Cyclical Earnings Variation and the Composition of Employment

David C. Maré

Statistics New Zealand and
Motu Economic and Public Policy Research

Dean R. Hyslop

Statistics New Zealand and
Department of Labour

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Access to the data used in this study was provided by Statistics New Zealand under conditions designed to give effect to the 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 person or firm. The tables in this paper contain information about groups of people so that the confidentiality of individuals is protected.

The results are based in part on tax data supplied by Inland Revenue to Statistics New Zealand under the Tax Administration Act 1994. These 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 discussion of data limitations or weaknesses is in the context of using the LEED for statistical purposes, and is not related to the ability of the data to support Inland Revenue's core operational requirements. Careful consideration has been given to the privacy, security and confidentiality issues associated with using tax data in this project. A full discussion can be found in the *LEED Project Privacy Impact Assessment* paper (Statistics New Zealand, 2003).

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Abstract

During the economic upswing in New Zealand between 1999 and 2007, employment increased by over 20 percent and average real earnings increased by 9 percent. It is plausible that many low-skilled and low-paid people were attracted into work over this period, changing the composition of employment and depressing average real earnings. Similarly, the boom may have encouraged the market entry of new firms, typically with lower than average productivity and paying lower than average wages, which would also have depressed average real earnings.

This paper uses Statistics New Zealand's Linked Employer-Employee Database (LEED) to assess the extent and impact of such changes in the employment composition of workers and firms over this period. LEED provides comprehensive coverage of all wage and salary employment since 1999. It enables longitudinal linking of both workers and firms, and also of the jobs that link them. As the LEED data do not directly measure hours worked or hourly wages, we construct a measure of the full-time equivalent (FTE) annual earnings rate associated with each job observed. Our analysis uses a linear model that regresses log(FTE annual earnings) on worker demographics (sex and age) and aggregate male and female time effects, and also controls for the effects of constant unobserved worker and firm specific factors. We use the estimates from this model, together with the employment transition patterns of workers and firms over the period, to investigate in detail the effects of compositional change on average earnings.

First, we find that workers who enter employment during the period have 19 percent lower earnings than the average worker over the period. This compares with workers who exit employment during the sample period having 2 percent lower average earnings, and workers who are employed in each of the eight years having 7 percent higher earnings than the average worker over the period. Similarly, we find that entering firms pay 8 percent lower earnings than average. In contrast to workers, exiting firms also pay 8 percent lower earnings on average, and firms who employed workers in each year pay 2 percent higher earnings than average.

In contrast to the 9 percent measured increase in real earnings, the model estimates imply that, if there had been no change in the composition of workers and firms over the period, average real earnings would have increased by 15 percent. This 6 percent difference is mainly due to a 5 percent decline in the average earnings premiums associated with workers. About 60 percent of this worker effect is attributed to new entrants over the period being lower-paid on average, 25 percent to existing lower-paid employees working more hours, and 15 percent to lower-paid intermittently employed workers working more hours. Furthermore, about 60 percent of the entry effect is due to new workers entering low-earnings industries, and 40 percent is due to the new workers earning below-average earnings within industries. The changing employment intensity contribution of continuing workers is largely due to within-industry intensity changes, rather than across-industry reallocation of those workers.

We also estimate that there was a 1 percent decline in average earnings associated with firms over the period. This decline was largely due to new firms entering production having lower earnings premiums than those of existing firms, but is offset to a small degree by an increase in employment by firms with higher earnings premiums. Three industry case studies (manufacturing, construction, and property and business services) look fairly representative of the pattern for all firms.

Our results imply that annual rate of growth of composition-adjusted earnings was 2.1 percent over the period, compared with 1.3 percent for measured raw earnings. It is plausible that a similar type of composition change effects also apply to changes in average labour productivity, although the magnitude of the effects on productivity will depend also on factors such as changes in technology and other inputs.

Keywords: LEED, two-way fixed effects, compositional change, wage cyclicality.

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1. Introduction

The absence of strong real wage cyclicality over the business cycle has been a long-standing puzzle for competing macroeconomic theories (e.g. see Abraham and Haltiwanger, 1995). The debate over real wage cyclicality was dominated by aggregate wage data until the 1980s.[1] Since then, several analyses have used micro panel data to focus on the effects of changes in workforce composition on measured aggregate wages over the business cycle.[2] The basic hypothesis is that different types of workers have different employment sensitivities over the business cycle, thereby affecting workforce composition. To the extent that employment of low-skilled, low-wage workers is more (pro-)cyclical than employment of higher skilled workers, wages of such workers will receive more weight in aggregate wage measures during an economic boom than during a recession, thus lowering the estimated procyclicality of average wages. Reviewing this literature, Abraham and Haltiwanger (1995) conclude that composition effects do make important contributions to cyclical wage movements, although the strength and direction of effects varies at different stages of the business cycle and over time.

Between 1999 and 2007, during a cyclical upswing, employment increased more than 20 percent in New Zealand and average real earnings increased 9 percent.[3] Simple estimates suggest that about one-half of the employment growth may be attributed to population growth, one-quarter to rising labour force participation and 20 percent to falling unemployment (see Appendix Table A1). To the extent that the latter two factors, in particular, reflect significant changes in the skill composition of employment, these changes will have a potentially significant downward effect on measured average wage and productivity growth over the period.[4] In addition to the growth in the number of workers employed, the number of firms operating in New Zealand also increased significantly (13 percent) over the period, potentially affecting the composition of employment.

In this paper we use Statistics New Zealand's Linked Employer-Employee Database (LEED) to investigate the impact of compositional change in employment on measured earnings growth during this period of substantial employment growth.[5]

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[1] See, for example, Keynes (1936), Lucas (1977), and Barro and King (1984).

[2] For example, see Bils (1985), Devereux (2001), Keane, Moffitt and Runkle (1998), and Solon, Barsky and Parker (1994).

[3] This 9 percent increase is based on our LEED estimates of average log(FTE earnings) over the period – i.e. a 0.09 log-increase. Using LEED we estimate that average FTE (full-time equivalent) annual earnings (in levels) increased 6.9 percent, and that workers (unadjusted) average annual earnings increased 7.1 percent. Using the Household Labour Force Survey annual Income Supplement (HLFS-IS), we estimate average real hourly wages increased 7.3 percent between 1999 and 2006.

[4] Using HLFS-IS data for the 1998–2004 period, Hyslop and Yahanpath (2006) report that both employment and hours growth was largely confined to the bottom half of the individual income distribution, which is suggestive of composition changes favouring lower-waged workers. Simple hypothetical analysis presented in Drew, Dupuy, Downing and Karagedikli (2005) suggests that the employment growth between 1998 and 2005 plausibly reduced annual labour productivity growth by 0.5 percent. For example, if new entrants to employment over the period from either unemployment or out of the labour force account for 10 percent of 2007 employment and their productivity levels are on average 10 percent lower than that of existing workers, then measured average productivity in 2007 will be 1 percent lower than it would have been in the absence of this employment growth.

[5] This work extends and updates some preliminary analysis contained in Maré and Hyslop (2006), based on LEED data for the six-year period 1999–2005. The current paper considers a longer time period, adopts an alternative identification strategy for estimating worker and firm fixed effects, and provides a more detailed analysis of compositional change.

LEED provides longitudinal data on workers, firms, and the jobs that link them. This information enables us to track the changes in both worker and firm composition over the period. In particular, we estimate models of job annual earnings rates that control for aggregate time effects, observable worker demographic characteristics, and unobservable worker and firm fixed effects. We then use the estimated worker and firm fixed effects components of earnings premia as dimensions of composition, and use the change in average annual worker and firm effects to infer the impact of changing employment composition.

Compared with the raw annual earnings increase of 9 percent, we estimate that the composition-adjusted earnings increase associated with the employment growth was 15 percent over the period. The difference between these estimates is due to a 5 percent decline in the average worker earnings premium and a 1 percent decline in the average firm earnings premium over the period. About 60 percent of the worker effect is attributed to new entrants over the period being lower-paid on average, 25 percent to continuing lower-paid employees working more hours, and 15 percent to lower-paid intermittently employed workers working more hours. The 1 percent decline in the average firm premium was largely due to the entry of new firms with below-average earnings premiums, but is offset to a small degree by an increase in employment by firms with higher earnings premiums.

The remainder of the paper is organised as follows. In the next section, we briefly describe LEED, and discuss some of the relevant properties of the data we use. In section 3 we describe the dynamics of compositional change along the observable dimensions of worker demographics and industry. Section 4 outlines the statistical model used in the estimation, and discuss the issues associated with identifying age-earnings profiles in the presence of individual worker effects. Section 5 contains the main discussion of the results, summarising changes in earnings components across time and for groups of workers and firms defined according to their movements into and out of employment during the period. These changes are analysed in terms of their contributions to average earnings growth and the extent to which contributions are associated with reallocation of employment between observably different groups of workers and firms. The paper concludes with a summary of our findings?.

2. Data

The analysis presented below uses data from Statistics New Zealand's Linked Employer-Employee Database (LEED).[6] LEED uses information from tax and statistical sources to construct a record of paid jobs. Each month all New Zealand employers file an Employer Monthly Schedule (EMS) record with Inland Revenue (IRD), which lists all employees at that firm in the month, the amount of income they received, and the amount of tax that was deducted at source. Two types of recipients are covered by EMS: those who have pay-as-you-earn (PAYE) tax deducted, who are employees, and those who pay withholding tax, who are a sub-set of self-employed individuals. In addition to employment earnings, LEED also captures and identifies various forms of non-employment PAYE-withheld income; specifically, working-age welfare benefits (Benefits), New Zealand Superannuation (NZS) pension, earnings-related accident compensation (ACC) income, Paid Parental Leave (PPL) payments, and Student Allowances (SA). Because of the uncertain nature of the selection of self-employed in LEED, we exclude those who pay withholding tax and focus only on PAYE-deducted employment.

Employees are identified by a unique (confidentialised) identifier based on the individual's IRD tax number. In the IRD data, employers are identified as the organisation to which the EMS return relates. Employers thus defined are an administrative unit and do not equate to any consistent conception of a firm. We use a version of the LEED data that has allocated EMS returns to geographic units, as

[6] See Kelly (2003) for a more detailed discussion of the LEED data.

defined in the Longitudinal Business Frame (LBF) (Seyb, 2003), and identified by a unique identifier – the Primary Business Number (PBN).

One significant weakness of the LEED data is that it contains no information on hours worked. Because the EMS returns report only monthly earnings for each employee, it is not possible to accurately distinguish low pay rates from low employment intensity (i.e. hours worked). Similarly, high earnings may result from either a high pay rate or high employment intensity. In order to partially adjust for the lack of hours, we use information on workers' earnings and non-work income to estimate monthly employment intensity.[7]

To estimate an individual's monthly employment intensity, we first assume that they can work up to one full-time equivalent unit of employment in any month in which they have LEED earnings information. We then reduce their effective employment intensity if they receive any 'non-work' income payments from Benefits, ACC, PPL, or SA.[8] Intensity is calculated as the proportion of combined work and non-work payments accounted for by work payments. An individual's estimated intensity is also scaled down proportionately if their total work earnings during the month are less than full-time minimum wage earnings during the month. Each of these (non-work income and low earnings) adjustments is likely to lead to an overstatement of monthly employment intensity for such workers because most work is rewarded more highly than both non-work and minimum wage levels.

An individual's total monthly employment intensity is then allocated across the jobs they held in that month in proportion to the earnings received in each job. Each job's monthly employment intensity is then aggregated across months in the year, and expressed as a proportion of the year, to give the annual FTE employment of the job. Finally, the FTE annual earnings rate of the job during the year is calculated as the total annual earnings of the job divided by the job's annual FTE employment. Aggregating the monthly LEED data to an annual basis smooths out the more noisy monthly earnings patterns and lessens the impact of seasonal earnings variation, both of which are prevalent in the LEED data.

The LEED data that we use contain the full coverage of jobs in New Zealand during the eight years from April 1999 to March 2007.[9] Table 1 provides a summary of the annual data. Over the eight-year period, there are 3,113,360 distinct employees, and 374,950 distinct firms (PBNs).[10] We define a job as a unique employer-employee combination, and a job-year as a unique employer-employee-year combination, giving 12,658,650 distinct jobs and 25,603,780 distinct job-year observations in our analysis dataset. The number of workers employed during the year increased 21 percent between the first and last years, the number of firms with employment increased 13 percent, and FTE employment increased 23 percent. The relatively larger increase in FTE employment compared with both the number of workers and firms reflects a small increase in workers' average FTE employment (0.4 percent), and a larger

[7] The algorithm is described more fully in Maré and Hyslop (2006).

[8] NZS pension income is not included in non-work payments for this exercise, as NZS is not subject to a work-test requirement.

[9] There are lags in some EMS returns being filed with Inland Revenue data, which may affect the coverage of the final few months of the period. At the date our data were extracted, there had been at least three months of returns for all monthly periods beyond the end of the sample period, which we believe limits the impact of such lags to less than 1 percent of monthly returns in the final month, March 2007.

[10] In addition to the 3,113,360 people observed in wage and salary employment over this period, there are 699,900 people who appear in the LEED with only non-employment income payments such as NZS, working age benefits, etc. On average these people appear in six out of the eight years of the sample, and have an average annual LEED income of $13,200.

increase in firms' average FTE employment (14 percent) over the period. Over the period there were also small increases (about 1 percent) in the within-year number of months and FTE employment of jobs.

Some of the worker-level changes over the period are consistent with generally recognised trends. For example, the increase in the average age of workers reflects a combination of the ageing of the population and increasing labour force participation and employment of older workers. The latter is also reflected in the large relative increase (74 percent) in the fraction receiving NZS payments among those employed during any year (albeit from a low base of 1.2 percent). Similarly, there was a large relative decline (-38 percent, again from a relatively low base of 6.3 percent) in the fraction receiving working-age transfer payments among those employed during any year, consistent with the large drop in the number of unemployment benefit recipients in particular over this time frame.

Throughout our analysis we express earnings and incomes in constant, June-quarter 2007 dollar-values, adjusted using the Consumers Price Index (CPI). Table 1 shows that FTE annual earnings increased 6.9 percent between the first and final years of the sample. Due to the small increase in workers' average FTE employment, this increase is slightly smaller than the increase in workers' average annual earnings.

Appendix Table A1 summarises trends in employment and earnings measured in the Household Labour Force Survey (HLFS), and Appendix 1 discusses the comparison of these trends with those observed in LEED. This comparison provides encouragement both that the observed employment in LEED accurately measures changes over the period, and that our measure of employment intensity provides a reasonable proxy for FTE employment in the absence of observed hours worked. Estimates of population, labour force participation and employment rate growth from the HLFS also suggest that about 55 percent of the observed employment growth over the sample period may be attributed to population growth, and the remainder to falling unemployment and rising labour force participation, which together contributed about a 10 percent increase in employment.

3. Descriptions of compositional change

At the job level, our outcome variable of interest is the logarithm of FTE annual earnings (which we refer to as 'log(earnings)'). Our analysis below focuses on the effect of the changing composition of employment on the average log(earnings). Before we formally analyse the impact on average earnings of the compositional change in employment observed, we first describe the worker- and firm-level changes over the period.

A key dimension of the changing employment composition is the labour market entry and exit of workers over the period. To provide a sense of the importance of worker entry and exit, we allocate each worker to one of four subgroups according to their patterns of annual employment participation over the eight-year period: 'continuers (C)' are workers who work in each of the eight years; single 'entrants (N)' are workers who are not employed during the first year (1999/2000), are employed during the last year (2006/07), and make a single transition from annual non-work to work during the period; similarly, single 'exiters (X)' are workers who make a single transition from work to non-work over the period; and 'multi-transition (M)' workers are all other workers (i.e. those who experience at least two LEED annual employment transitions over the period).[11] We similarly characterise firms' employment participation patterns over the period and stratify firms into 'continuers', 'entrants', 'exiters', and 'multi-transition' subgroups.

[11] This characterisation ignores any intra-year high-frequency employment transitions, which may be an important dimension for part-year workers in particular. To some extent this effect may be reflected in changes in the FTE employment patterns of the subgroups defined here.

Net employment growth leads to a change in the mix of transition groups, with an increase in the employment share of entrants and a decrease in that of exiters. If entrants have lower than average log(earnings), this changing mix potentially contributes to slower earnings growth. Further, lower earnings of entrants may reflect, in part, that entrants disproportionately belong to age and industry groups that have low average log(earnings), and/or in part, that entrants within each group earn below their group average. In the discussion we highlight the possible links between the changing mix of transition groups and changes in the age and industry mix of employment as contributors to lowered log(earnings) growth. In section 5, we analyse in greater detail the actual contributions to average log(earnings) change of the changing mix of transition groups within and between identifiable groups of workers and firms.

Workers

The subgroup of continuing workers contributes 66 percent of the total FTE employment over the period (67 percent in the first year and 60 percent in the final year), entering workers 14 percent (28 in the final year), exiting workers 9 percent (21 in the first year), and multi-transition workers contribute 11 percent (12 percent in both the first and last years).

Figure 1 describes the male and female age distributions of the four subgroups stratified by transition status as well as by all workers. There will be a degree of worker entry and exit even in a stationary labour market environment, reflecting life cycle employment and migration patterns. The extent to which such stationary dynamics dominate the make up of the four transition groups may affect the observed patterns and differences across them. For example, the demographic differences across these groups are broadly consistent with some common life cycle patterns of employment. Continuers are relatively more likely to be prime-aged workers, and have higher than average earnings. Conversely, each of the three non-continuers groups tends to be over-represented among younger workers, with lower than average earnings; exiters are over-represented among older workers; and secondary workers such as returning mothers are one identifiable type of the multi-transition group. Our analysis examines these patterns in more detail and attempts to draw out more clearly some of the differences.

Figure 2 describes the male and female age profiles of average log(earnings) of all workers and for each of these four subgroups. For males (Figure 2a), each of the subgroups has similar concave age-earnings profiles. In addition, the group of continuers tends to have higher than average earnings, entrants and multi-transition workers have substantially lower than average earnings, particularly among prime age and older workers, and exiters have very close to average earnings at all ages. Figure 2b shows analogous profiles for female workers. The relative average earnings patterns across the subgroups of female workers are similar to those of males, except that mid-age and older exiters tend to have lower earnings.

The greater contributions to employment of entrants than exiters, together with lower average relative earnings of entrants, suggests a potentially important role for composition changes on aggregate average earnings measures over the period.

Firms

Figure 3 presents analogous industry profiles of FTE employment distributions (Figure 3a) and average log(earnings) (Figure 3b) for all jobs, and each of the four firm-level transition subgroups. In both of these figures, industries have been ordered from left to right from lowest to highest average log(earnings). Continuing firms dominate the total employment (accounting for 80 percent of total FTE employment), entering firms account for about 10 percent, and exiting firms for 9 percent of employment over the period. Figure 3a shows quite a degree of variability in the employment distributions across industries. Firm entry and exit appears to be positively correlated across

industries, and is relatively high in some industries (e.g. Agriculture, Forestry and Fishing; Construction; and Property and Business services), and lower in others (e.g. Health and Community Services; Manufacturing; and Government Administration and Defence). However, there does not appear to be a strong relationship between either total industry employment share, or the employment share associated with entry or exit, and industry average log(earnings).

Figure 3b generally shows that the average log(earnings) of non-continuing firms is lower than that of continuing firms across industries, particularly in the mid-range earnings industries. However, the average log(earnings) differences between the firm subgroups are lower and less systematic across industries than average log(earnings) differences between worker subgroups across the lifecycle shown in Figure 2. Also, the employment shares of entering and exiting firms are roughly equal and substantially lower than for workers. These patterns suggest perhaps less scope for composition changes among firms over the period to have a strong systematic impact on measured average earnings.

Simple estimates of changing composition effects on earnings

To give a sense of the possible magnitude of the impact of the change in employment composition on average log(earnings) growth over the period, consider the following two simple 'back-of-the-envelope' calculations. First, a crude way to control for the effects of compositional change is to estimate the change in average log(earnings) of the continuers group of workers. This group experienced growth of 0.17 which, compared with the average log(earnings) growth of 0.09, suggests a compositional change impact of about -0.08. Second, the average log(earnings) of workers who enter employment during the period is about 0.19 lower than the overall worker average (reported in Table 2). This difference combined with the 23 percent increase in FTE employment over the period (Table 1), suggests a compositional change impact on average log(earnings) of about -0.04.

These estimates are both quite simple and ignore potentially important confounding effects. For example, the first estimate is likely to be overstated because it ignores the earnings growth associated with increasing employment experience inherent in this group of workers;[12] while, the second estimate ignores the relative difference between entry and exit workers, as well as demographic differences and changes over the period, and the contributions of these factors to the compositional change effect. Nonetheless, these estimates are suggestive of sizeable effects on the order of those hypothesised by Drew et al (2005). In the next section, we outline the statistical model that we use to control for such confounding effects and the allocation of the impacts to worker and firm contributions.

4. Statistical model

In order to quantify the actual contribution of compositional change on earnings growth, we estimate a model that will allow us to identify the changing mix of workers and firms across both observable and unobservable components of earnings, and to separate the contributions of entry, exit and reallocation. Following much of the literature on two-way worker and firm fixed effects analyses (e.g. Abowd and Kramarz, 1999; Abowd, Creecy and Kramarz, 2002), we specify a log-linear statistical model for job-year FTE annual earnings as in the following equation:

$$y_{ijt} = X'_{ijt}\beta + \tau_t^M + \tau_t^F + \theta_i + \psi_j + \varepsilon_{ijt} \qquad (1)$$

where y_{ijt} is the log(earnings) – i.e. log(FTE annual earnings rate) – of the job held by worker-*i* in firm-*j* in year-*t*, X'_{ijt} is a vector of observable covariates pertaining to the

[12] However, this estimate also ignores compositional changes associated with changes in hours worked within this group that we show below is important.

job-year observation, τ_t^M and τ_t^F are year-specific effects for males and females to capture aggregate changes, θ_i is a worker fixed effect component of the earnings rate, ψ_j is a firm fixed effect component, and ε_{ijt} is the job-year residual effect.

The worker fixed effect component (θ_i) reflects the portable earnings premium that each worker receives in whichever firm they work for, and ψ_j is the time-invariant premium that each firm pays to all the workers it employs. These components also absorb the premium associated with any time-invariant attributes of workers (such as sex) and of firms (such as industry or technology).

The observable characteristics that we use are restricted to worker demographics (age and sex) and time controls. In particular, we adopt separate quartic polynomials in age for males and females and also allow aggregate year-effects to differ by sex.[13] This combination of year-dummy variables, individual worker fixed effects, and the linear component of the quartic age profile leads to the common 'age-time-cohort' identification problem in panel data.[14] We deal with this identification issue in the model by imposing restrictions on the age profiles of males and females. Specifically, based on preliminary analysis of the sex-specific age-earnings profiles, we restrict the derivatives of the male and female regression-adjusted age profiles to be zero at ages where the raw profiles are relatively flat: age 45 for males and 48 for females.[15]

Our analysis includes all job-year observations, and the estimation is weighted by the job-year's FTE employment level (ω_{ijt}), which captures both the extensive (full-year) and the intensive (full-time) dimension of the job. The estimation procedure uses a weighted variant of the exact solution for estimation of this model, as described in Abowd, Creecy and Kramarz (2002). Given the large number of person and firm fixed effects parameters in the model, it is not feasible to follow the standard estimation approach of direct least squares estimation, which would involve inversion of a very large sparse covariate matrix. Instead, we adopt the Abowd, Creecy and Kramarz (2002) approach, implemented in Fortran, of using a preconditioned conjugate-gradient algorithm developed by Dongarra et al (1991).[16]

Figure 4 presents three sets of age profiles for male and female log(earnings): first, the actual profiles of age-specific averages; second, the predicted profiles from an ordinary least squares (OLS) weighted regression of log(earnings) on sex-specific year dummy variables and quartic age profiles with the identifying restrictions imposed (i.e. the derivatives of the male and female profiles are zero at age 45 and 48, respectively – points that are circled in the figures); and third, the predicted profiles based on the estimates from equation (1).[17] Figure 4a shows the quartic profile estimated from the simple OLS regression provides a very close fit to the actual age-earnings profile for males. For females, the fit of the OLS profile in Figure 3b is not as good, having some trouble fitting the bimodal nature of the female age-earnings

[13] To lessen the possible impacts of outlying young and old ages on the age quartile estimates, we trim ages at 18 and 65 years respectively.

[14] That is, because individuals age at the same rate as time progresses it is not possible to separately identify age, time and (e.g. birth) cohort effects without further identifying restrictions.

[15] This identification approach is common in the literature, e.g. see McKenzie (2006). Figure 4 compares the empirical and estimated male and female age – log(earnings) profiles.

[16] The Abowd, Creecy and Kramarz (2002) Fortran programs are available for download from http://instruct1.cit.cornell.edu/~jma7/fortran_code.zip. We adapted the programs to allow for weighted estimation. The appendix contains details of the identification and normalisations adopted in the estimation. Appendix Table A2 presents a summary of the estimation results.

[17] Each of the predicted profiles in Figure 4 is plotted such that the weighted average residual relative to the actual empirical profile is zero.

profile and predicting a stronger drop in earnings after age 60, but generally appears reasonable. When the worker and firm fixed effects are included in the model, the resulting conditional age-earning profiles fit the raw profiles less well. For males, the predicted profile is higher than the raw profile for ages up to 33, and lower for ages from 34. For females, the profile is essentially flat from ages 35 to 52 and shows no bimodality. Conditional on the identifying assumptions imposed on the age-profiles, these differences have implications for the age profiles of the estimated worker and firm effects, which we return to in the next section.

Based on the regression estimates of equation (1), our approach is to interpret the changes in the annual averages of each of the components as reflecting the effects of changes in the composition of employment over the period. Specifically

$$\bar{y}_t = \sum_{i,j} \omega_{ijt} y_{ijt} \Big/ \sum_{i,j} \omega_{ijt} \ ,$$

$$\overline{X\beta}_t = \sum_{i,j} \omega_{ijt} X'_{ijt} \beta \Big/ \sum_{i,j} \omega_{ijt} \ ,$$

$$\bar{\theta}_t = \sum_{i} \omega_{it} \theta_i \Big/ \sum_{i} \omega_{it} \ ,$$[18] and

$$\bar{\psi}_t = \sum_{j} \omega_{jt} \psi_j \Big/ \sum_{j} \omega_{jt}$$

are, respectively, the year-*t* average (raw) log(earnings) of jobs, average worker demographic effect, average worker effect of workers, and average firm effect of firms in year-t. Finally, the time effects (τ_t^M and τ_t^F) reflect the composition adjusted average log(earnings) in year-t.

5. Results

In this section we begin by providing a brief overview of the trends in earnings and the contributions of alternative components. We then examine the patterns in more detail.

Summary trends in earnings components

Table 2 summarises the variation in average log(earnings) over the period and the estimated contributions to this variation of the observable and unobservable components in the regression specification (1). The first row presents the mean effects for the full sample. The average log(earnings) over the period is 10.6 (corresponding to FTE earnings of about $40,100), and the standard deviation (shown in parentheses) of log(earnings) is 0.51. By construction, the mean effect of the worker demographics (sex and age) is also 10.6, and the time effects, worker fixed effects, firm fixed effects, and residual effects are mean zero across the full sample period.

The next panel in Table 2 summarises the annual means for each year of the sample, with each entry expressed relative to the full sample average shown in row 1. Each of the individual year average log(earnings) entries is equal to the sum of the component entries for that row. The first column shows that average log(earnings) increased about 9 percent over the eight years from -0.040 in year 1 to +0.049 in year 8 relative to the full-period average. For example, the first year (1999/2000) entry (-0.040) is attributed to a slightly lower than average worker demographic effect (-0.002), a large negative year effect (-0.070), and positive worker (0.025) and firm (0.006) effects. The time pattern for each component is then shown in its respective column. The contribution of worker demographics to log(earnings) exhibits little systematic changes

[18] Note that ω_{it} is worker-i's total FTE employment in year-t, calculated as the sum across all their jobs in that year. Similarly, ω_{jt} is firm-j's total FTE employment in year-t.

over the period, showing a net increase of 0.002 between the first and last years. In contrast, the time, worker and firm effects display quite strong trends. The average worker effect declines over the period from +0.025 in the first year to -0.023 in the last year; while the average firm effect declines from +0.006 to -0.003 in the final year. Counterbalancing these declines, and also incorporating the aggregate earnings growth, the regression adjusted time effects display a strong increase over the period from -0.070 to +0.076. This latter time effect implies that, compared with the actual average log(earnings) increase of 0.090, in the absence of any worker or firm compositional effects, the average would have increased 0.146 over the period.

The decline in the annual average worker effects and average firm effects over the period must be due to compositional changes over the period. This could occur either at the 'extensive' margin via the entry and exit of workers and firms that have different average earnings effects than continuing workers and firms; and/or at the 'intensive' margin via relative changes in the employment intensity of workers and firms with different earnings effects within the continuers and multi-transition groups. For example, if the employment of lower-earnings workers is more procyclical than that of higher-earnings workers, this may show up both in terms of entrants having lower average earnings-effects than continuing workers, and/or the lower-earning workers within the continuing subgroup increasing their employment over the period. To investigate the contributions of each of these effects, we first summarise the differences in each of the earnings components across the employment subgroups, and then decompose the changes over the period into these contributions.

The lower panel in Table 2 describes the pattern of variation across subsamples of jobs defined by the LEED transition patterns of firms or workers. Continuing workers (those employed in every year) contribute about two-thirds of the FTE employment over the period, and have about 7 percent higher than average earnings, which is due to higher earning demographics (0.034), higher worker fixed effects (0.028), and because they work in firms with higher firm fixed effects (0.010). Single-exit workers have about 2 percent lower than average earnings, and these workers' demographic effects are slightly negative (-0.008), but they have higher than average worker fixed effects (0.023) and work for firms with slightly positive (0.003) firm effects.[19] The average time effect associated with these workers is negative (-0.039), reflecting they are observed early, but not late, in the period. Single-entry workers have much lower (19 percent) earnings than average, which is largely due to low-earnings demographics (-0.122), but also lower than average worker effects (-0.070) and their being in firms with low firm effects (-0.031), counterbalanced by positive average time effects (0.036), reflecting entry over the period. The multi-transition group of workers also have much lower (16 percent) average earnings, again due to a combination of low-earnings demographic effects (-0.040), worker effects (-0.097) and firm effects (-0.024).[20]

[19] The male and female age profiles of average worker fixed effects are displayed in Figure 5, and of average firm fixed effects are displayed in Figure 6 for each of the employment transition groups. Also, Appendix Table A1a shows the distribution of worker effects stratified by workers' transition group. The distributions have quite similar shapes, suggesting the differences are well summarised by the mean effects.

[20] In Appendix Table A3 we describe some of the characteristics of these worker subgroups, particularly pertaining to the source and destination of entering and exiting workers. About 19 percent of single entrants have appeared in LEED with non-employment income payments in years prior to their first employment experience, and 29 percent of single exiters receive non-employment income in years after their final employment spell. Of the entrants, those with prior non-employment income are older, have only slightly lower average log(earnings) but substantially lower average worker effects and about average demographic contributions, than those who have no prior non-employment income: this other subgroup of entrants have lower than average worker effects, but substantially lower demographic contributions reflecting their younger ages. Of the exiters, those who receive post-employment non-employment income are older and have lower than average

The patterns across subgroups stratified by firms' LEED transitions are broadly similar, although the differences are substantially smaller than for workers. The average log(earnings) of jobs in continuing firms are 2 percent higher than the full sample average, and these firms account for about 80 percent of the FTE employment over the period. In contrast, the average earnings of jobs in entering and exiting firms are each about 8 percent below average, and in multi-transition firms 15 percent below average.[21] The differences between continuer, and entrant and exiter firms are largely consistent with analogous estimates of productivity across such firms provided by Law and McClellan (2005). The 2 percent higher log(earnings) in continuing firms is attributed roughly equally to average worker demographics (0.006), worker fixed effects (0.008), and firm fixed effects (0.007). The other three groups of firms have lower than average contributions from each of these components, and average time effects that largely reflect their entry compared with exit status. Interestingly, the contributions to single-entry firms' average earnings are substantially lower than those to single-exit firms across each of worker demographic (-0.032 compared with -0.011), worker fixed effects (-0.037 compared with -0.019) and firm fixed effects (-0.046 compared with -0.003). The overall similarity is due to the difference in the general economic conditions as reflected in the time effects (0.038 compared with -0.044). The effects across the multi-transition group of firms are comparatively similar to those of single-entry firms, except for the time effect which is close to zero (-0.003) for these firms.

More detailed summaries of the worker and firm effects both across and within the worker-transition subgroups of continuing, entering, exiting, and multi-transition workers are presented in appendix Tables A4 and A5. Table A4 presents the average annual worker effects of the various subgroups and shows that the average is declining over time for each group. For continuers, this is due to a relative increase in employment intensity over the period of those workers with lower effects, thus increasing their weighted contribution to the average in the latter years. Table A5 provides a detailed description of the patterns for the single-entry and single-exit groups. Tracking down the main diagonal for each group shows that there is generally a decline in the average effect associated with each successive cohort of workers entering and of workers exiting. Furthermore, tracking down any column shows that the annual FTE employment weighted average effect also generally declines over time, reflecting that (as for the continuers) there is a relative increase in employment intensity by workers with lower effects within each cohort over the period. Thus, the patterns for continuers and entrants are consistent with the notion that there was an increase in employment of lower-earnings workers at both the extensive (worker entry) and intensive margins, and this effect became progressively stronger over the business cycle upswing.

The contributions of changing employment composition to earnings growth

We assess next the contributions of the changing composition of workers and firms to the changing average log(earnings) over the period. For this exercise, we focus on the aggregate contributions of the entry and exit of workers (or of firms), as characterised by groups of continuers (C), entrants (N), exiters (X), and multi-transition (M) workers (or firms) over the full sample period, and the changing intensity of employment within the group of continuing workers (or firms). In particular, we decompose the growth in average log(earnings) using the following formula:

---

log(earnings), worker and firm effects, compared with other exiters who have higher than average log(earnings), and worker and firm effects.

[21] Appendix Table A1b presents the kernel density estimates of the distributions of estimated firm effects in each of the transition groups. The shapes of the distributions are largely similar, suggesting that the mean effects provide reasonable summary statistics across the groups.

$$
\begin{aligned}
(\overline{Y}_1 - \overline{Y}_0) = {} & w_0^C * (\overline{Y}_1^C - \overline{Y}_0^C) + (w_1^C - w_0^C) * (\overline{Y}_1^C - \overline{Y}_0) \\
& + w_1^N * (\overline{Y}_1^N - \overline{Y}_0) \\
& - w_0^X * (\overline{Y}_0^X - \overline{Y}_0) \\
& + w_0^M * (\overline{Y}_1^M - \overline{Y}_0^M) + (w_1^M - w_0^M) * (\overline{Y}_1^M - \overline{Y}_0) \qquad (2)
\end{aligned}
$$

where w_t^k (k=C, N, X, M; t=0, 1) denotes the share of group-k in year-t FTE employment, and $\overline{Y}_t^k$ is the average log(earnings) of group-k in year-t. This decomposition involves two terms for each of the groups of continuing (C) and multi-transition (M) workers: the first term reflects the change in each group's average earnings over the period, holding its share of FTE employment constant at the first-year level, and the second term reflects the change in each group's employment share over the period multiplied by the group's last-year average log(earnings) relative to the first-year full-sample average log(earnings). For the groups of entering (N) and exiting (X) workers, the decomposition has just one term: the group's employment share in the year it appears multiplied by the difference between its average log(earnings) relative to the first-year full-sample average.

In Table 3 we present the results of this exercise for the change between the first year (1999/2000) and last year (2006/07) of the sample period, for raw log(earnings) and for each of the regression-estimated components discussed above. The first row contains the sample-period changes for each component, repeated from Table 2.

The next panel of results in Table 3 contains the analysis of worker employment compositional changes. The main contributions to the compositional changes come from the subgroups of continuing workers, which account for between 60 and 67 percent of the total FTE employment in the first and last year respectively, and the single-transition entrants, that account for about 28 percent of the final year employment. The first two rows of this panel pertain to the subgroup of continuers (workers who are employed in each of the eight sample years), which is the largest group. The 'income' contribution of this group to the raw average log(earnings) changes is 0.115, and reflects that the average log(earnings) increased strongly, by about 0.17.[22] This 0.17 raw increase for continuers mainly consists of a 0.04 increase in earnings due to experience (i.e. associated with life-cycle ageing), a 0.15 increase associated with time effects, and a 0.02 decline in average unobserved worker effects.[23] The second row presents the contributions of the changing relative employment share of the group of continuers, weighted by the difference between the year-8 average log(earnings) and the year-1 full-sample average log(earnings). This term contributes -0.015 to the average log(earnings) change over the period, which reflects the higher than average earnings of this group together with the drop in its share of FTE employment from 67 percent in the first year to 60 percent in the last year.

The next row shows the effect of entrants during the period was to contribute -0.025 to the increase in average log(earnings), reflecting that this group has 0.09 lower final-year average earnings than the first-year population average. entrants had 0.11 lower than average demographic contributions (largely younger workers), 0.10 lower than average worker effects, and worked for firms with 0.03 lower average firm effects.

[22] The contribution is the raw average log(earnings) change of 0.17, multiplied by the continuers' share of employment (67%).

[23] The decline in the average worker fixed effect across this fixed sample of continuers is due to changes in the relative intensity of employment of workers within this group. In particular, the employment intensity of lower-effect workers increased which, in turn, lowered the weighted average worker-effect of the group.

These negative effects were partly offset by the positive 0.15 time effects over the period.

The groups of single-transition exiters and multi-transition workers contribute relatively little to the aggregate changes. For the exiters, as shown in Figure 2, this is largely because their first-year average earnings and each of the components are relatively close to the first-year population average, at least in terms of the components that we characterise here. The group of multiple transition workers account for only about 12 percent of employment in either year.

Analogous results for firms are presented in the third panel of Table 3. FTE employment is strongly concentrated in continuing firms – such firms account for about 80 percent of employment in either year, while single-exit firms account for 18 percent of first-year employment, single-entrant firms 20 percent of final-year employment, and multi-transition firms 1–2 percent of employment. As a result, the continuing firms account for most of the aggregate change in earnings over the period, both in terms of the raw change and also the components. That said, there are noticeable contributions to the time, worker and firm effects components by the group of entering firms. In particular, these firms have substantially lower average worker effects (2.4 percent lower) and firm effects (4.4 percent lower) than the final-year sample average. The latter implies that the contribution of firm entry (-0.011) more than fully accounts for the decline in average firm effects over time (-0.009), with the difference due to a small positive (0.002) effect from increasing employment in continuing firms.

Subgroup changes

In section 3 we described how employment and earnings varied across and within age for workers stratified by their employment patterns, and across and within industries for firms stratified by their employment patterns over the period, and how these sources of variation may have affected the measurement of average log(earnings). In this section, we describe the relative changes in employment and the measured changes in average raw log(earnings) and the log(earnings) components estimated from the regression, across different worker and firm subgroups. From these employment and earnings changes, it is possible to infer the between-group and within-group contributions of the various subgroups to the compositional change impacts on measured average log(earnings) growth.

Table 4 summarises the changes that occurred over the period for different subgroups, stratified by worker sex and age, and firm industry, size and location. The first row summarises the changes for the full sample, and presents the total FTE employment over the eight-year period in column 1; relative changes in FTE employment, the number of workers and the number of firms between the first and last years' in columns 2–4. That is, as shown in Table 1, FTE employment increased 23 percent, the number of annual workers increased 21 percent and the number of firms increased 13 percent between the first and last years. The remaining columns 5–10 show, from Table 2, the change in average log(earnings) between the first and last years, and the contribution of each component to this change.

For each subsequent block in Table 4, column 1 contains the relative contribution of each subgroup to the total FTE employment over the period and columns 2–10 present the year-1 to year-8 changes expressed relative to the full sample changes shown in the first row. The FTE employment changes in the second column can be combined with the corresponding mean log(earnings) reported in Appendix Table A4 to infer the between-group contributions of the employment composition change impacts. Similarly, the within-group contributions can be derived by combining the relative earnings changes reported in columns 5–10 with an appropriate employment weighting measure.

Worker demographics

Female employment increased slightly more than male employment (22.2 compared with 20.6 percent in terms of numbers of workers, and 23.4 compared with 23.0 percent on an FTE basis), and females' average log(earnings) showed a relatively stronger increase (0.116 compared with 0.068).

Relative employment growth across different age groups perhaps reflects population ageing and other particular policy changes. In particular, the fraction of older workers (aged 55–65) employed increased 60 percent and their FTE employment increased 74 percent, compared with overall increases of 21 and 23 percent, respectively. This strong increase in the employment of older workers presumably reflects a combination of a direct policy effect of the increasing age of eligibility for NZS to 65 in 2001, secular increases in older workers employment patterns, and strong cyclical demand for workers (see Dixon and Hyslop, 2008). There was also relatively strong employment growth for 45–54 year-old workers, and the employment growth of young and prime aged workers was relatively low. Average log(earnings) also grew more strongly for young workers (aged 18–24), and relatively weakly for those aged 25–34.

The change in average person effects for males (-0.061) is greater than for females (-0.034), suggesting that the impact of compositional change is more pronounced for males than for females. Appendix Figure A2 shows the patterns of growth in log(earnings) and in composition-adjusted earnings for males and females. Although the raw growth is faster for females, the composition-adjusted growth is similar for males and females.

The relative changes in average worker effects between males and females and across the age groups also largely reflected the relative changes in raw average log(earnings) across these groups. This also appears broadly true for changes in average firm effects associated with the firms that workers work in, although the firm effects are generally smaller.

Firm size, location and industry

Both the employment and average log(earnings) growth across different sized firms is not systematic with respect to firm size. Regional employment growth was also quite uneven. Employment growth in Wellington was relatively weak (15.5 percent compared with 23 percent overall), while outside the three main centres, employment growth was relatively strong (25.3 percent). Average FTE earnings also increased more strongly in Christchurch and other areas (over 10 percent), compared with Wellington and Auckland (7 and 8 percent, respectively).

Employment growth across industries varied substantially, although the total employment (as measured by FTE employment) in each 1-digit industry increased over the period. For example, FTE employment in the Construction industry, which accounted for about 6 percent of employment over the period, increased by almost 65 percent between 1999/2000 and 2006/07. At the other extreme, FTE employment in Communication Services, which accounted for 1.4 percent of total employment, increased by less than 6 percent. However, broadly consistent with the industry employment and earnings patterns shown in Figure 3, there does not appear to be any obvious relationship either between the relative change in FTE employment and average log(earnings) in an industry, or between the relative change in industry average log(earnings) and employment levels or growth. That said, one noticeable pattern in Table 4 is that there were larger than average declines in the average worker effect in all service industries (industries J–Q) except for the Health and Community Services industry.[24]

[24] These worker effect declines were partly balanced by generally positive average residual changes in these industries.

Industry contributions to changing composition impacts

Because of the relatively large number of industries shown in Table 4, it is difficult to gauge the role played by reallocation of employment across industries as opposed to changes in composition within industries. To provide a more interpretable summary of the nature of compositional change by industry, we decompose the overall change in average log(earnings) into within- and between- industry changes, separately estimating the contribution of different worker and firm transition groups. We also examine patterns of within-industry compositional change in more detail for a selected subset of industries.

Formally, we decompose each of the components in equation (2), giving:

$$
\begin{aligned}
(\overline{Y}_1 - \overline{Y}_0) = {} & w_0^C \sum_k \left\{ w_{0k}^C (\overline{Y}_{1k}^C - \overline{Y}_{0k}^C) + (w_{1k}^C - w_{0k}^C) * (\overline{Y}_{1k}^C - \overline{Y}_0) \right\} \\
& + (w_1^C - w_0^C) \sum_k w_{1k}^C \left\{ (\overline{Y}_{1k}^C - \overline{Y}_{1k}) + (\overline{Y}_{1k} - \overline{Y}_0) \right\} \\
& + w_1^N \sum_k w_{1k}^N \left\{ (\overline{Y}_{1k}^N - \overline{Y}_{1k}) + (\overline{Y}_{1k} - \overline{Y}_0) \right\} \\
& - w_0^X \sum_k w_{0k}^X \left\{ (\overline{Y}_{0k}^X - \overline{Y}_{0k}) + (\overline{Y}_{0k} - \overline{Y}_0) \right\} \\
& + w_0^M \sum_k \left\{ w_{0k}^M (\overline{Y}_{1k}^M - \overline{Y}_{0k}^M) + (w_{1k}^M - w_{0k}^M) * (\overline{Y}_{1k}^M - \overline{Y}_0) \right\} \\
& + (w_1^M - w_0^M) \sum_k w_{1k}^M \left\{ (\overline{Y}_{1k}^M - \overline{Y}_{1k}) + (\overline{Y}_{1k} - \overline{Y}_0) \right\}. \qquad (3)
\end{aligned}
$$

In equation (3), subscript-*k* indexes industries, subscripts-0 and 1 index the first and last years respectively, and the superscripts C, N, X and M index the subgroups of continuing, entering, exiting and multi-transition workers or firms, respectively. First, this decomposition breaks down the two 'earnings change' components associated with the groups of continuing and multi-transition workers into a within-industry average earnings change effect and a between-industry employment-share change effect for each group. Second, the decomposition breaks the 'employment-share change' components for each of the four groups into an effect associated with the difference between the within-industry group-average and the industry-total average log(earnings), and an effect associated with the difference between the (total) industry average log(earnings) and the total first-year average log(earnings). For each group, these measure the extent to which the employment effects are due to within-industry earnings differences of the groups compared with general across-industry earnings differences.

A selection of results from this decomposition is presented in Table 5. Based on the results in Table 3, we focus on the industry contributions to changes associated with raw average earnings, the composition-adjusted time effects, and the worker and firm fixed effects. The first block in the table is based on the characterisation of workers according to their entry and exit patterns and the second block is based on the analogous characterisation of firms. Most of our discussion will focus on the contributions of continuing and entering workers.

The first row in Table 5 decomposes the change in the raw average earnings rate. The single major contribution to the overall 0.090 log-point increase was the 0.108 within-industry average earnings growth of continuing workers, largely reflecting general earnings growth over the period (the 'multi-transition' group of workers contributes a similar but small component). Beyond this, the between-industry reallocation of employment of continuing workers contributed 0.007, and the increasing employment associated with worker-entry and increasing continuing-worker intensity tended to be associated with lower-earning jobs within industries (contributing -0.040 and -0.007, respectively). The increasing intensity of continuing

workers also occurred in lower-earning industries (-0.008 contribution), while entering workers tended to move into higher earning industries (0.015 contribution).

The second row decomposes the time effects, which measure the composition-adjusted earnings growth. The overall 0.146 growth is due to within-industry earnings growth of continuing (0.099), multi-transition (0.017) and entering workers (0.041). Between-industry employment shifts of continuing workers again contributed negatively (-0.011) to the overall change.

The third row of Table 5 shows the results for the change in average worker effects over the period. As was seen in Table 3, 60 percent (-0.029) of this is due to worker entry. In turn, about 60 percent (-0.016) of this worker-entry component is associated with entry into industries with lower than average worker earnings premiums, and 40 percent (-0.012) is associated with entering workers having earnings premiums below their industry's average. The remaining 40 percent overall is due to the increasing employment intensity of lower-earning continuing (-0.014) and multi-transition (-0.006) workers over the period and mainly due to within-industry earnings differences.

The final row in this panel decomposes the change in average firm effects over the period. In net, entrants account for the full 0.009 decline in average firm effect: one-third of this is due to worker entry into lower paying firms within industries, and two-thirds to lower-paying industries. As well as these entrant effects, there were off-setting contributions associated with continuing workers: the between-industry reallocation of employment of continuing workers' contributed 0.003, and there were -0.001 contributions from within-industry firm changes and increasing employment intensity associated with lower-paying firms.

The second panel presents results stratified by firm entry and exit patterns. As continuing firms dominate the employment, accounting for 81 percent of effective employment over the period, they generally dominate the change contributions presented here. That said, nearly one-third of the net 0.049 decline in average worker effects is associated with entering firms; about one-quarter is due to entering firms having lower than average within-industry worker effects; and three-quarters is due to those industries having lower than average worker effects. The results in the final row for the change in firm effects show that there was a -0.011 decline associated with firm entry (-0.007 within-industry and -0.004 between-industry entry effects) while within-industry reallocation of employment of continuing firms acted to reduce the overall decline in average firm effects slightly (0.002).

Three industry case studies

Finally, we present within-industry decompositions of the impacts of worker and firm entry and exit on the industry average earnings rate over the period. In order to keep the analysis manageable, we present the results for three industry case studies, selected on the basis of their size and/or the employment growth over the sample period. Manufacturing was the largest industry in terms of employment, accounting for 16 percent of total effective employment, but had relatively slow employment growth (8 percent) over the period. Construction was the fastest growing industry (64 percent FTE employment growth) over the period. Property and Business Services was the second-largest industry by employment (13 percent) and had the third-highest employment growth (32 percent) over the period. Each of these industries had below-average raw log(earnings) growth of 0.062 to 0.075.[25]

For each of these industries, we decompose the industry average log(earnings) and its various regression components using the equation (2) decomposition stratified by

[25] Also, each of these industries has greater than average earnings. From Appendix Table A4, in Manufacturing this is due to positive firm effects; in Construction this is due to positive worker effects; and in Business and Property Services this is due to positive worker and firm effects.

both worker and firm transition groups.[26] The results are presented in Table 6. Although the results vary across these industries, the general patterns are broadly similar to those in Table 4 and Table 5 for all industries. The average worker and firm effect declined over the period in each of the industries, and the declines were largely due to entry effects, although in Construction, employment intensity changes among continuing workers contributed half of the decline in worker effects.

Entering firms contributed -0.3 percent to the raw average log(earnings) growth in each of these industries, while exiting firms contributed positively by 1–1.5 percent. These results are broadly consistent with Law and McClellan's (2005) conclusions that entering and exiting firms tend to have lower productivity on average than continuing firms. With the exception of the time effects rows, negative and positive contributions of entering and exiting firms, respectively are also observed across the other dimensions.

In each of the industries, the entry of new firms lowered average log(earnings) growth, both because they had lower firm effects (-1.1 to -1.5 percent contribution), and because they employed workers with lower person effects, particularly in the Construction (-2.1 percent) and Property and Business Services (-3.0 percent) industries.

6. Concluding discussion

Between 1999 and 2007, employment in New Zealand increased by more than 20 percent, of which about half was from increasing labour force participation and falling unemployment and half was from population growth. In this paper, we use LEED employment and earnings data that links both workers and firms longitudinally to estimate the impact of changes in the composition of employment on measures average earnings growth over this period.

Based on our analysis, we conclude that compositional change in employment has had a substantial downwards effect on measured average earnings growth. Compared with the raw average log(earnings) growth of 0.09 (9 percent), we estimate the composition-adjusted increase in average log(earnings) was 0.15. This 0.06 difference between the raw and composition-adjusted increases is mainly due to a 0.05 decline in the average earnings premiums of workers. About 60 percent (-0.029) of this decline is associated with new workers entering employment, 25 percent (-0.013) is due to an increase in the employment intensity of lower-earning workers who are employed throughout the period, and the remainder (-0.006) is due to a combination of entry and increasing employment intensity of workers who were employed intermittently over the period. Furthermore, we estimate that about 60 percent of the worker-entry contribution is due to entry into low-earnings industries, and 40 percent is due to the new workers earning below-average earnings in those industries. The contribution from the changing employment intensity of continuing workers is largely due to within-industry intensity changes, rather than across-industry reallocation of those workers.

In addition to the contribution of the changing composition of workers, we also estimate a 0.01 decline in the average earnings premiums of firms over the period. This decline for firms was more than fully accounted for by the entry of new firms (-0.011), but was offset to a small degree (+0.002) by an increase in employment by firms with higher earnings premiums.

These results imply that the effects of compositional changes in employment on measured average earnings growth over this period appears to have been strong. For

[26] Note the worker and firm transition groups are defined at the aggregate LEED level so that, for workers in particular, for example the group of 'continuers' refers to the group of workers in an industry in either the first or last year who had worked in any industry in each of the sample years.

example, compared with 1.3 percent annual growth rate of measured raw earnings, composition-adjusted earnings grew at 2.1 percent over the period. It is plausible that similar type of composition change effects also apply to changes in average labour productivity, although the magnitude of the effects on productivity will depend also on changes in technology, and other inputs.

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Appendix 1: Labour Market Trends in the Household Labour Force Survey

For purposes of comparison with the employment and earnings trends observed in LEED, Appendix Table A1 presents some estimates derived from the Household Labour Force Survey (HLFS) over the same period covered by our analysis (April 1999 – March 2007). In contrast to the annual employment measure that we use in LEED, the HLFS estimates pertain to a reference week around the date of the survey, so the employment levels can be expected to differ; nonetheless, the relative changes may be more or less comparable. The top panel describes the changes in the working-age (15+) population, the labour force participation rate, the employment rate (the fraction of the labour force employed, calculated as 1 – the unemployment rate), total employment, and wage and salary employment. The employment increases are broadly comparable with those in LEED: total employment increased by 19 percent and wage and salary employment increased 23 percent, compared with the 21 and 23 percent increases in numbers of workers and FTE employment in LEED. The increase in employment is due to a combination of population increase, and increasing labour force participation and employment (falling unemployment) rates. The final column provides estimates of the relative contribution of each of these components, which suggests that increasing population accounts for about 55 percent of the increase in employment, increasing labour force participation accounts for about one-quarter, and falling unemployment for the remaining 20 percent. Abstracting from the increasing population, and assuming that the participation and unemployment rate changes are purely cyclical, suggests the business cycle upswing was responsible for about a 10 percent increase in employment over the period.

In the next panel of Appendix Table A1, we present estimates of the average hourly wage from the HLFS-Income Supplement (HLFS-IS). Average real hourly wages increased 7.3 percent over the period, compared with the LEED-based estimate of average FTE annual earnings of 6.9 percent. We have also estimated the average weekly hours worked: for wage and salary workers, this average was roughly constant over the period.[27] Finally, the bottom three rows of Appendix Table A1 present alternative measures of average FTE employment from the HLFS-IS: the first two are calculated by taking the average ratio of reported hours worked relative to 30 and 40 hours respectively (and censored above at 1); the third is based on workers' reported earnings and non-earnings income, using an analogous algorithm to that with the LEED data (described above). The average income-based FTE employment measure from the HLFS-IS (0.88) is similar to the average worker monthly employment intensity in months worked in LEED of 0.86 (weighted by months worked) and is closer to the average from the hours-based measure using 30 hours per week as the full-time level than that using 40 hours per week. Thus, although we expect our FTE employment measure to be biased upwards for both part-time workers and workers with benefit income, these comparisons provide some confidence around the adjustment made.

[27] Average weekly hours worked across all employment fell about 3 percent over the period, but this appears to be entirely due to falling hours worked among self employed workers.

Appendix 2: Identification of worker and firm fixed effects

Abowd, Creecy and Kramarz (2002) discuss two estimation issues that arise with the simultaneous estimation of worker and firm fixed effects models such as that shown in Equation (1). First, not all firm and person fixed effects are estimable. To determine which effects are estimable requires workers and firms to be allocated to non-overlapping groups of 'connected' firms and workers. Abowd, Creecy and Kramarz (2002, p. 3) summarise the essence of this connectedness:

"Connecting persons and firms requires that some of the individuals in the sample be employed in multiple employers. When a group of persons and firms is connected, the group contains all the workers who ever worked for any of the firms in the group and all the firms at which any of the workers were ever employed. In contrast, when a group of persons and firms is not connected to a second group, no firm in the first group has ever employed a person in the second group, nor has any person in the first group ever been employed by a firm in the second group."

We apply the Abowd, Creecy and Kramarz (2002) grouping algorithm to identify G distinct groups of connected firms and workers using data on all job-year observations during the eight year sample period. The results of this grouping are shown in Appendix Table A2. The vast majority (99.8%) of job-year observations appear in the largest group.

Second, the estimates of the estimable effects are not unique, and an explicit identification procedure must be imposed. The non-uniqueness of estimates arises because, within each group, it is arbitrary which effect is omitted – the group mean, one of the person effects, or one of the firm effects. To obtain unique estimates, we set the mean person effect within each group to be zero, and the overall mean firm effect to be zero. Thus, within a group g containing N_g persons and J_g firms, it is possible to identify the group mean, $N_g - 1$ person effects and $J_g - 1$ firm effects, yielding $N_g + J_g - 1$ identified effects. Across all G groups, there are $N + J - G$ estimable effects, and we can identify the overall mean of the dependent variable, and $N + J - G - 1$ person and firm fixed effects.

Table 1

Sample Characteristics,
1999/2000–2006/07

Variable	All years	Year 1: 1999/2000	Year 8: 2006/07	Year 1 to 8 change
Job-level characteristics				
Annual months	0.847	0.845	0.853	0.9%
FTE annual employment	0.783	0.780	0.789	1.1%
Annual earnings	$38,630	$37,580	$40,610	8.0%
FTE annual earnings	$46,590	$45,510	$48,640	6.9%
Worker-level characteristics				
Age (at 30th September)	38.5	37.5	39.3	4.8%
Female	0.462	0.462	0.463	0.2%
Annual months in LEED	0.953	0.953	0.951	-0.2%
Total FTE annual employment	0.878	0.875	0.878	0.4%
Months with transfer income	0.051	0.063	0.039	-38.4%
Months with NZS income	0.015	0.012	0.021	74.3%
Months with earnings	0.936	0.933	0.937	0.5%
Total annual earnings	$42,760	$41,630	$44,600	7.1%
Total annual transfer income	$550	$650	$450	-30.1%
Total annual NZS income	$200	$150	$280	83.0%
Total annual LEED income	$43,520	$42,430	$45,340	6.8%
No. jobs in year	1.56	1.58	1.52	-4.1%
Firm-level characteristics				
No. jobs in year	302.9	283.1	308.3	8.9%
Total annual job-months	191.8	177.5	200.7	13.0%
Total FTE annual employment	165.5	152.7	174.4	14.2%
No. Observations	25,603,780	2,920,770	3,439,660	17.8%
Total FTE employment	11,046,545	1,239,345	1,526,740	23.2%
No. worker-year observations	16,111,360	1,825,410	2,215,200	21.4%
No. firm-year observations	1,654,450	195,040	220,890	13.3%

Note: Over the eight-year sample period, there are 3,113,360 distinct employees, 374,950 distinct firms, and 12,658,650 distinct jobs observed. All earnings and incomes are in constant CPI-adjusted June 2007 $-values. Transfer income consists of working-age taxable benefits, student allowances, paid parental leave, and ACC payments.

Table 2

Summary of Earnings Components

Sample (No. Obs; total FTE)	Log (Earnings) (y_{ijt})	Worker sex & age ($X'_{ijt}\beta$)	Time effects (τ_t)	Worker effects (θ_i)	Firm effects (ψ_j)	Residual (ε_{ijt})
Full sample	10.600	10.600	0	0	0	0
(25.6m; 11.05m)	(0.51)	(0.19)	(0.05)	(0.37)	(0.16)	(0.17)
Annual composition effects (relative to full sample)						
1999/2000	-0.040	-0.002	-0.070	0.025	0.006	0.000
(2.92m; 1.24m)	(0.54)	(0.19)	(0.00)	(0.39)	(0.16)	(0.20)
2000/01	-0.043	-0.001	-0.067	0.020	0.005	0.000
(2.99m; 1.27m)	(0.52)	(0.19)	(0.00)	(0.39)	(0.16)	(0.18)
2001/02	-0.027	0.001	-0.043	0.012	0.003	0.000
(3.07m; 1.30m)	(0.51)	(0.19)	(0.00)	(0.38)	(0.16)	(0.16)
2002/03	-0.021	0.002	-0.027	0.004	0.000	0.000
(3.12m; 1.35m)	(0.50)	(0.19)	(0.00)	(0.38)	(0.15)	(0.16)
2003/04	0.006	0.001	0.010	-0.003	-0.002	0.000
(3.24m; 1.40m)	(0.50)	(0.19)	(0.00)	(0.37)	(0.15)	(0.15)
2004/05	0.022	0.000	0.035	-0.009	-0.003	0.000
(3.35m; 1.45m)	(0.50)	(0.19)	(0.00)	(0.37)	(0.16)	(0.15)
2005/06	0.035	-0.001	0.056	-0.017	-0.003	0.000
(3.47m; 1.50m)	(0.50)	(0.19)	(0.00)	(0.36)	(0.16)	(0.16)
2006/07	0.049	0.000	0.076	-0.023	-0.003	0.000
(3.44m; 1.53m)	(0.49)	(0.19)	(0.01)	(0.36)	(0.16)	(0.18)
1999/00 to 2006/07	0.090	0.001	0.146	-0.049	-0.009	0.000
Panel transitions (relative to full sample)						
Workers						
Continuers	0.069	0.034	-0.002	0.028	0.010	0.000
(8.64m; 7.26m)	(0.49)	(0.14)	(0.05)	(0.37)	(0.15)	(0.16)
Entrants	-0.187	-0.122	0.036	-0.070	-0.031	0.000
(2.87m; 1.52m)	(0.49)	(0.29)	(0.04)	(0.34)	(0.16)	(0.15)
Exiters	-0.021	-0.008	-0.039	0.023	0.003	0.000
(1.65m; 1.02m)	(0.55)	(0.16)	(0.04)	(0.42)	(0.17)	(0.18)
Multi-transition	-0.159	-0.040	0.002	-0.097	-0.024	0.000
(2.95m; 1.24m)	(0.51)	(0.21)	(0.05)	(0.37)	(0.17)	(0.19)
Firms						
Continuers	0.020	0.006	-0.001	0.008	0.007	0.000
(0.833m; 8.95m)	(0.50)	(0.18)	(0.05)	(0.38)	(0.15)	(0.16)
Entrants	-0.076	-0.032	0.038	-0.037	-0.046	0.000
(0.346m; 1.05m)	(0.49)	(0.22)	(0.04)	(0.35)	(0.19)	(0.17)
Exiters	-0.076	-0.011	-0.044	-0.019	-0.003	0.000
(0.252m; 0.77m)	(0.53)	(0.20)	(0.03)	(0.38)	(0.19)	(0.19)
Multi-transition	-0.147	-0.037	-0.003	-0.053	-0.054	0.000
(0.224m; 0.27m)	(0.50)	(0.22)	(0.05)	(0.35)	(0.22)	(0.19)

Note: Entries in parentheses are standard deviations.

Table 3

Decomposition of the Effect of Employment Composition Changes on FTE Earnings

	Log (Earnings) (y_{ijt})	**Worker sex & age ($X'_{ijt}\beta$)**	**Time effects (τ_t)**	**Worker effects (θ_i)**	**Firm effects (ψ_j)**	**Residual (ε_{ijt})**
1. Aggregate change	0.090	0.001	0.146	-0.049	-0.009	0.000
2. Worker transition group contributions						
Continuers: $w_0^C * (\overline{Y}_1^C - \overline{Y}_0^C)$	0.115	0.027	0.099	-0.013	0.002	0.001
$(w_1^C - w_0^C) * (\overline{Y}_1^C - \overline{Y}_0)$	-0.015	-0.004	-0.011	0.000	0.000	0.000
Entrants: $w_1^N * (\overline{Y}_1^N - \overline{Y}_0)$	-0.025	-0.031	0.041	-0.029	-0.009	0.003
Exiters: $- w_0^X * (\overline{Y}_0^X - \overline{Y}_0)$	0.003	0.003	0.000	-0.001	0.001	0.001
Multi: $w_0^M * (\overline{Y}_1^M - \overline{Y}_0^M)$	0.010	0.006	0.017	-0.005	-0.002	-0.005
$(w_1^M - w_0^M) * (\overline{Y}_1^M - \overline{Y}_0)$	0.000	0.000	0.001	-0.001	0.000	0.000
3. Firm transition group contributions						
Continuers: $w_0^C * (\overline{Y}_1^C - \overline{Y}_0^C)$	0.084	0.005	0.118	-0.040	0.002	0.000
$(w_1^C - w_0^C) * (\overline{Y}_1^C - \overline{Y}_0)$	-0.003	0.000	-0.003	0.001	0.000	0.000
Entrants: $w_1^N * (\overline{Y}_1^N - \overline{Y}_0)$	-0.002	-0.006	0.030	-0.015	-0.011	0.000
Exiters: $- w_0^X * (\overline{Y}_0^X - \overline{Y}_0)$	0.008	0.002	0.000	0.006	0.000	0.000
Multi: $w_0^M * (\overline{Y}_1^M - \overline{Y}_0^M)$	0.001	0.000	0.002	0.000	0.000	0.000
$(w_1^M - w_0^M) * (\overline{Y}_1^M - \overline{Y}_0)$	0.000	0.000	0.000	0.000	0.000	0.000

Note: See equation 2 and text for details and discussion of the decomposition.

Table 4

Seven-year Changes in Earnings Components

	Fraction of FTE employment	Rel. Change in FTE employment	Change in no. of workers	Change in no. of firms	Log (Earnings) (y_{ijt})	Worker sex & age ($X'_{ijt}\beta$)	Time effects (τ_t)	Worker effects (θ_i)	Firm effects (ψ_j)	Residual (ε_{ijt})
Full sample	1	0.232	0.214	0.133	0.090	0.001	0.146	-0.049	-0.009	0.000
					Relative to full sample					
Males	0.538	-0.002	-0.008	...	-0.022	-0.002	-0.005	-0.012	-0.003	0.000
Females	0.462	0.003	0.008	...	0.026	0.002	0.006	0.015	0.004	0.000
Age group (years):										
18–24	0.142	-0.058	0.009	...	0.030	0.000	-0.001	0.027	0.003	0.001
25–34	0.245	-0.188	-0.173	...	-0.047	0.000	0.000	-0.026	-0.007	-0.013
35–44	0.256	-0.049	-0.067	...	-0.007	0.000	-0.001	-0.022	0.002	0.014
45–54	0.210	0.084	0.070	...	-0.009	0.000	-0.001	0.002	0.003	-0.014
55–65	0.112	0.503	0.394	...	0.003	0.000	-0.009	0.009	0.003	0.001
Firm size										
1–9	0.155	-0.038	...	-0.018	0.034	0.007	-0.001	0.039	-0.001	-0.011
10–19	0.128	0.021	...	0.037	0.008	0.000	0.000	0.012	0.000	-0.004
20–49	0.189	0.027	...	0.065	-0.002	-0.004	0.000	0.002	0.002	-0.002
50–99	0.144	-0.052	...	-0.012	-0.003	-0.001	0.000	-0.006	0.002	0.002
100–249	0.164	-0.020	...	0.048	-0.012	0.000	0.000	-0.012	-0.004	0.003
250–499	0.094	0.047	...	0.067	0.013	0.008	0.000	-0.010	0.005	0.010
500+	0.126	0.041	...	0.176	-0.046	-0.009	0.001	-0.037	-0.008	0.008
Region										
Auckland	0.339	0.002	...	0.073	-0.010	0.006	0.000	-0.019	0.002	0.001
Wellington	0.128	-0.076	...	-0.024	-0.019	0.000	0.000	-0.018	-0.005	0.003
Christchurch	0.132	0.008	...	-0.004	0.014	-0.003	0.000	0.015	0.004	-0.002
Other	0.402	0.021	...	-0.033	0.013	-0.003	0.000	0.018	0.000	-0.001

Table 4 (continued)

	Fraction of FTE employment	Relative change in FTE employment	Change in no. of workers	Change in no. of firms	Log (Earnings) (y_{ijt})	Worker sex & age ($X'_{ijt}\beta$)	Time effects (τ_t)	Worker effects (θ_i)	Firm effects (ψ_j)	Residual (ε_{ijt})
Full sample	1	0.232	0.214	0.133	0.090	0.001	0.146	-0.049	-0.009	0.000
					Relative to full sample					
Industry										
A Agr., Forestry & Fishing	0.051	0.004	...	-0.166	0.062	0.017	-0.002	0.054	0.003	-0.010
B Mining	0.003	0.231	...	-0.038	0.078	-0.012	-0.004	0.021	0.059	0.014
C Manufacturing	0.158	-0.146	...	-0.073	-0.024	-0.002	-0.002	0.011	-0.009	-0.023
D Electricity, Gas & Water	0.004	-0.100	...	-0.294	-0.056	-0.011	-0.001	-0.042	0.004	-0.005
E Construction	0.061	0.412	...	0.297	-0.015	-0.015	-0.004	0.004	-0.003	0.002
F Wholesale Trade	0.068	-0.029	...	-0.015	-0.028	0.001	-0.001	-0.015	-0.010	-0.003
G Retail Trade	0.111	-0.026	...	0.011	0.038	0.016	0.001	0.020	0.007	-0.005
H Acc., Cafes & Restaurants	0.045	0.020	...	0.119	0.050	0.003	0.001	0.041	0.007	-0.003
I Transport & Storage	0.044	0.013	...	-0.053	-0.036	-0.001	-0.002	-0.011	-0.007	-0.015
J Communication Services	0.014	-0.174	...	-0.105	-0.032	0.014	0.000	-0.031	0.002	-0.017
K Finance & Insurance	0.030	-0.121	...	-0.002	0.009	0.004	0.001	-0.021	0.001	0.023
L Property & Bus. Services	0.134	0.084	...	0.199	-0.027	-0.002	0.000	-0.032	-0.003	0.010
M Govt Admin & Defence	0.039	0.008	...	-0.187	0.000	0.000	0.001	-0.032	0.014	0.017
N Education	0.088	-0.034	...	-0.119	-0.011	-0.008	0.002	-0.028	0.008	0.015
O Health & Comm Services	0.092	0.020	...	-0.073	0.044	-0.005	0.004	0.016	0.013	0.016
P Cultural & Rec. Services	0.023	0.029	...	0.033	0.006	0.002	0.000	-0.018	0.012	0.009
Q Personal & Other Serv.	0.035	0.074	...	0.058	-0.004	0.000	0.000	-0.003	0.004	-0.005

Note: Entries in the first column are fractions of total FTE employment over the eight -year sample period. Other column entries in first row are percentages changes over the period for the full sample; and entries in other rows are percentage changes expressed relative to the full sample change in each column.

Symbol: …not applicable

Table 5

Detailed Industry Decomposition of the Effect of Employment Changes

	Aggregate change	1. Continuers				2. Entrants		3. Exiters	4. Others
		Earnings		Share		Earnings			
		W/in	Btwn	W/in	Btwn	W/in	Btwn		
1. Worker transition groups									
Log(FTE Earnings) (y_{ijt})	0.090	0.108	0.007	-0.007	-0.008	-0.040	0.015	0.003	0.010
Time Effects (τ_t)	0.146	0.099	0.000	0.000	-0.011	0.000	0.041	0.000	0.018
Worker Effects (θ_i)	-0.049	-0.017	0.003	-0.003	0.003	-0.012	-0.016	-0.001	-0.006
Firm Effects (ψ_j)	-0.009	-0.001	0.003	-0.001	0.000	-0.003	-0.006	0.001	-0.002
2. Firm transition groups									
Log(FTE Earnings) (y_{ijt})	0.090	0.078	0.006	0.000	-0.002	-0.014	0.012	0.008	0.002
Time Effects (τ_t)	0.146	0.118	0.000	0.000	-0.003	0.000	0.030	0.000	0.002
Worker Effects (θ_i)	-0.049	-0.043	0.002	0.000	0.001	-0.004	-0.011	0.006	0.000
Firm Effects (ψ_j)	-0.009	0.000	0.002	0.000	0.000	-0.007	-0.004	0.000	0.000

Note: The components of the decomposition presented in Table 3 are as follows:

1. Continuers: $$w_0^C \sum_k \left\{ \underbrace{w_{0k}^C (\overline{Y}_{1k}^C - \overline{Y}_{0k}^C)}_{Earnings,within} + \underbrace{(w_{1k}^C - w_{0k}^C) * (\overline{Y}_{1k}^C - \overline{Y}_0)}_{Earnings,between} \right\} + (w_1^C - w_0^C) \sum_k w_{1k}^C \left\{ \underbrace{(\overline{Y}_{1k}^C - \overline{Y}_{1k})}_{Share,within} + \underbrace{(\overline{Y}_{1k} - \overline{Y}_0)}_{Share,between} \right\};$$

2. Entrants: $$w_1^N \sum_k w_{1k}^N \left\{ \underbrace{(\overline{Y}_{1k}^N - \overline{Y}_{1k})}_{Earnings,within} + \underbrace{(\overline{Y}_{1k} - \overline{Y}_0)}_{Earnings,between} \right\};$$

3. Exiters: $$- w_0^X \sum_k w_{0k}^X \left\{ (\overline{Y}_{0k}^X - \overline{Y}_{0k}) + (\overline{Y}_{0k} - \overline{Y}_0) \right\};$$

4. Others: $$w_0^M \sum_k \left\{ w_{0k}^M (\overline{Y}_{1k}^M - \overline{Y}_{0k}^M) + (w_{1k}^M - w_{0k}^M) * (\overline{Y}_{1k}^M - \overline{Y}_0) \right\} + (w_1^M - w_0^M) \sum_k w_{1k}^M \left\{ (\overline{Y}_{1k}^M - \overline{Y}_{1k}) + (\overline{Y}_{1k} - \overline{Y}_0) \right\}.$$

Table 6
Decomposition of employment Employment Change Effects within Industries

Industry	Total change	Contribution of			
		continuers	entrants	exiters	multi
Worker transition groups					
C. Manufacturing					
Log(FTE Earnings) (y_{ijt})	0.065	0.085	-0.027	0.004	0.004
Time Effects (τ_t)	0.145	0.097	0.034	0.000	0.014
Sex & age ($X_{ijt}'\beta$)	-0.001	0.021	-0.028	0.003	0.003
Worker Effects (θ_i)	-0.037	-0.010	-0.023	-0.002	-0.003
Firm Effects (ψ_j)	-0.018	-0.007	-0.009	0.001	-0.003
E. Construction					
Log(FTE Earnings) (y_{ijt})	0.075	0.073	-0.017	0.007	0.012
Time Effects (τ_t)	0.143	0.078	0.043	0.000	0.021
Sex & age ($X_{ijt}'\beta$)	-0.014	0.017	-0.041	0.004	0.006
Worker Effects (θ_i)	-0.045	-0.023	-0.016	0.001	-0.007
Firm Effects (ψ_j)	-0.012	-0.004	-0.006	0.002	-0.004
L. Property and Business Services					
Log(FTE Earnings) (y_{ijt})	0.062	0.091	-0.025	-0.008	0.004
Time Effects (τ_t)	0.147	0.082	0.044	0.000	0.021
Sex & age ($X_{ijt}'\beta$)	0.000	0.015	-0.023	0.003	0.005
Worker Effects (θ_i)	-0.081	-0.015	-0.042	-0.010	-0.013
Firm Effects (ψ_j)	-0.013	0.003	-0.008	-0.002	-0.005
Firm transition groups					
C. Manufacturing					
Log(FTE Earnings) (y_{ijt})	0.065	0.057	-0.003	0.010	0.001
Time Effects (τ_t)	0.145	0.128	0.016	0.000	0.001
Sex & age ($X_{ijt}'\beta$)	-0.001	0.000	-0.002	0.001	0.000
Worker Effects (θ_i)	-0.037	-0.040	-0.004	0.007	0.000
Firm Effects (ψ_j)	-0.018	-0.008	-0.011	0.001	0.000
E. Construction					
Log(FTE Earnings) (y_{ijt})	0.075	0.060	-0.003	0.015	0.003
Time Effects (τ_t)	0.143	0.092	0.047	0.000	0.004
Sex & age ($X_{ijt}'\beta$)	-0.014	-0.006	-0.012	0.004	0.000
Worker Effects (θ_i)	-0.045	-0.033	-0.021	0.010	0.000
Firm Effects (ψ_j)	-0.012	0.002	-0.015	0.001	0.000
L. Property and Business Services					
Log(FTE Earnings) (y_{ijt})	0.062	0.053	-0.003	0.010	0.002
Time Effects (τ_t)	0.147	0.102	0.043	0.000	0.002
Sex & age ($X_{ijt}'\beta$)	0.000	0.001	-0.004	0.002	0.000
Worker Effects (θ_i)	-0.081	-0.057	-0.030	0.006	0.000
Firm Effects (ψ_j)	-0.013	-0.001	-0.014	0.002	0.000

Note: Industry-level decompositions are used that are analogous to the aggregate decompositions in Table 3.

Appendix Table A1

Survey-based Employment Growth and Wage Changes

1999–2006

	1999/2000	2006/07	Change	Employment growth [1]
		Contributions to employment growth		
Working-age population	2,922,000	3,229,000	10.5%	55.0%
LF participation rate	65.4%	68.4%	3.0%	26.7%
Employment rate	93.4%	96.3%	2.9%	18.3%
Employed (Total)	1,785,000	2,126,000	19.1%	100.0%
Wage and salary employed	1,409,000	1,738,000	23.1%	
Average		**Wage and Salary workers[2]**		
Hourly wages	$19.20	$20.60	7.3%	
Usual weekly hours	37.1	37.1	0.0%	
FTE (FT=30 hours)	0.877	0.894	1.9%	
FTE (FT=40 hours)	0.831	0.849	2.1%	
FTE (Income based)	0.884	0.881	-0.3%	

Note: Estimates are derived from published statistics from the Household Labour Force Survey (HLFS) for the 1999/2000 and 2006/07 years, and the HLFS-Income Supplement (HLFS-IS). Employment includes wage and salary and self-employment and, in contrast to LEED's annual-employment measure, is a current employment measure at the time of the survey. Wages are expressed in CPI-adjusted June 2007 $-values.

[1] The employment growth is decomposed into population, labour force and employment rate contributions by the respective components in: $\Delta Emp = ER_{99}*LFPR_{99}*\Delta Pop + ER_{99}*\Delta LFPR*Pop_{06} + \Delta ER*LFPR_{06}*Pop_{06}$.

[2] Using data from the HLFS-IS June Quarter.

Appendix Table A2

Results of Grouping Algorithm

	Largest group (% of total)	Second largest group	Average in other groups	Total of all groups
Observations	25,554,120 (99.8%)	56	5	25,603,780
FTE	11,015,188 (99.7%)	50	3	11,046,546
Persons	3,099,670 (99.6%)	51	1	3,113,360
Firms	363,400 (96.9%)	4	1	374,950
Estimable effects	3,463,070 (99.6%)	54	1	3,477,520

Note: There are 10,788 distinct groups of connected workers and firms.

Appendix Table A3
Source and Destination of Entering and Exiting Workers

	All workers	Worker transition group							
		Continuers	Entrants		Exiters		Multi-transitions	
Only non-jobs	0.096	...	0.189		0.282		0.391	
Jobs & non-jobs	0.330	0.388	0.230		0.231		0.189	
Any non-jobs	0.426	0.388	0.418		0.513		0.579	
Ever only non-jobs			Yes	No	Yes	No	Yes	No
Female	0.46	0.46	0.50	0.45	0.48	0.45	0.49	0.48
Age	38.5	40.4	37.2	31.0	48.5	36.0	35.2	33.6
Non-job only years	0.2	...	1.8	...	2.2	...	1.8	...
Non-job years	1.3	1.0	4.3	0.5	4.4	0.7	4.8	0.6
LEED years	7.3	8.0	7.5	5.1	7.4	5.3	7.3	5.4
log(FTE earnings)	10.600	10.669	10.380	10.420	10.437	10.634	10.318	10.519
Time effects	0.000	-0.002	0.030	0.037	-0.041	-0.039	0.003	0.002
Sex and age	0.000	0.034	0.010	-0.153	-0.029	0.000	-0.040	-0.041
Worker effects	0.000	0.028	-0.220	-0.035	-0.073	0.061	-0.202	-0.030
Firm effects	0.000	0.010	-0.039	-0.029	-0.021	0.012	-0.042	-0.012
No. workers	3,113,360	1,080,480	120,140	667,480	146,000	292,490	322,310	484,450

Symbol: …not applicable

Appendix Table A4
Summary of Earnings Components across Employment Subgroups

Sample	Log (Earnings) (y_{ijt})	Worker sex & age ($X'_{ijt}\beta$)	Time effects (τ_t)	Worker effects (θ_i)	Firm effects (ψ_j)	Residual (ε_{ijt})
1. FTE weighted	10.60	10.60	0	0	0	0
(Overall R^2=0.890)	(0.51)	(0.19)	(0.05)	(0.37)	(0.16)	(0.17)
Males	0.12	-0.01	0.00	0.12	0.02	0
	(0.52)	(0.19)	(0.05)	(0.37)	(0.16)	(0.17)
Females	-0.14	0.01	0.00	-0.14	-0.02	0
	(0.45)	(0.18)	(0.54)	(0.33)	(0.15)	(0.17)
Aged:						
18–24	-0.33	-0.28	0.00	-0.02	-0.03	0.00
	(0.33)	(0.13)	(0.05)	(0.20)	(0.14)	(0.17)
25–34	0.03	0.03	0.00	-0.01	0.02	0.00
	(0.42)	(0.06)	(0.05)	(0.32)	(0.15)	(0.17)
35–44	0.12	0.11	0.00	-0.01	0.02	0.00
	(0.51)	(0.01)	(0.05)	(0.42)	(0.16)	(0.17)
45–54	0.12	0.11	0.00	0.00	0.00	0.00
	(0.52)	(0.00)	(0.05)	(0.43)	(0.16)	(0.16)
55–65	0.05	0.03	0.01	0.03	-0.01	0.00
	(0.51)	(0.07)	(0.05)	(0.43)	(0.16)	(0.17)
Region						
Auckland	0.08	0.00	0.00	0.04	0.04	0
	(0.53)	(0.18)	(0.05)	(0.40)	(0.15)	(0.17)
Wellington	0.10	0.01	0.00	0.06	0.03	0
	(0.55)	(0.17)	(0.05)	(0.41)	(0.16)	(0.18)
Christchurch	-0.05	0.00	0.00	-0.03	-0.03	0
	(0.48)	(0.19)	(0.05)	(0.36)	(0.14)	(0.16)
Other	-0.08	-0.01	0.00	-0.04	-0.03	0
	(0.47)	(0.20)	(0.05)	(0.34)	(0.15)	(0.16)

Appendix Table A4 (continued)

Sample	Log (Earnings) (y_{ijt})	Worker sex & age ($X'_{ijt}\beta$)	Time effects (τ_t)	Worker effects (θ_i)	Firm effects (ψ_j)	Residual (ε_{ijt})
A Agri, forestry & fishing	-0.24	-0.07	0.00	-0.08	-0.09	0
	(0.40)	(0.25)	(0.05)	(0.30)	(0.15)	(0.18)
B Mining	0.38	0.04	0.00	0.13	0.21	0
	(0.48)	(0.14)	(0.05)	(0.35)	(0.19)	(0.17)
C Manufacturing	0.08	0.01	0.00	0.00	0.07	0
	(0.44)	(0.17)	(0.05)	(0.34)	(0.14)	(0.16)
D Electricity, gas & water	0.38	0.05	0.00	0.17	0.16	0
	(0.52)	(0.12)	(0.05)	(0.42)	(0.12)	(0.18)
E Construction	0.04	-0.02	0.00	0.05	0.00	0
	(0.40)	(0.20)	(0.05)	(0.28)	(0.15)	(0.15)
F Wholesale trade	0.11	0.02	0.00	0.06	0.03	0
	(0.50)	(0.16)	(0.05)	(0.39)	(0.14)	(0.17)
G Retail trade	-0.29	-0.08	0.00	-0.09	-0.11	0
	(0.44)	(0.26)	(0.05)	(0.31)	(0.12)	(0.16)
H Accomm., cafes & rest.	-0.38	-0.10	0.00	-0.14	-0.14	0
	(0.38)	(0.26)	(0.05)	(0.28)	(0.09)	(0.17)
I Transport & storage	0.11	0.03	0.00	0.04	0.05	0
	(0.46)	(0.15)	(0.05)	(0.34)	(0.15)	(0.17)
J Communication services	0.13	0.01	0.00	0.03	0.09	0
	(0.58)	(0.19)	(0.05)	(0.42)	(0.16)	(0.19)
K Finance & insurance	0.28	0.04	0.00	0.09	0.15	0
	(0.59)	(0.13)	(0.05)	(0.49)	(0.15)	(0.20)
L Property & bus. services	0.12	0.01	0.00	0.07	0.04	0
	(0.57)	(0.16)	(0.05)	(0.43)	(0.18)	(0.18)
M Govt. admin & defence	0.21	0.03	0.00	0.09	0.09	0
	(0.45)	(0.14)	(0.05)	(0.38)	(0.07)	(0.16)
N Education	0.07	0.05	0.00	0.05	-0.03	0
	(0.47)	(0.11)	(0.05)	(0.41)	(0.07)	(0.17)
O Health & comm. services	-0.07	0.05	0.00	-0.09	-0.03	0
	(0.50)	(0.12)	(0.05)	(0.41)	(0.13)	(0.16)
P Cultural & rec. services	-0.03	-0.01	0.00	0.01	-0.03	0
	(0.53)	(0.19)	(0.05)	(0.39)	(0.16)	(0.18)
Q Personal & other services	-0.02	0.02	0.00	-0.03	-0.01	0
	(0.48)	(0.17)	(0.05)	(0.33)	(0.18)	(0.15)
Firm size						
1–9	-0.14	-0.01	0.00	-0.04	-0.08	0.00
	(0.30)	(0.13)	(0.03)	(0.23)	(0.14)	(0.11)
10–19	-0.07	-0.01	0.00	-0.02	-0.04	0.00
	(0.31)	(0.13)	(0.03)	(0.22)	(0.09)	(0.11)
20–49	-0.02	-0.01	0.00	0.00	-0.01	0.00
	(0.32)	(0.13)	(0.03)	(0.23)	(0.09)	(0.11)
50–99	0.02	0.00	0.00	0.01	0.01	0.00
	(0.33)	(0.12)	(0.03)	(0.25)	(0.09)	(0.11)
100–249	0.05	0.01	0.00	0.01	0.03	0.00
	(0.35)	(0.12)	(0.04)	(0.26)	(0.09)	(0.11)
250–499	0.07	0.00	0.00	0.01	0.05	0.00
	(0.36)	(0.13)	(0.04)	(0.26)	(0.10)	(0.11)
500+	0.13	0.02	0.00	0.05	0.06	0.00
	(0.34)	(0.10)	(0.03)	(0.27)	(0.09)	(0.11)

Appendix Table A5
Mean Worker and Firm Effects across Worker Transition Groups

Year	Continuers	Single-entrants	Single-exiters	Multiple-transitions	Total
			Mean worker effects		
1999/00	0.040	...	0.032	-0.069	0.025
2000/01	0.035	-0.053	0.028	-0.074	0.020
2001/02	0.031	-0.060	0.022	-0.086	0.012
2002/03	0.028	-0.064	0.017	-0.096	0.004
2003/04	0.026	-0.066	0.014	-0.104	-0.003
2004/05	0.024	-0.067	0.011	-0.108	-0.009
2005/06	0.022	-0.071	0.008	-0.113	-0.017
2006/07	0.020	-0.078	...	-0.114	-0.023
All years	0.028	-0.070	0.023	-0.097	0.000
			Mean firm effects		
1999/00	0.007	…	0.007	-0.037	0.006
2000/01	0.007	-0.030	0.004	-0.037	0.005
2001/02	0.007	-0.034	-0.002	-0.041	0.003
2002/03	0.006	-0.036	-0.011	-0.053	0.000
2003/04	0.006	-0.044	-0.019	-0.066	-0.002
2004/05	0.007	-0.047	-0.017	-0.059	-0.003
2005/06	0.008	-0.048	-0.015	-0.064	-0.003
2006/07	0.009	-0.047	...	-0.065	-0.003
All years	0.007	-0.045	-0.002	-0.054	0.000

Symbol: …not applicable

Appendix Table A6

Mean Worker and Firm Effects across Worker Transition Groups
By entry and exit year

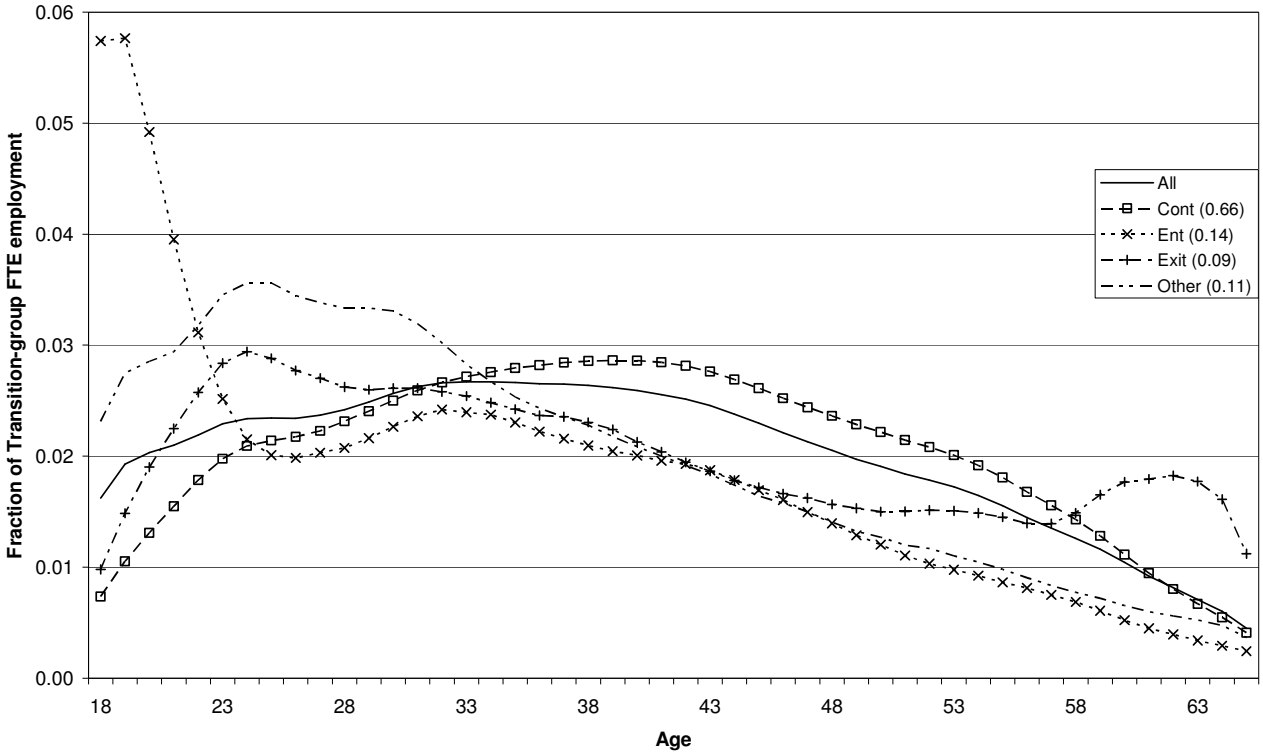
	Single-entrants – first seen in:							Single-exiters – last seen in:						
	2000/01	**2001/02**	**2002/03**	**2003/04**	**2004/05**	**2005/06**	**2006/07**	**1999/00**	**2000/01**	**2001/02**	**2002/03**	**2003/04**	**2004/05**	**2005/06**
	Mean worker effects													
1999/00	...	...	...	...	...	...	...	0.030	0.050	0.051	0.034	0.026	0.020	0.013
2000/01	-0.053	...	...	...	...	...	...	...	0.039	0.050	0.035	0.026	0.019	0.010
2001/02	-0.061	-0.056	...	...	...	...	...	...	...	0.044	0.033	0.025	0.017	0.008
2002/03	-0.066	-0.064	-0.058	...	...	...	...	...	...	...	0.026	0.026	0.016	0.008
2003/04	-0.068	-0.065	-0.063	-0.068	...	...	...	...	...	...	...	0.023	0.017	0.009
2004/05	-0.071	-0.065	-0.064	-0.070	-0.064	...	...	...	...	...	...	...	0.014	0.009
2005/06	-0.075	-0.068	-0.066	-0.072	-0.069	-0.083	...	...	...	...	...	...	...	0.008
2006/07	-0.078	-0.071	-0.068	-0.073	-0.070	-0.082	-0.117	...	...	...	...	...	...	...
All years	-0.069	-0.066	-0.065	-0.071	-0.069	-0.082	-0.117	0.030	0.046	0.049	0.033	0.025	0.017	0.009
	Mean firm effects													
1999/00	...	...	...	...	...	...	...	0.008	0.001	0.026	0.035	-0.012	-0.007	-0.016
2000/01	-0.030	...	...	...	...	...	...	...	-0.013	0.020	0.032	-0.012	-0.007	-0.015
2001/02	-0.031	-0.039	...	...	...	...	...	...	...	0.013	0.022	-0.017	-0.014	-0.014
2002/03	-0.032	-0.039	-0.041	...	...	...	...	...	...	...	0.016	-0.018	-0.016	-0.015
2003/04	-0.036	-0.036	-0.053	-0.062	...	...	...	...	...	...	...	-0.021	-0.018	-0.018
2004/05	-0.035	-0.038	-0.051	-0.058	-0.056	...	...	...	...	...	...	...	-0.013	-0.019
2005/06	-0.032	-0.035	-0.050	-0.053	-0.058	-0.071	...	...	...	...	...	...	...	-0.015
2006/07	-0.029	-0.030	-0.048	-0.050	-0.054	-0.065	-0.060	...	...	...	...	...	...	...
All years	-0.032	-0.036	-0.049	-0.055	-0.056	-0.067	-0.060	0.008	-0.004	0.022	0.028	-0.015	-0.012	-0.016

Symbol: …not applicable

Figure 1

Age Profiles of FTE Employment Distributions
By transition-group

(a) Males



(b) Females

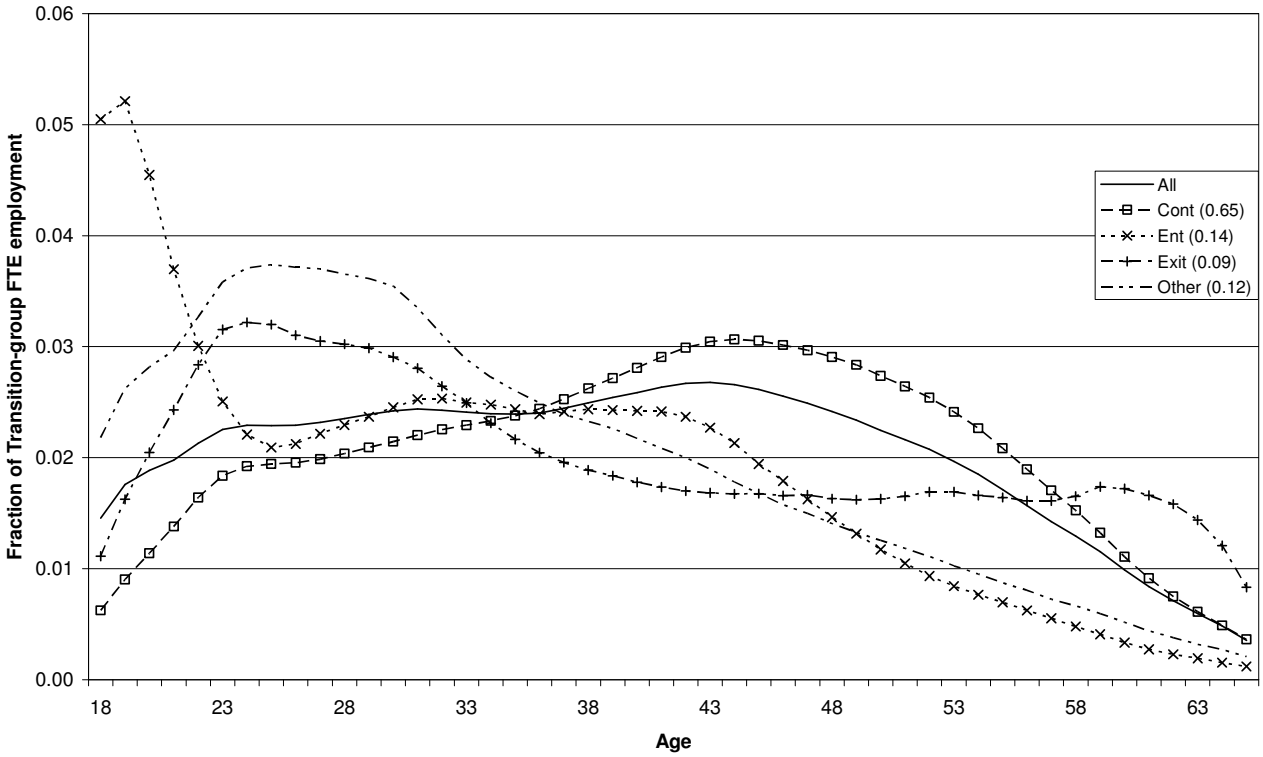
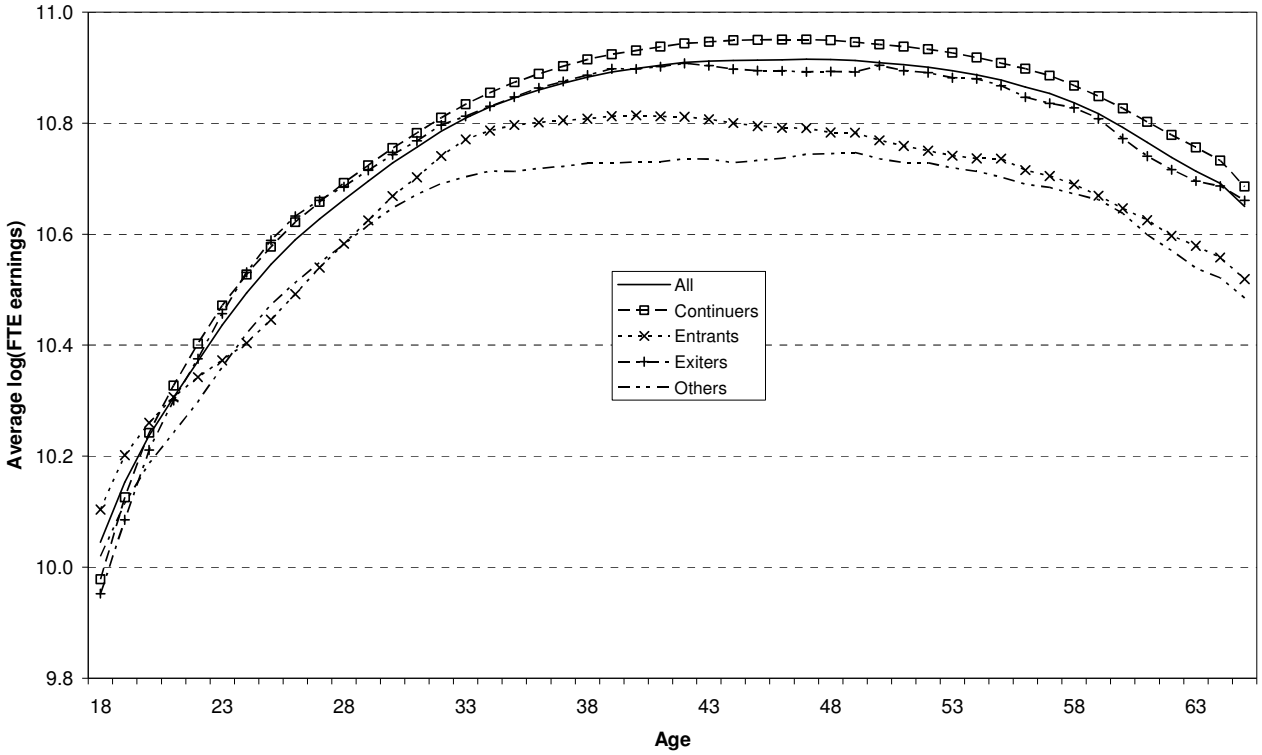


Figure 2

Age Profiles of log(FTE earnings)
By transition group

(a) Males



(b) Females

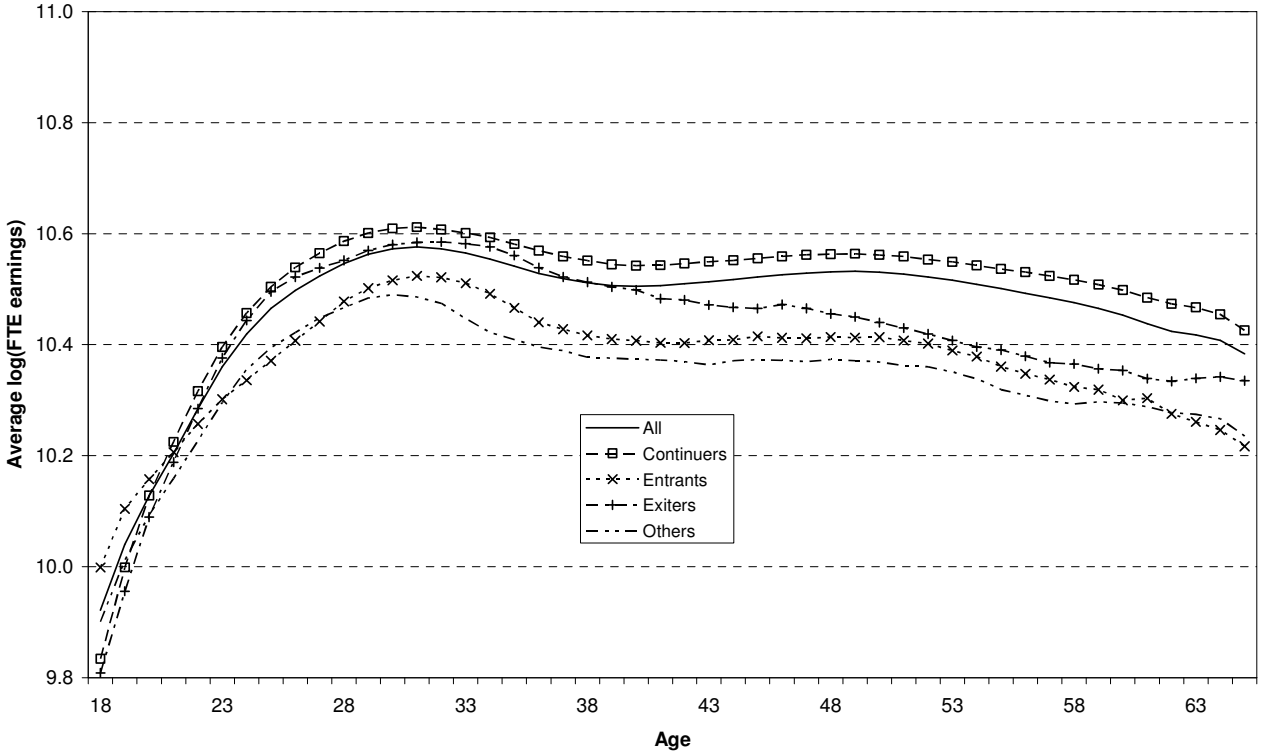
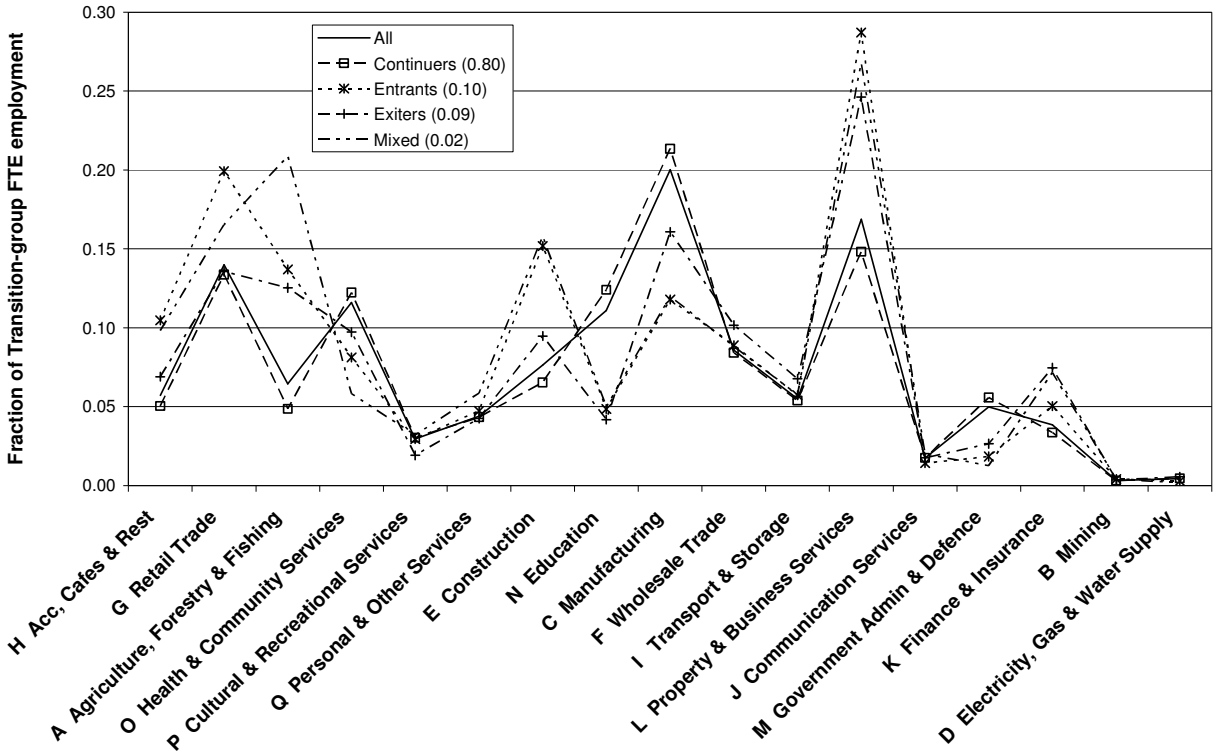


Figure 3
Industry Profiles of FTE Employment Distributions and log(FTE earnings)
By transition group

(a) FTE employment distributions



(b) log(FTE earnings)

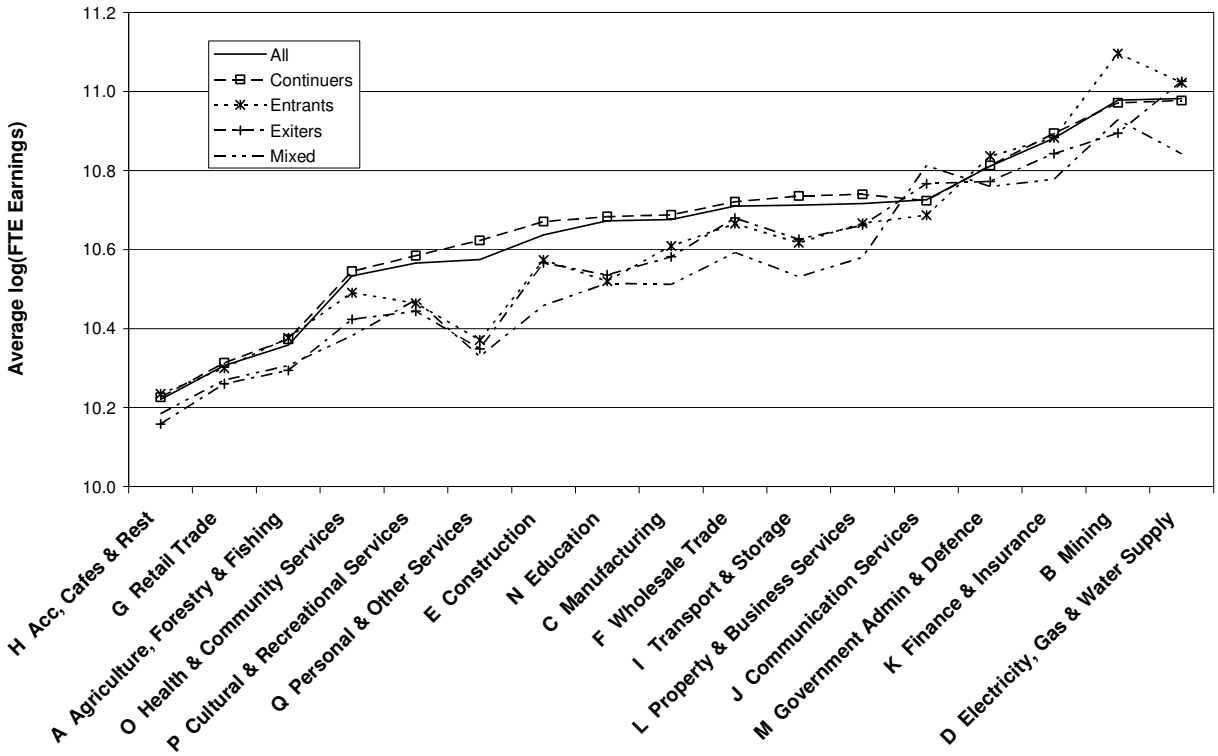
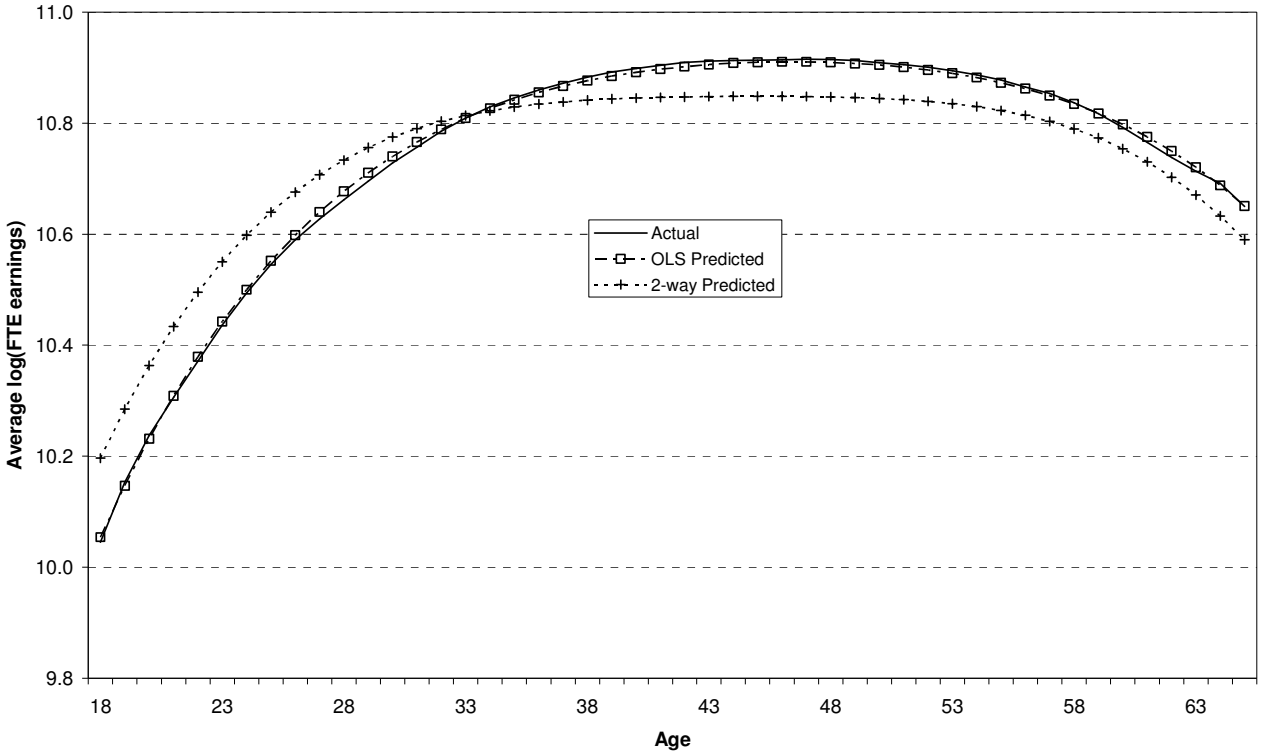


Figure 4

Age Profiles of log(FTE earnings)
Actual and predicted

(a) Males



(b) Females

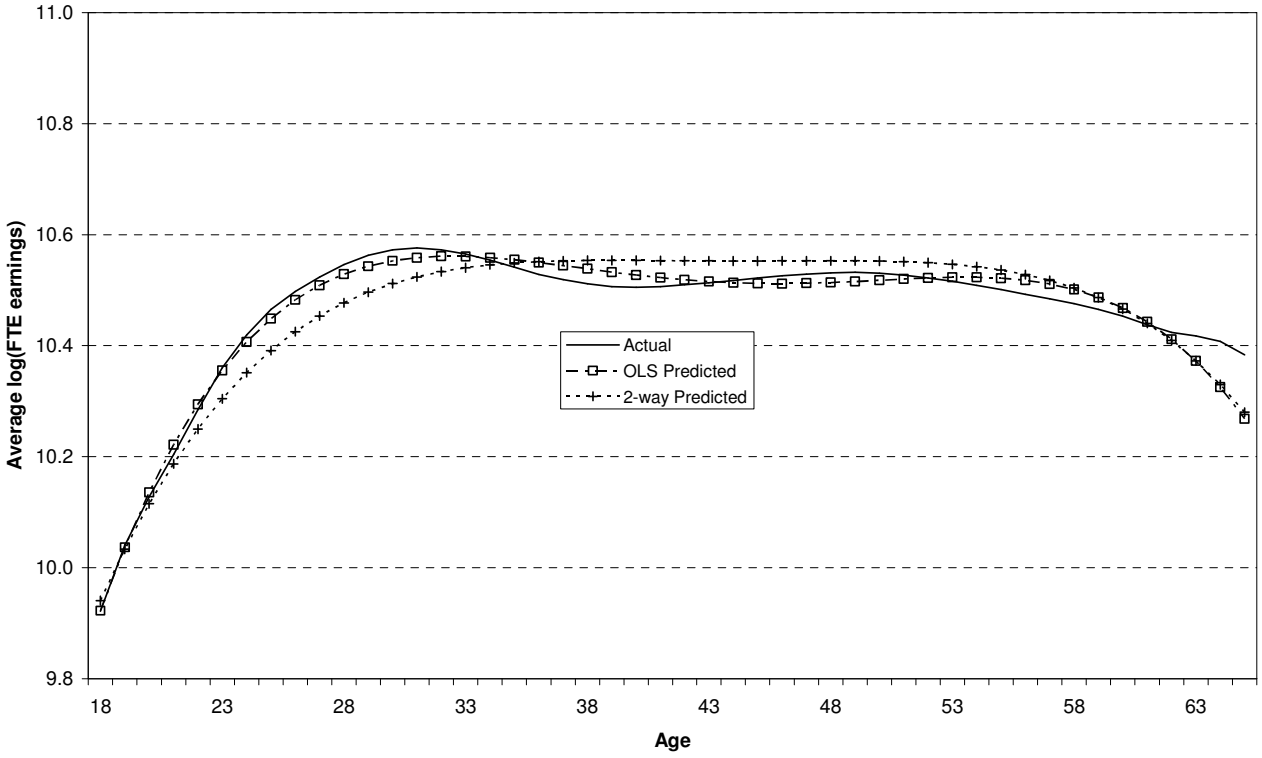
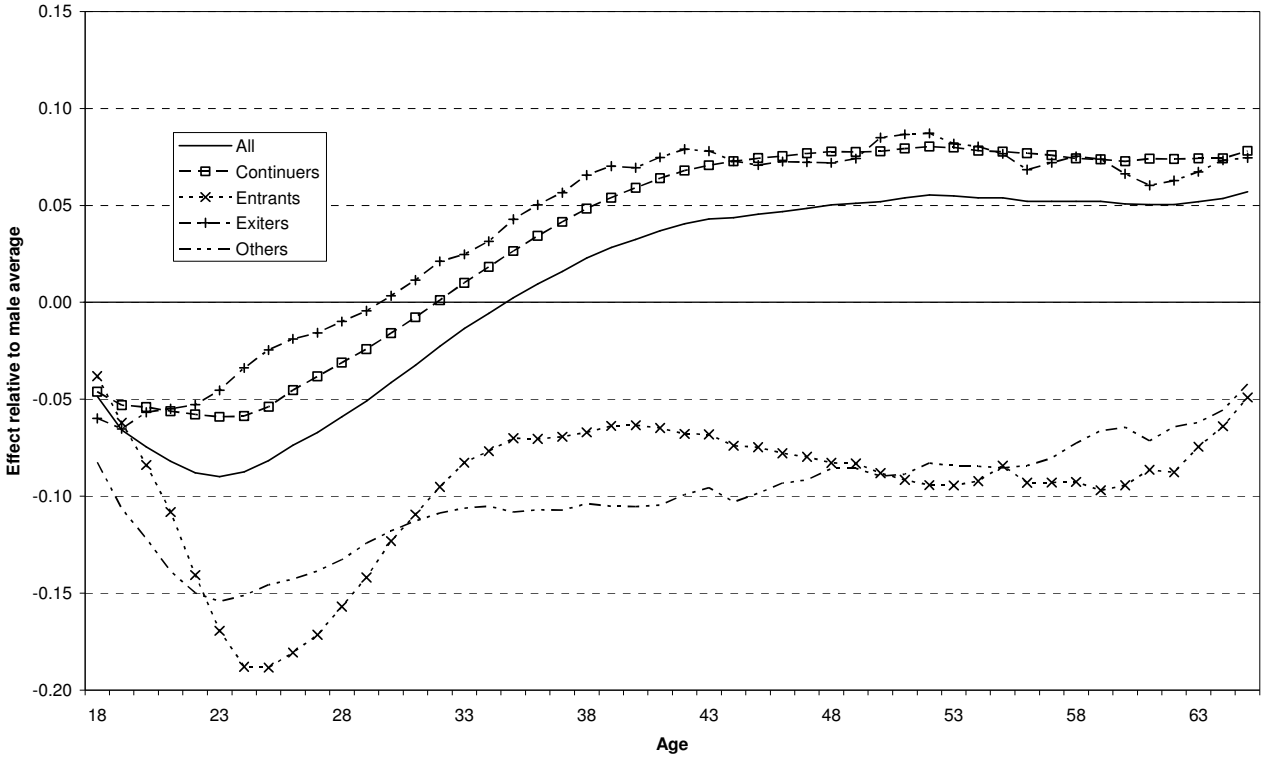


Figure 5

Age Profiles of Worker Fixed Effects
By transition group

(a) Males (Average male effect = 0.12)



(b) Females (Average female effect = -0.14)

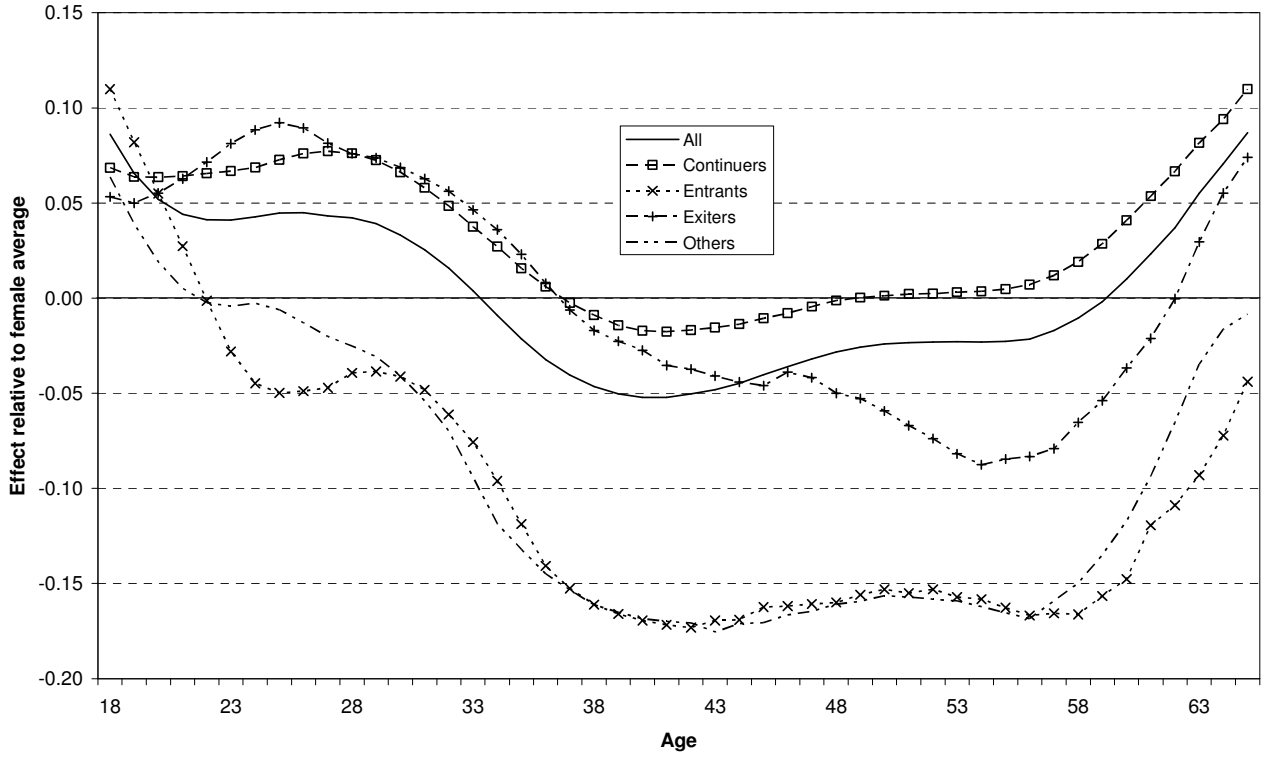
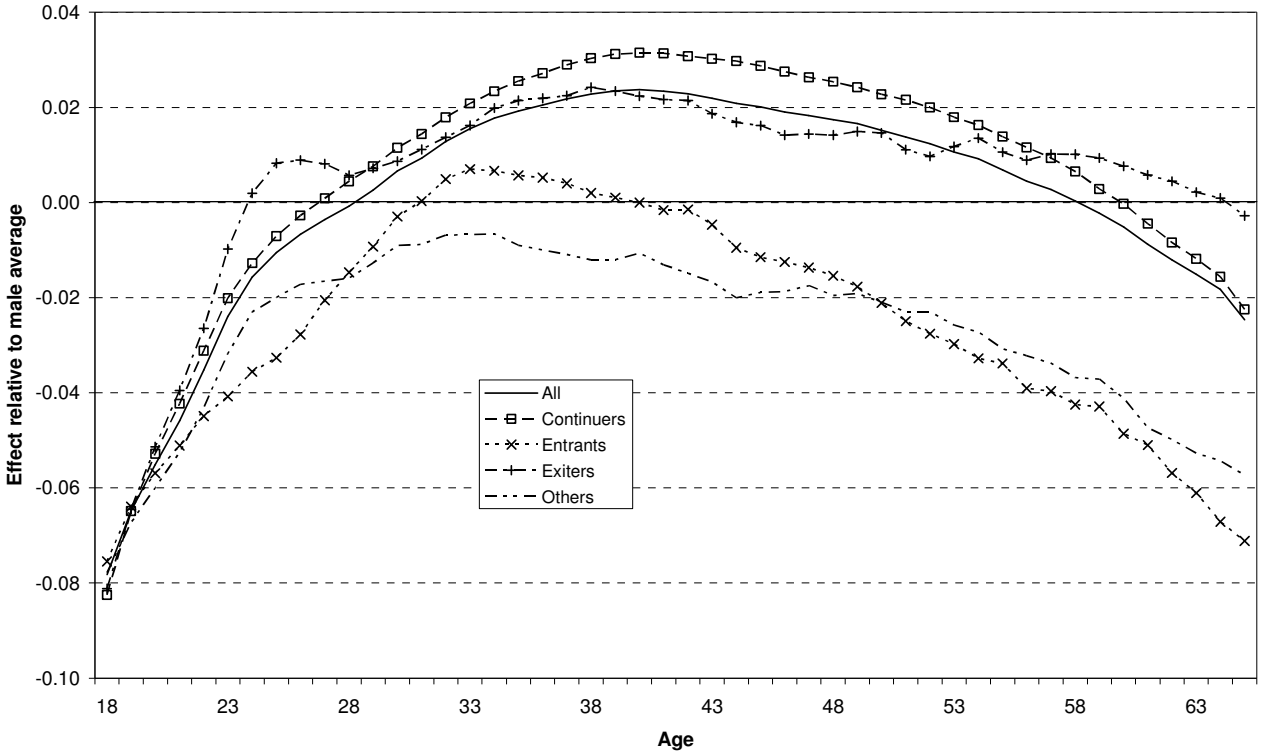


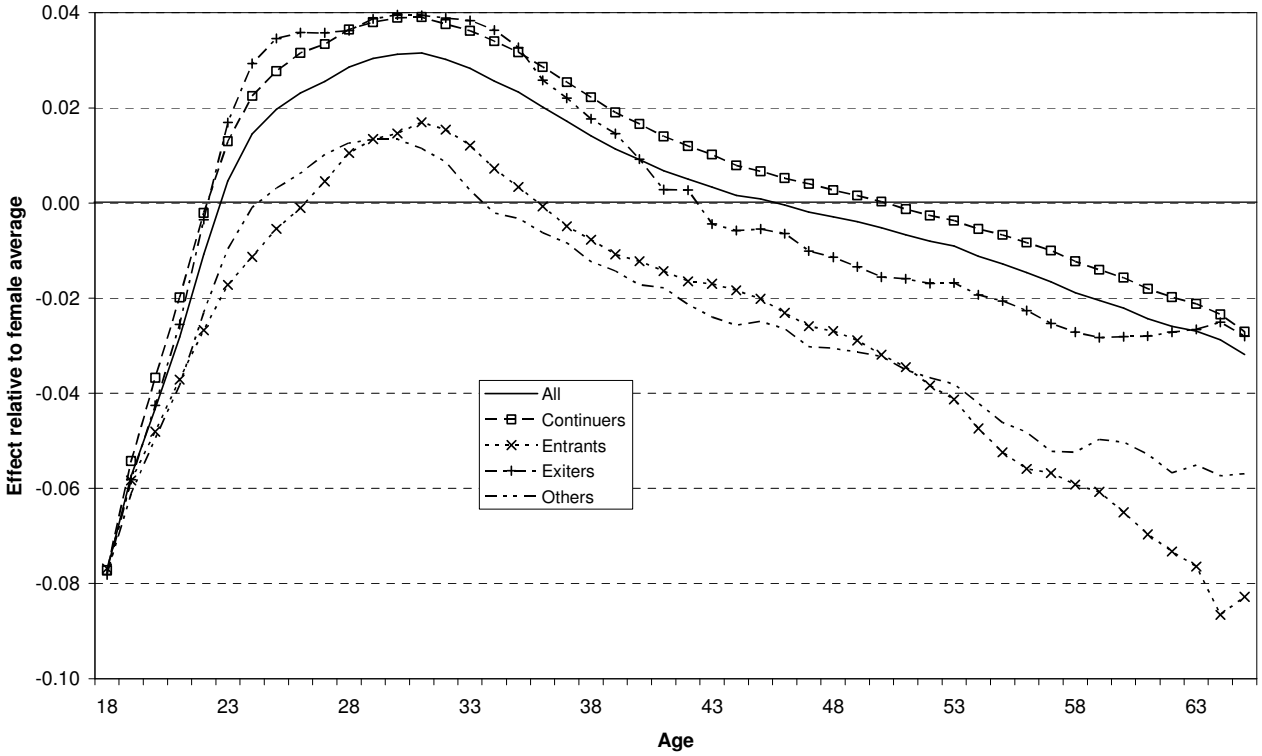
Figure 6

Age Profiles of Firm Fixed Effects
By transition group

(a) Males (Average male effect = 0.02)

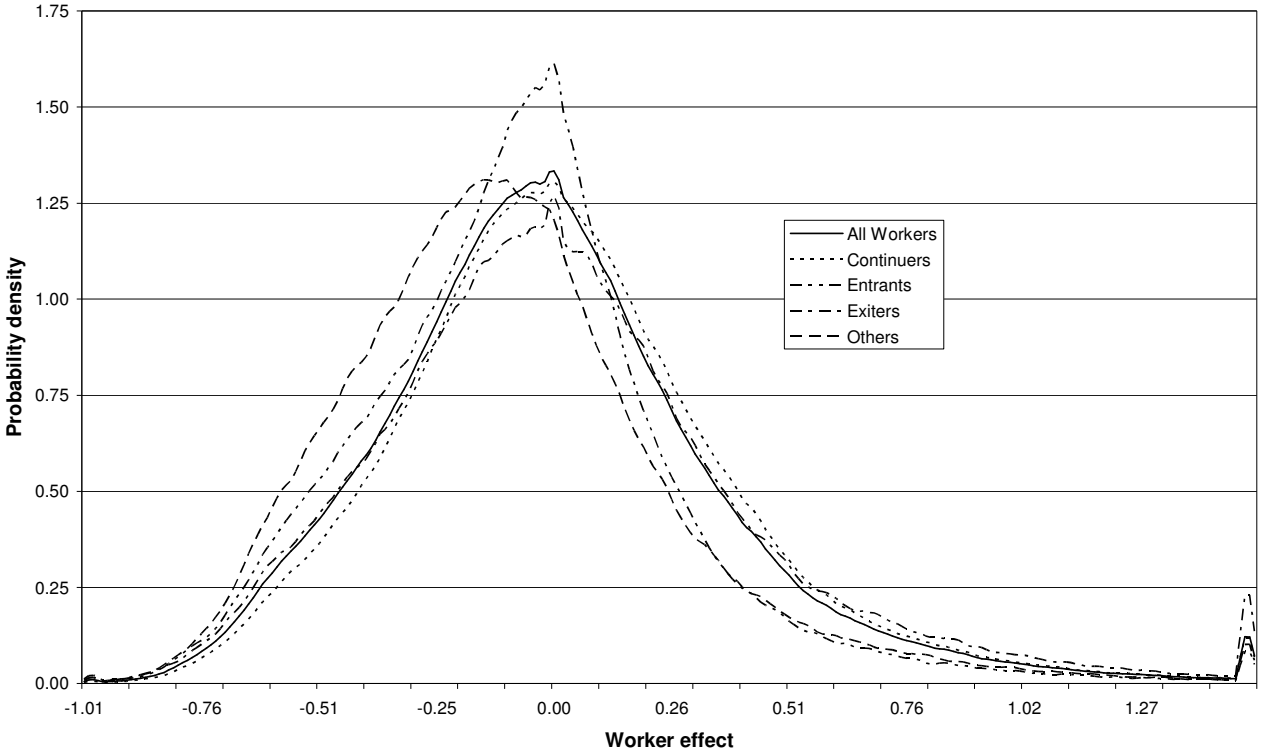


(b) Females (Average female effect = -0.02)

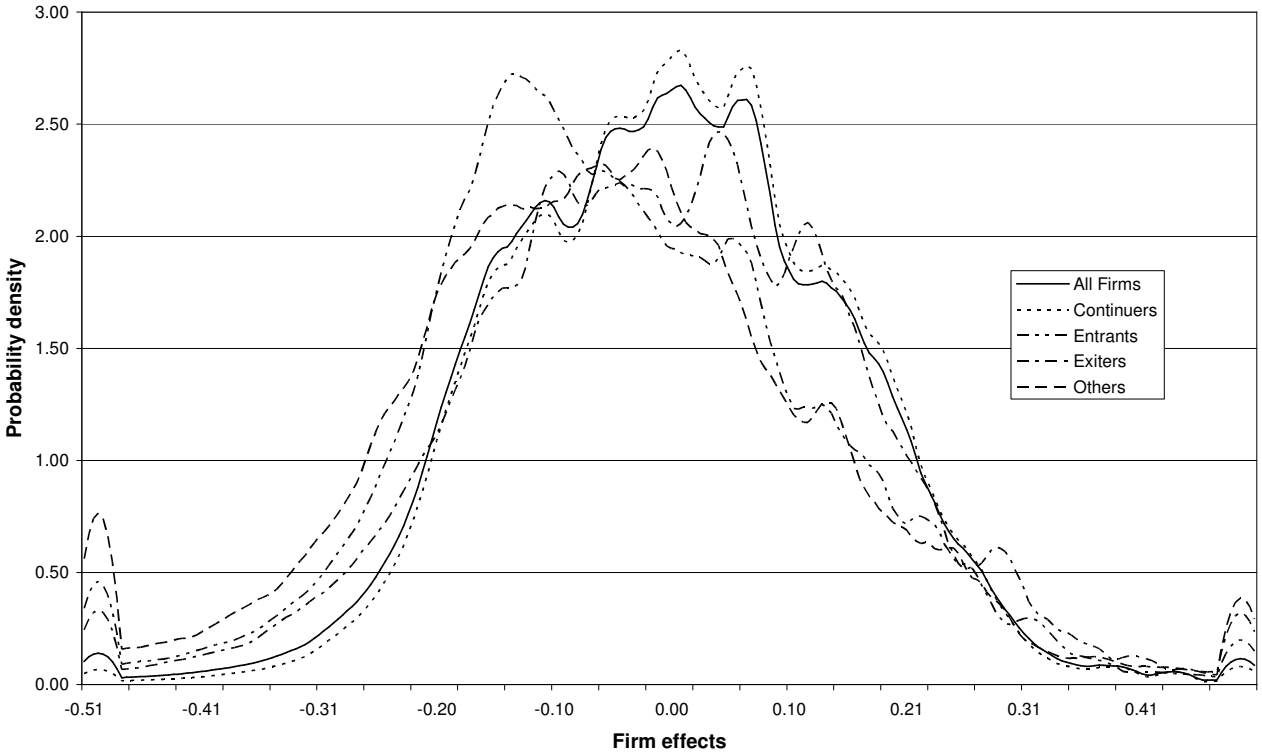


Appendix Figure A1

(a) Distribution of Worker Fixed Effects
Stratified by Workers' Transition Group



(b) Distribution of Firm Fixed Effects
Stratified by Firms' Transition Group



Appendix Figure A2

Raw and Composition-adjusted Time Trends
by sex