work practices <u>after</u> an initial sorting period has occurred. Figure 3 suggests that, on average, adopters of performance pay systems experience an increase in their employee turnover (relative to industry average), so that it may be the case that sorting is important. The overall effect of changing performance pay practices is identified from the fact that firms that drop performance-related compensation method suffer a substantial increase in employee turnover. Overall our estimates and the data suggest that the long-run effect of adopting high-performance work systems, and especially performance pay, is to reduce employee turnover (as postulated in our model), but there may be a transition effect whereby recent adoption of such systems temporarily increases employee turnover, consistent with a sorting effect.

[29] The unweighted cross-section estimates for the balanced panel (Table 7, column 2b) suggests a potential relationship between labour productivity and HRM_GENERAL.

Up to this point we have mainly considered the "buy" option as a way of increasing human capital within the firm. There is indication in the data that the "make" option is also important. Aside from the fact that high-intensity training is a strong component of HRM_GENERAL, there is evidence that introducing high levels of TRAINING has a very strong effect on both MFP and labour productivity, ranging from 7.1-8.6% (depending on controls) in the panel estimates.

To get an overall impression of the role of human capital (either "make" or "buy") we make use of worker fixed effects estimates from Maré and Hyslop (2008). These results are only presented in the cross-section since the worker fixed effects are estimated across all years, making any interpretation of panel results impossible. Our worker fixed effects results here provide context particularly for the cross-sectional average wage results in Table 9. Both that table and Table 13 show consistently positive relationships between bundles of HRM practices, individual practices and performance. It appears that firms with good HRM practices pay higher wages and at least a good portion of this effect is because well-organized firms have better workers, either because they have practices that reward success (and therefore attract better individuals) or because the management practices adopted improve the (potentially workplace-specific) skills of employees.

In general, our manufacturing sub-industry estimates (columns 3(a) and 3(b) in cross-section, and columns 2(a) and 2(b) in panel tables) are consistent with our full economy estimates. If anything, our results are stronger for this section of the economy, perhaps reflective of the nature of the management model reflected in the survey. The panel relationship between productivity growth and HRM_GENERAL is approximately twice as strong for manufacturers (bearing in mind that these effects are all relative to two-digit industry), while the average wage and employee turnover results are consistently significant in the panel estimate.

Before concluding, we consider one alternative interpretation of our HRM results. Because labour is measured as an employee count, the productivity effect we observe may partly come from high-performance work practices encouraging employees to work longer hours. As with worker quality, we have no longitudinal measure of hours worked in the data, however we do have an estimate of total hours worked in 2005 (from BOS).[30] Table 14 presents an extension of our model by replacing the log average wage with the log average hourly wage (the common sample estimate for log average wage is included in column 1(a) and 1(b) for comparison). Bearing in mind that our hourly wage variable is measured with error, these results (columns 2a/2b) suggest that some, but not all, of the average wage effect is potentially caused by longer working hours. However, even in these estimates, the hourly wage effect accounts for fully a third to a quarter of the overall average wage effect. These results are consistent with our earlier interpretation that introducing high-performance work practices has a positive effect on staff retention at least partly because workers benefit from consequential productivity gains.

[30] Some respondents to the survey had trouble answering this question and in particular supplied average rather than total hours worked. As a consequence, we restrict this analysis to firms reporting total hours worked that is consistent with a minimum implied by their reported full-time staff, and further drop the top and bottom 5% of derived hourly wage rates as potentially being unreliable.

5 Conclusions

This paper has looked at the role personnel practices play in determining performance differences across firms. The availability of a uniquely rich panel dataset has allowed us to examine this issue in a way that extends the existing literature.[31] The strengths of the data include extensive controls for non-HRM practices within the firm, a relatively long time period between observations of business practices, a large panel (over 1,500 firms), a wide cross-section of industries with a low employment cut-off, access to the universe of administrative performance data covering both firm and worker outcomes.

Following the existing literature, we model the effect of high-performance work practices as linear, and test the importance of a suite of practices using principal components to combine discrete practices into indices. Our three resulting principal components have intuitive interpretations as representing "good" broad HRM practices, performance measurement and reward, and the degree of employee autonomy. After controlling for general (non-HRM) business practices and firm fixed effects, we find that changing the broad suite of HRM practices has a strong effect on firm performance in terms of raising productivity, better staff retention and higher average human capital in workers. These effects are economically large, with MFP increases of at least 4% for firms in the upper quartile of positive change in the suite of practices. Workers also share in the productivity gains, receiving higher average wages. This may reflect increased on-the-job training and greater job security encouraging higher investment in firm-specific skills. Although we estimate a drop in employee turnover from adopting high-performance work practices, it is possible that sorting of higher-quality workers into firms with good HRM practices is a mechanism through which firms secure higher quality (better paid) workers.[32]

We have interpreted our findings as implying causal relationships and we turn now to whether that interpretation is appropriate. Our method not only controls for unchanging (fixed effect) characteristics of the firm, but also contemporaneous changes to non-HRM business practices. This makes it highly unlikely that our approach attributes the effects on performance of changes in non-personnel practices to contemporaneously adopted HRM practices, so strengthening the claim that the results imply causality. However, our estimation approach will potentially produce results that are biased if HRM practice decisions are endogenous to changes in firm performance (which are not, in turn, being driven by changes in our other controls). Several studies have explicitly focussed on the issue of what triggers radical rethinking on personnel policies (eg, Ichniowski and Shaw 1995; Nickell *et al.* 2001). Among other factors, a performance crisis can stimulate re-engineering of HRM practices, possibly because the potential loss of jobs from closure provides the necessary stimulus for managers and workers to overcome existing low-trust relationships that have made change difficult in the past (Ichniowski and Shaw 1995). Our summary of the average initial MFP of firms is consistent with this picture – firms that make large change in practices (either up or down) tend to be relatively poor performers. If negative shocks to the prospective future performance of the firm cause HRM practice changes, then we might expect our estimated fixed effects coefficients to be biased downwards. Using German linked employer-employee data, Bauer (2003) tests this hypothesis and finds that "…the effects of implementing flexible

[31] In particular, the existing New Zealand literature is based almost exclusively on cross-sectional analysis (eg, Guthrie 2001; Guthrie *et al.* 2002; Fabling and Grimes 2007a), though even within that setting some causal interpretations have been offered using instrumental variables techniques (Fabling and Grimes 2007b).

[32] Average worker turnover in New Zealand is over 10%, so that even firms with below average turnover may have sufficient scope to accommodate quite large changes in worker composition over a three year period.

workplace systems on labor productivity are biased downwards due to… the potential endogeneity of… workplace practices. The estimates further imply that the endogeneity bias is quantitatively more important than the bias resulting from omitted variables".

Another potential source of coefficient bias comes from the inability to identify exactly when HRM practice changes occurred. Our data source gives us a wide distribution of potential time intervals between high-performance work practice adoption and subsequent performance measurement, ranging from as little as one day to over three years. If, as is likely, there are lags between making changes and feeling the full impact of those changes then our results will again be biased downwards by including very recent practice changers. This possibility, together with Bauer's results, suggests our findings may well underestimate the true causal effect.

We conclude by discussing whether our modelling approach for the HRM suite and its effect could be further improved. Our method of estimating linear effects from principal component-based indices is a standard approach in this literature. However the locally-weighted regression results (Figure 2) are suggestive that a different estimation approach may further enhance insights into our research question. In particular, there are possibly non-linear threshold effects consistent with a theory that requires bundles of practices to be adopted for the desired effect to be gained. If there are practices that must be adopted together to work properly, say performance assessments and performance pay,[33] then the principal components approach will only capture this relationship in-so-far as sufficient firms have already learnt the importance of joint adoption. Alternative ways to identify whether firms are moving towards or away from an optimal (potentially industry-size-specific) mix, could feasibly come from either a more structural modelling approach (through, say, imposing stronger priors on what is important), or through non-linear estimation using the current "suites" of practices. We leave investigation of such approaches to future work.

[33] This is not tautologically the case, since performance pay need not be conditional on individual performance.

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CHARTS AND TABLES*

*All results presented here are derived by the authors from the LBD
All counts of firms are randomly rounded to base 3 for confidentiality purposes

Figure 1 – Data sources

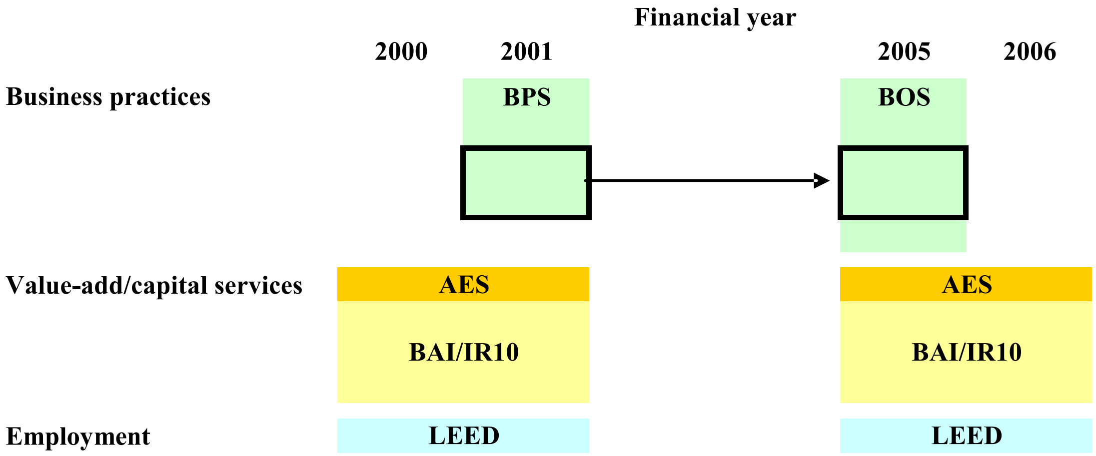
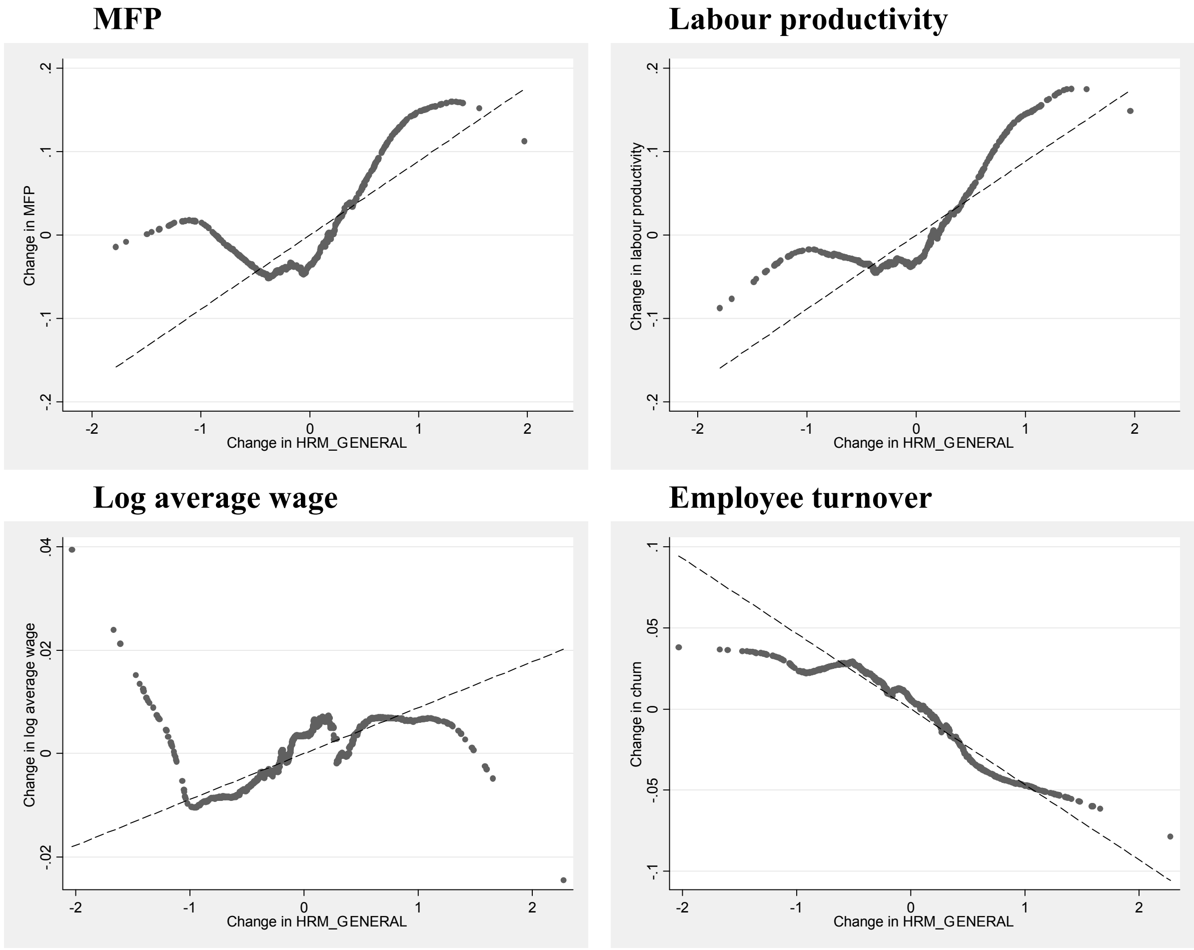


Figure 2 – Locally-weighted regression for panel results



* Stata's *lowess* procedure used with bandwidth=0.8. Change in performance metric and change in HRM_GENERAL both subject to partial regression on growth in both general business factors and the other two HRM principal components. That is, results presented are consistent with the estimated HRM_GENERAL coefficient in column (1b) of each panel table (those estimated linear relationships are included as dashed line).

Figure 3 – Mean employee turnover relative to industry average by change in PERF_PAY

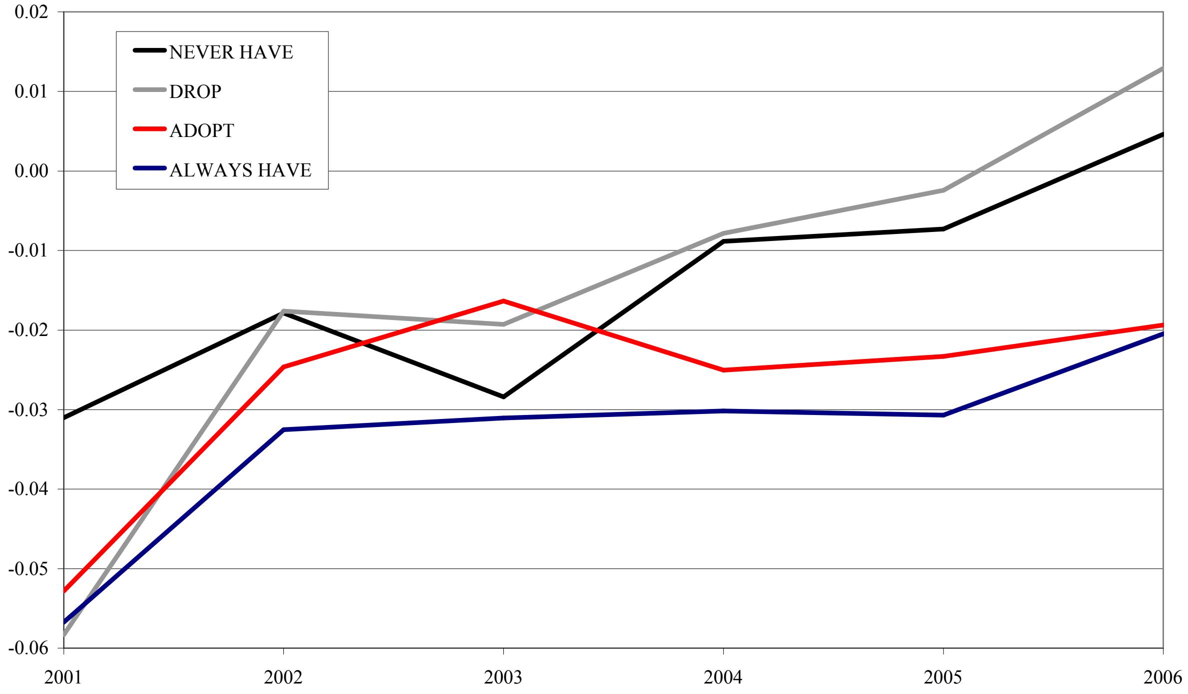


Table 1 – Observations by industry and year

Industry (ANZSIC Division)	N(2001)	N(2005)	N(Panel)
A - Agriculture, forestry and fishing	285	870	123
B- Mining	45	60	30
C - Manufacturing	936	1,626	492
D- Electricity, gas and water	0	15	0
E - Construction	96	429	51
F- Wholesale trade	267	636	168
G - Retail trade	126	468	81
H - Accommodation, cafes and restaurants	132	270	57
I - Transport and storage	114	393	72
J - Communication services	54	111	30
K - Finance and insurance	159	399	102
L - Property and business services	300	1,497	171
N - Education	63	189	48
O - Health and community services	120	426	69
P - Cultural and recreational services	60	246	36
TOTAL	**2,757**	**7,635**	**1,530**

* Firms in the panel are classified by their 2005 industry

Table 2 – HRM practice questions and means

Variable	Question (BOS)	Responses	m(01)	m(05)
CONSULT	*In developing goals, how often does this business incorporate the requirements of employees?* *(4-point scale + "don't know")*	*"Never", "Sometimes", Frequently"=0* *"Always"=1*	0.372	0.308
VALUES	*To what extent does this business promote a set of company values to its employees?* *(4-point scale + "don't know")*	*"Not at all", "A little amount", "A moderate amount"=0* *"A great deal"=1*	0.456	0.453
SUPPLY_AUTON	*When supply problems arise, do this business's non-managerial staff have the authority to contact external suppliers?* *(3-point scale + "don't know")*	*"Never", "Sometimes"=0* *"Always"=1*	0.301	0.248
FIRM_HR_PERF	*During the last two financial years, to what extent did this business focus on human resources (eg job satisfaction, skill development) when assessing [business] performance?* *(4-point scale + "don't know")*	*"Not at all", "A little amount"=0* *"A moderate amount", "A great deal"=1*	0.666	0.658
PERF_REVIEWS	*Over the last financial year, what percentage of employees in this business had formal performance reviews (consistent methods that are recognised and regularly used)?* *(6-point scale + "don't know")*	*"Zero"=0* *Anything else=1*	0.632	0.627
PERF_PAY	*What percentage of employees in this business are on "pay for performance" schemes (eg productivity based incentives, profit sharing, bonuses, etc)?* *(6-point scale + "don't know")*	*"Zero"=0* *Anything else=1*	0.431	0.409
TRAINING	*Over the last financial year, please estimate the percentage of employees in this business who participated in training* *(5-point scale + "don't know")*	*≤ 50% of staff trained=0* *>50% of staff trained=1*	0.472	0.395
QUAL_AUTON	*Are non-managerial staff actively encouraged to identify problems in goods, services or processes?* *Are non-managerial staff actively encouraged to suggest improvements to goods, services or processes?* *(4-point scales + "don't know")*	*"Not at all", "A little amount", "A moderate amount"=0* *"A great deal"=1*	0.598	0.711

* Population-weighted means excluding "don't know" and missing responses

Table 3 – HRM practice transitions in the panel

Variable	Adopted	Dropped	Unchanged
CONSULT	0.140	0.246	0.615
VALUES	0.195	0.165	0.640
SUPPLY_AUTON	0.146	0.181	0.673
FIRM_HR_PERF	0.193	0.162	0.646
PERF_REVIEWS	0.113	0.089	0.798
PERF_PAY	0.132	0.111	0.757
TRAINING	0.157	0.196	0.648
QUAL_AUTON	0.247	0.134	0.620

* Unweighted ("don't know" and missing responses excluded)

Table 4 – HRM principal component weights

Variable	HRM_GENERAL	HRM_PERF	HRM_AUTON
CONSULT	**0.347**	-0.264	-0.157
VALUES	**0.435**	-0.213	-0.090
SUPPLY_AUTON	0.175	0.180	**0.847**
FIRM_HR_PERF	**0.452**	-0.183	-0.195
PERF_REVIEWS	**0.369**	**0.446**	-0.279
PERF_PAY	0.181	**0.759**	-0.068
TRAINING	**0.349**	0.048	0.006
QUAL_AUTON	**0.406**	-0.205	**0.360**

* Principal components calculated using tetrachoric correlation matrices with population-weights ("don't know" and missing responses excluded on a pairwise basis)

Table 5 – MFP cross-section results (pooled OLS)

	Without General Factors							With General Factors						
	(1a)	(2a)	(3a)	(4a)	(5a)	(6a)	(7a)	(1b)	(2b)	(3b)	(4b)	(5b)	(6b)	(7b)
HRM_GENERAL	-0.016 [0.449]	-0.003 [0.915]	-0.050 [0.101]					0.032 [0.221]	0.059 [0.112]	-0.022 [0.570]				
HRM_PERF	0.019 [0.476]	-0.007 [0.836]	-0.066 [0.159]					0.028 [0.321]	0.036 [0.376]	-0.030 [0.520]				
HRM_AUTON	0.075** [0.033]	0.104*** [0.003]	0.039 [0.450]					0.034 [0.330]	0.084** [0.034]	0.034 [0.499]				
SUPPLY_AUTON				0.063** [0.050]							0.059* [0.078]			
PERF_REVIEWS					-0.055* [0.052]							0.003 [0.921]		
PERF_PAY						0.011 [0.689]							0.019 [0.512]	
TRAINING							-0.012 [0.671]							0.030 [0.281]
OBS	5475	1218	1464	6312	6315	6453	6360	4992	1008	1362	5508	5490	5574	5523
R^2	0.045	0.124	0.020	0.037	0.042	0.037	0.038	0.057	0.145	0.052	0.051	0.053	0.051	0.052
PC joint test	0.128	0.030	0.032					0.356	0.090	0.711				
GF joint test								0.019	0.024	0.568	0.014	0.038	0.014	0.006

* All estimates are population weighted taking account of survey stratification, include all firms with available data and control for 2-digit (ANZSIC) industry as described in Appendix B, except columns 2(a/b) which only includes the balanced panel sub-sample (and is unweighted); and columns 3(a/b) which is only estimated on the manufacturing sub-sample. Robust p-values in brackets: ***=1%, **=5%, *=10% significance level.

Table 6 – MFP panel results (fixed effects)

	Without General Factors						With General Factors					
	(1a)	(2a)	(3a)	(4a)	(5a)	(6a)	(1b)	(2b)	(3b)	(4b)	(5b)	(6b)
HRM_GENERAL	0.062* [0.069]	0.149*** [0.003]					0.089** [0.050]	0.186*** [0.008]				
HRM_PERF	0.006 [0.900]	0.052 [0.457]					0.054 [0.372]	0.096 [0.214]				
HRM_AUTON	0.018 [0.688]	0.059 [0.192]					-0.01 [0.839]	0.025 [0.662]				
SUPPLY_AUTON			0.047 [0.245]						0.021 [0.658]			
PERF_REVIEWS				-0.05 [0.362]						-0.026 [0.692]		
PERF_PAY					0.049 [0.241]						0.073 [0.166]	
TRAINING						0.071** [0.037]						0.079** [0.045]
OBS	609	207	738	753	780	741	504	177	573	579	594	576
R^2	0.007	0.049	0.002	0.001	0.002	0.006	0.071	0.231	0.051	0.052	0.052	0.059
PC joint test	0.280	0.002					0.232	0.011				
GF joint test							0.143	0.039	0.246	0.164	0.129	0.126

* Estimates are unweighted and include all firms with available data, except columns 2(a/b) which is only estimated on the manufacturing sub-sample. Robust p-values in brackets: ***=1%, **=5%, *=10% significance level.

Table 7 – Labour productivity cross-section results (pooled OLS)

	Without General Factors							With General Factors						
	(1a)	(2a)	(3a)	(4a)	(5a)	(6a)	(7a)	(1b)	(2b)	(3b)	(4b)	(5b)	(6b)	(7b)
HRM_GENERAL	-0.004 [0.885]	0.065* [0.053]	0.010 [0.768]					0.029 [0.332]	0.120*** [0.005]	0.019 [0.653]				
HRM_PERF	0.105*** [0.001]	0.078* [0.054]	0.059 [0.222]					0.091*** [0.009]	0.090* [0.067]	0.048 [0.326]				
HRM_AUTON	0.06 [0.109]	0.100** [0.024]	0.045 [0.402]					0.042 [0.273]	0.090* [0.078]	0.058 [0.281]				
SUPPLY_AUTON				0.087** [0.014]							0.091** [0.016]			
PERF_REVIEWS					0.006 [0.860]							0.027 [0.485]		
PERF_PAY						0.082*** [0.006]							0.080** [0.016]	
TRAINING							0.006 [0.844]							0.029 [0.359]
OBS	5493	1224	1467	6342	6348	6486	6393	5007	1014	1365	5535	5517	5601	5553
R^2	0.079	0.163	0.028	0.07	0.073	0.072	0.071	0.084	0.178	0.057	0.075	0.077	0.075	0.073
PC joint test	0.004	0.020	0.408					0.047	0.010	0.386				
GF joint test								0.267	0.125	0.831	0.577	0.475	0.663	0.683

* All estimates are population weighted taking account of survey stratification, include all firms with available data and control for 2-digit (ANZSIC) industry as described in Appendix B, except columns 2(a/b) which only includes the balanced panel sub-sample (and is unweighted); and columns 3(a/b) which is only estimated on the manufacturing sub-sample. Robust p-values in brackets: ***=1%, **=5%, *=10% significance level.

Table 8 – Labour productivity panel results (fixed effects)

	Without General Factors						With General Factors					
	(1a)	(2a)	(3a)	(4a)	(5a)	(6a)	(1b)	(2b)	(3b)	(4b)	(5b)	(6b)
HRM_GENERAL	0.070* [0.060]	0.131** [0.027]					0.089* [0.061]	0.159** [0.034]				
HRM_PERF	0.014 [0.789]	0.058 [0.501]					0.044 [0.489]	0.082 [0.364]				
HRM_AUTON	0.038 [0.413]	0.054 [0.325]					0.019 [0.728]	0.016 [0.806]				
SUPPLY_AUTON			0.055 [0.225]						0.028 [0.589]			
PERF_REVIEWS				-0.079 [0.193]						-0.097 [0.218]		
PERF_PAY					0.029 [0.557]						0.027 [0.671]	
TRAINING						0.076** [0.030]						0.086** [0.030]
OBS	612	207	741	756	780	744	507	180	576	582	594	579
R^2	0.009	0.035	0.003	0.003	0.001	0.006	0.061	0.189	0.035	0.039	0.034	0.050
PC joint test	0.190	0.045					0.284	0.120				
GF joint test							0.225	0.069	0.627	0.426	0.545	0.237

* Estimates are unweighted and include all firms with available data, except columns 2(a/b) which is only estimated on the manufacturing sub-sample. Robust p-values in brackets: ***=1%, **=5%, *=10% significance level.

Table 9 – Log average wage cross-section results (pooled OLS)

	Without General Factors							With General Factors						
	(1a)	(2a)	(3a)	(4a)	(5a)	(6a)	(7a)	(1b)	(2b)	(3b)	(4b)	(5b)	(6b)	(7b)
HRM_GENERAL	0.064*** [0.000]	0.054*** [0.000]	0.040*** [0.002]					0.040** [0.027]	0.026 [0.168]	0.005 [0.727]				
HRM_PERF	0.167*** [0.000]	0.155*** [0.000]	0.131*** [0.000]					0.159*** [0.000]	0.145*** [0.000]	0.095*** [0.000]				
HRM_AUTON	0.021 [0.335]	0.029 [0.142]	0.032* [0.065]					0.035 [0.108]	0.040* [0.072]	0.044** [0.012]				
SUPPLY_AUTON				0.108*** [0.000]							0.095*** [0.000]			
PERF_REVIEWS					0.133*** [0.000]							0.093*** [0.000]		
PERF_PAY						0.176*** [0.000]							0.151*** [0.000]	
TRAINING							0.040** [0.030]							0.007 [0.697]
OBS	7218	1932	1968	8340	8340	8523	8400	6540	1614	1818	7209	7185	7296	7242
R^2	0.071	0.085	0.078	0.025	0.037	0.053	0.015	0.103	0.111	0.149	0.068	0.070	0.087	0.059
PC joint test	0.000	0.000	0.000					0.000	0.000	0.000				
GF joint test								0.000	0.015	0.000	0.000	0.000	0.000	0.000

* All estimates are population weighted taking account of survey stratification, include all firms with available data and control for 2-digit (ANZSIC) industry as described in Appendix B, except columns 2(a/b) which only includes the balanced panel sub-sample (and is unweighted); and columns 3(a/b) which is only estimated on the manufacturing sub-sample. Robust p-values in brackets: ***=1%, **=5%, *=10% significance level.

Table 10 – Log average wage panel results (fixed effects)

	Without General Factors						With General Factors					
	(1a)	(2a)	(3a)	(4a)	(5a)	(6a)	(1b)	(2b)	(3b)	(4b)	(5b)	(6b)
HRM_GENERAL	0.008 [0.420]	-0.007 [0.648]					0.009 [0.490]	-0.01 [0.654]				
HRM_PERF	0.019 [0.133]	0.035** [0.038]					0.031** [0.027]	0.035** [0.040]				
HRM_AUTON	0.000 [0.975]	0.016 [0.330]					-0.006 [0.615]	0.01 [0.617]				
SUPPLY_AUTON			0.001 [0.933]						-0.002 [0.847]			
PERF_REVIEWS				0.014 [0.289]						0.010 [0.544]		
PERF_PAY					0.016 [0.150]						0.033** [0.010]	
TRAINING						0.011 [0.274]						0.002 [0.872]
OBS	966	342	1209	1212	1251	1200	807	300	927	927	948	927
R^2	0.002	0.014	0.000	0.001	0.001	0.001	0.033	0.116	0.024	0.023	0.027	0.023
PC joint test	0.379	0.133					0.102	0.187				
GF joint test							0.307	0.177	0.305	0.409	0.379	0.412

* Estimates are unweighted and include all firms with available data, except columns 2(a/b) which is only estimated on the manufacturing sub-sample. Robust p-values in brackets: ***=1%, **=5%, *=10% significance level.

Table 11 – Employee turnover cross-section results (pooled OLS)

	Without General Factors							With General Factors						
	(1a)	(2a)	(3a)	(4a)	(5a)	(6a)	(7a)	(1b)	(2b)	(3b)	(4b)	(5b)	(6b)	(7b)
HRM_GENERAL	-0.012 [0.209]	-0.030*** [0.000]	-0.034*** [0.007]					-0.004 [0.720]	-0.031*** [0.006]	-0.019 [0.145]				
HRM_PERF	0.002 [0.897]	-0.034*** [0.006]	-0.003 [0.854]					0.000 [0.979]	-0.033** [0.020]	0.001 [0.974]				
HRM_AUTON	-0.032** [0.018]	-0.004 [0.703]	-0.021 [0.226]					-0.030** [0.030]	-0.005 [0.717]	-0.029* [0.097]				
SUPPLY_AUTON				-0.036*** [0.008]							-0.030** [0.032]			
PERF_REVIEWS					0.001 [0.911]							0.019 [0.192]		
PERF_PAY						-0.003 [0.765]							-0.002 [0.896]	
TRAINING							-0.015 [0.212]							-0.012 [0.340]
OBS	7215	1932	1968	8337	8337	8520	8397	6537	1608	1818	7206	7182	7293	7239
R^2	0.019	0.044	0.020	0.013	0.011	0.010	0.011	0.034	0.070	0.069	0.030	0.027	0.027	0.028
PC joint test	0.071	0.000	0.005					0.182	0.007	0.061				
GF joint test								0.047	0.137	0.005	0.052	0.113	0.063	0.062

* All estimates are population weighted taking account of survey stratification, include all firms with available data and control for 2-digit (ANZSIC) industry as described in Appendix B, except columns 2(a/b) which only includes the balanced panel sub-sample (and is unweighted); and columns 3(a/b) which is only estimated on the manufacturing sub-sample. Robust p-values in brackets: ***=1%, **=5%, *=10% significance level.

Table 12 – Employee turnover panel results (fixed effects)

	Without General Factors						With General Factors					
	(1a)	(2a)	(3a)	(4a)	(5a)	(6a)	(1b)	(2b)	(3b)	(4b)	(5b)	(6b)
HRM_GENERAL	-0.054*** [0.000]	-0.052*** [0.002]					-0.046*** [0.001]	-0.055*** [0.003]				
HRM_PERF	-0.024 [0.227]	-0.055** [0.015]					-0.027 [0.185]	-0.047** [0.033]				
HRM_AUTON	0.027* [0.076]	0.051** [0.011]					0.019 [0.240]	0.060*** [0.003]				
SUPPLY_AUTON			0.011 [0.435]						0.009 [0.540]			
PERF_REVIEWS				-0.042** [0.018]						-0.016 [0.399]		
PERF_PAY					-0.041** [0.035]						-0.044** [0.030]	
TRAINING						-0.028** [0.045]						-0.019 [0.231]
OBS	966	342	1206	1212	1251	1200	804	300	927	927	948	927
R^2	0.019	0.045	0.000	0.004	0.005	0.003	0.057	0.144	0.035	0.037	0.041	0.040
PC joint test	0.000	0.002					0.005	0.000				
GF joint test							0.012	0.132	0.015	0.012	0.016	0.008

* Estimates are unweighted and include all firms with available data, except columns 2(a/b) which is only estimated on the manufacturing sub-sample. Robust p-values in brackets: ***=1%, **=5%, *=10% significance level.

Table 13 – Average worker fixed effect cross-section results (pooled OLS)

	Without General Factors							With General Factors						
	(1a)	(2a)	(3a)	(4a)	(5a)	(6a)	(7a)	(1b)	(2b)	(3b)	(4b)	(5b)	(6b)	(7b)
HRM_GENERAL	0.036*** [0.001]	0.048*** [0.000]	0.021* [0.084]					0.025* [0.051]	0.037** [0.011]	0.01 [0.508]				
HRM_PERF	0.108*** [0.000]	0.099*** [0.000]	0.061*** [0.000]					0.102*** [0.000]	0.103*** [0.000]	0.037** [0.012]				
HRM_AUTON	0.031** [0.032]	0.028* [0.061]	0.035** [0.042]					0.036** [0.019]	0.027 [0.107]	0.046*** [0.006]				
SUPPLY_AUTON				0.066*** [0.000]							0.064*** [0.000]			
PERF_REVIEWS					0.070*** [0.000]							0.043*** [0.008]		
PERF_PAY						0.116*** [0.000]							0.109*** [0.000]	
TRAINING							0.036*** [0.007]							0.019 [0.148]
OBS	7215	1932	1968	8340	8337	8520	8400	6537	1608	1818	7212	7185	7296	7239
R^2	0.055	0.088	0.030	0.019	0.022	0.042	0.015	0.080	0.121	0.062	0.052	0.052	0.071	0.047
PC joint test	0.000	0.000	0.000					0.000	0.000	0.002				
GF joint test								0.002	0.061	0.013	0.000	0.000	0.011	0.000

* All estimates are population weighted taking account of survey stratification, include all firms with available data and control for 2-digit (ANZSIC) industry as described in Appendix B, except columns 2(a/b) which only includes the balanced panel sub-sample (and is unweighted); and columns 3(a/b) which is only estimated on the manufacturing sub-sample. Robust p-values in brackets: ***=1%, **=5%, *=10% significance level.

Table 14 – Log average hours wage comparison (BOS cross-section only)

	Log average wage		Log average hourly wage	
	(1a)	(1b)	(2a)	(2b)
HRM_GENERAL	0.082*** [0.003]		-0.006 [0.748]	
HRM_PERF	0.162*** [0.000]		0.054*** [0.005]	
HRM_AUTON	0.055** [0.015]		0.064*** [0.003]	
PERF_PAY		0.146*** [0.000]		0.036* [0.066]
OBS	3435	3861	3435	3861
R^2	0.119	0.089	0.221	0.217
PC joint test	0.000		0.001	
GF joint test	0.003	0.000	0.036	0.167

* All estimates are population weighted taking account of survey stratification, include all firms with available data (common sample applied across corresponding a-b pair) and include 2-digit (ANZSIC) industry dummies as described in Appendix B and general business factors Robust p-values in brackets (***=1%, **=5%, *=10% significance level).

APPENDIX A: GENERAL MANAGEMENT PRACTICE VARIABLES

The general factors are principal components (tetrachoric correlations) constructed from binary response categories to a wide range of survey questions outside of HRM. Only factors with eigenvalues greater than one are retained, yielding twenty-two variables to act as controls for general business practices. The following questions were used in the construction of the factors (BOS 2005 wording):[34]

Strategy and goals

- How important are the following to the strategies of this business: pricing of products; quality of products; flexibility/ability to make changes; delivery of products; innovation (5 questions, 4-point scale + “don’t know”)
- During the last two financial years, to what extent did this business focus on existing domestic markets? (4-point scale + “don’t know”)
- Does this business have a clear vision or mission for the future? (yes/no)

Customers

- Does this business have set procedures (consistent methods that staff know and adhere to) for dealing with customer complaints? (yes/no)
- To what extent do staff, other than sales and marketing staff, have contact with major customers? (4-point scale + “don’t know”)
- How closely does this business work with customers to develop or improve products? (4-point scale + “don’t know”)

Information and benchmarking

- Does this business have a formal system in place to manage the storing and retrieving of information? (yes/no)
- Is it part of the regular work of one or more people (either staff or outside contractors) to assess whether this business is achieving its goals? (yes/no/not applicable)
- During the last two financial years, to what extent did this business focus on the following when assessing performance: financial measures; cost measures; quality measures (3 questions, 4-point scale + “don’t know”)
- During the last two financial years, has the performance or processes of this business been compared in a systematic way to businesses: in the same industry; in different industries; within New Zealand; overseas (4 questions, 4-point scale + “don’t know”)
- How closely does this business monitor competitors’ products? (4-point scale + “don’t know”)

Employee practices

- Does this business have processes in place to manage health and safety? (yes/no)

Quality and process

- Does this business have quality management systems certification? (yes/no)
- Does this business have measures in place to reduce the environmental impact of this business? (yes/no)

[34] In a small number of cases some grouping of responses was required to achieve a consistent categorisation across years. A small number of consistently-measured business practice variables have also been dropped where the question response rate (accounting for “don’t know” responses) would have seriously reduced the number of observations of general business factors.

APPENDIX B: CONSTRUCTION OF PERFORMANCE METRICS

Productivity variables

MFP is calculated by way of OLS regression assuming a Cobb-Douglas production function in labour and capital with industry-year-specific coefficients (almost exclusively at the two-digit ANZSIC level), and the potential for non-constant returns to scale.

$$\ln(Y_{it}) = \ln(aL_{it}) + \ln(bK_{it}) + \mathbf{A} + \varepsilon_{it} \qquad t=2000/01,2005/06 \qquad \text{(A1)}$$

MFP is the residual of this estimation, that is, MFP= ε_{it}. To estimate this production function we must construct measures of value-added (Y), labour (L) and capital services (K). Each of these data is discussed in turn.

Value-added is defined as gross output less intermediate consumption. Our first choice is to source value-added from the Annual Enterprise Survey. This data relies on industry-specific survey questions to construct value-added of a sufficient quality to be acceptable for National Accounts purposes. In our dataset, observations sourced from postal AES returns account for 5% of observations, but 49% of total employment reflecting a sampling strategy consistent with estimating GDP accurately. In the absence of AES observations, we make use of administrative tax data to construct:

$$Y = \text{sales} - (\text{purchases} - \Delta\text{stocks}) \qquad \text{(A2)}$$

where sales and purchases are sourced from the BAI and changes in stocks are sourced from IR10s.[35]

The labour input measure is sourced from LEED and is the sum of two components: employees and working proprietors. The first of these is the annual average number of employees drawing a PAYE wage as at the 15th of each month (ie, a rolling mean employment or RME). Working proprietor counts come from various tax sources, which are generally collected annually in line with the firm's financial year. The lack of a more refined estimate of working proprietor labour input is particularly problematic to the estimation of labour input for firms that are starting up or ceasing. We assume that working proprietors work half of the year in such cases, however, to be cautious, we exclude observations of entering and exiting firms from our estimation of MFP coefficients.[36,37]

In common with many other datasets, construction of a useable capital services measure is the most taxing research task. Capital services data come from the same source as value-added – that is, either AES or IR10 – and is calculated as the sum of rental and leasing costs, together with depreciation and a cost-of-capital charge for owned assets. The first of these is observed directly in IR10s, but not collected separately in AES. To cope with this, rental cost as a proportion of other expenses are estimated from IR10s as an industry-year-specific function of depreciation costs and fixed asset holdings. Estimated rental cost shares are then applied to

35 While IR10 data contains information on sales and purchases, a mixed tax source approach is preferred because of analysis suggesting that IR10 purchases are systematically under-reported (Cox 2006).

36 A robustness check suggests that including these firms doesn't affect estimated coefficients.

37 Almost by construction, very few firms in our panel are likely to be affected by this issue because: (a) the working proprietor component of the total labour is likely to be small; and (b) very few panel firms either enter in 2000 or exit in 2006.

AES other expenses, except in cases where a firm has both an AES form and an IR10, in which case the firms actual rental cost share from their IR10 is applied to the AES data.[38]

Depreciation costs are collected directly in both AES and IR10s, which just leaves the estimation of the cost-of-capital component. We use a constant year-specific interest rate for all firms, being a "risk-adjusted" four percentage points over the annual average 90 day borrowing rate.[39] This interest rate is applied to the productive capital held over the period, calculated by averaging opening and closing book values of total fixed assets. Because IR10s only collect closing book values, lagged IR10 data are used as the source of opening book values. For AES, both opening and lagged closing book values may be available from the same survey form. To be consistent across data sources, preference is given to using lagged AES closing values where they exist. For both AES and IR10-based estimates, entering firms are assumed to have zero opening assets.

Regression coefficients from this calculation are shown in table A1. In aggregate, the relative contribution of labour and capital are quite consistent with macroeconomic benchmarks (a third being a ballpark figure). Some returns to scale might be described as more than "mildly" increasing but, all-in-all, these estimates look quite plausible for New Zealand. Labour productivity is calculated by the difference between log value-added and log total employment controlling for value-added data source.[40]

Worker variables

All worker variables – average wage, employee turnover and average worker fixed effect – are derived from LEED. While the log average wage is self-explanatory, the other two variables need some definition. Annual employee turnover is derived from summed quarterly estimates of worker accessions (L^A_{it}) and separations (L^S_{it}) using the following formula:

$$[(L^A_{it}+L^S_{it})-(L_{it}-L_{it-1})]/[L_{it}+L_{it-1}] \qquad t=2001, 2006 \qquad \text{(A3)}$$

That is, the measure captures the number of employees that change over and above the number required to account for the net change in employment over the year, divided by average employment across the two years. Because the source data has exceptional coverage, we treat missing employment observations as zero, provided the firm is observed to be economically active.

The average worker fixed effect is sourced from Maré and Hyslop (2008) which uses a variant of the Abowd *et al.* (2002) methodology to estimate the unobservable component of worker earnings after controlling for age and gender. We average these worker fixed effects across all workers in the firm and interpret the results as a proxy measure for human capital

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38 Because both AES and IR10-based value-added estimates treat these rental costs as purchases, the estimated rental cost is then added back into value-added.

39 For New Zealand, this cost-of-capital varies between 9.34% and 11.28% (including the risk adjustment factor). Tests with higher and lower risk adjustment factors indicated that the regression coefficients were robust to plausible variations in this assumption.

40 For both MFP and labour productivity a dummy is included to control for differences between data-sources. This dummy is positive and significant for almost all industries, indicating that AES tends to be associated with higher value-added firms. Comparison for firms that have both data sources suggests that some of this levels difference is measurement related. Initial panel estimation in the main paper also included a dummy controlling for changes in productivity industry. Very few firms change two-digit industry and inclusion of that dummy had no effect on the main estimated coefficients and so it was dropped.

differences between firms. Because the worker fixed effects are estimated over the full time period, it is not possible for us to use or interpret this variable in our panel estimation.

Table A1

Industry (2-digit ANZSIC)	a**(00/01)**	a**(05/06)**	b**(00/01)**	b**(05/06)**
A01 – Agriculture	0.799	0.797	0.503	0.465
A02 - Services to agriculture, hunting & trapping	0.940	0.990	0.234	0.223
A03 - Forestry & logging	1.060	0.972	0.273	0.285
A04 - Commercial fishing	0.463	0.590	0.454	0.389
B - Mining	0.813	0.940	0.458	0.314
C21 - Food, beverage & tobacco	0.760	0.734	0.413	0.406
C22 - Textile, clothing, footwear & leather manufacturing	0.916	0.875	0.294	0.272
C23 - Wood & paper product manufacturing	0.886	0.880	0.369	0.315
C24 - Printing, publishing & recorded media	0.681	0.788	0.493	0.384
C25 - Petroleum, coal, chemical & associated product manufacturing	0.708	0.679	0.454	0.422
C26 - Non-metallic mineral product manufacturing	0.946	0.901	0.345	0.392
C27 - Metal product manufacturing	0.962	0.891	0.256	0.282
C28 - Machinery & equipment manufacturing	0.962	0.888	0.252	0.276
C29 - Other manufacturing	0.977	0.879	0.261	0.301
E41 - General construction	1.024	1.026	0.156	0.154
E42 - Construction trade services	1.061	1.027	0.154	0.153
F45 - Basic material wholesaling	0.744	0.768	0.411	0.370
F46 - Machinery & motor vehicle wholesaling	0.765	0.713	0.402	0.425
F47 - Personal & household good wholesaling	0.719	0.699	0.439	0.398
G51- Food retailing	0.755	0.737	0.368	0.346
G52 - Personal & household good retailing	0.805	0.811	0.409	0.356
G53 - Motor vehicle retailing & services	0.866	0.857	0.330	0.318
H57 - Accommodation, cafes & restaurants	0.844	0.824	0.345	0.332
I61- Road transport	0.762	0.788	0.396	0.361
I63 - Water transport	0.715	0.706	0.504	0.309
I64 - Air & space transport	0.715	0.481	0.387	0.566
I66 - Services to transport	0.949	1.096	0.368	0.348
I67 - Storage	0.599	0.474	0.444	0.581
I62+I65 - Rail & other transport	0.532	0.658	0.529	0.319
J71 - Communication services	0.691	0.692	0.227	0.276
K73 - Finance	0.779	0.621	0.348	0.316
K74 - Insurance	0.187	0.568	0.644	0.407
K75 - Services to finance & insurance	0.793	0.796	0.248	0.269
L77 - Property services	0.549	0.708	0.352	0.246
L78 - Business services	0.809	0.808	0.272	0.257
N84 - Education	0.719	0.632	0.305	0.319
O86 - Health services	0.586	0.655	0.326	0.236
O87 - Community services	0.712	0.698	0.216	0.203
P91 - Motion picture, radio & television services	0.600	0.575	0.327	0.359
Weighted average (whole economy)	**0.819**	**0.824**	**0.340**	**0.313**