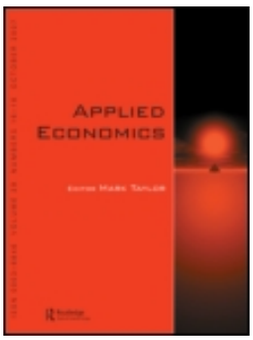

Applied Economics

ISSN: 0003-6846 (Print) 1466-4283 (Online) Journal homepage: http://www.tandfonline.com/loi/raec20

Worker turnover and job reallocation in Taiwanese manufacturing

Meng-Wen Tsou , Jin-Tan Liu & James K. Hammitt

To cite this article: Meng-Wen Tsou , Jin-Tan Liu & James K. Hammitt (2002) Worker turnover and job reallocation in Taiwanese manufacturing, Applied Economics, 34:4, 401-411, DOI: 10.1080/00036840110046016

To link to this article: http://dx.doi.org/10.1080/00036840110046016

Applied Economics, 2002, **34**, 401–411

Worker turnover and job reallocation in Taiwanese manufacturing

MENG-WEN TSOU, JIN-TAN LIU† and JAMES K. HAMMITT‡*

Department of International Trade, Tamkang University, † *Department of Economics, National Taiwan University* and ‡ *Centre for Risk Analysis, School of Public Health, Harvard University*

The paper examines time-series patterns of job and worker flows in a newly industrializing economy (NIE). Using plant-level data from the Taiwan manufacturing sector, the cyclical behaviour of job reallocation and its relation with worker turnover is analysed. It is found that job reallocation and labour turnover are pro-cyclical, at both the aggregate and (two-digit) industry levels. The share of worker turnover caused by gross job reallocation is 17%, suggesting the majority of observed worker turnover reflects rotations of positions that are neither created or destroyed. There is substantial heterogeneity in plant-specific job and worker turnover patterns. Job creation and job destruction rates are higher among small plants and private-sector plants. The private plants are more dynamic than public plants in terms of worker turnover. Controlling for year and industry effects, it is found that job creation and worker turnover are both higher in export-oriented industries.

I. INTRODUCTION

There is a large and growing literature on the dynamics of labour markets, including job creation and destruction, worker hiring and separation, and the relation of these flows to the business cycle, innovation and international trade. Most of the existing research has examined conditions in advanced industrialized countries. In this paper, a unique plant-level data set is used to examine simultaneously both job and worker flows in a newly industrializing economy (NIE).

Three main issues are addressed. First, the time-series patterns of job flows and worker flows are examined. The study is particularly interested in the cyclical properties of job and worker flows and the fraction of worker turnover that is due to job reallocation. Second, the relationship between net employment growth, hiring and separation rates at the plant level are investigated. The rates of job and worker flows are compared using two observable plant characteristics: plant size and ownership type. Third, using a regression framework, the roles of innovation and trade exposure in the determination of job-flow and worker-flow rates are explored. A limitation of our study is that it is unable to analyse the contribution of entry and exit to worker and job reallocation, because complete information on newly created and exiting plants is not available.

The principal findings are as follows. There are substantial differences in the variability of job and worker flows. While job creation and destruction are inversely correlated, hirings and separations are positively correlated over the business cycle. Job creation is more volatile than job destruction, hence job reallocation is pro-cyclical. Worker turnover also exhibits a pro-cyclical pattern.

Job reallocation and worker turnover are also pro-cyclical at the (two-digit) industry level. The majority of job reallocation occurs within industrial sectors.

Hiring and separation of workers occur simultaneously at the plant level. Contracting plants account for a high percentage of hires, expanding plants contribute a large share of exits. There is also substantial heterogeneity in plant-specific job and worker turnover patterns. Job creation and job destruction rates are higher in small plants than in large ones, but the large plants play the dominant role in job creation and destruction. Although hiring rates

* Corresponding author. E-mail: jkh@hsph.harvard.edu

decline monotonically with plant size, separation rate shows no systematic relationship to plant size. Private plants are more dynamic than public plants in terms of job and worker turnover rates.

Variation in the growth of industry output affects job and worker flows. Industries with higher growth have higher job creation rates and lower job destruction rates. Hirings and separations are positively related to an industry's output growth. Furthermore, job creation rates and worker turnover rates are higher in export-oriented industries.

The remainder of the paper is organized as follows. Section II summarizes some of the results of previous studies investigating these issues in other countries. Section III describes the data sources and measurements of employment flows. Section IV describes the basic patterns of job and worker flows in the manufacturing sector in Taiwan. In Section V, the relationship between employment changes and firm size and ownership type are reported and discussed. Section VI discusses the determinants of industry-level job and worker flows. Section VII concludes.

II. PREVIOUS RESULTS

Much previous research has focused on job reallocation, which occurs through job creation and destruction. With the exception of Roberts (1996a), Konings *et al.* (1996), and Bilsen and Konings (1998), most of the empirical studies have considered the manufacturing sectors in developed countries.[1] This empirical work has identified some stylized facts: First, the level of job creation and job destruction is remarkably large, with both processes occurring simultaneously even within narrowly defined sectors. Second, studies of Canada, the United States and several European countries find that job destruction fluctuates more over time than does job creation. Third, firm-specific characteristics such as age, size, and ownership type affect the levels of job creation and job destruction.

More recently, economists have begun to examine the cyclical properties of worker turnover (or labour turnover, the sum of hiring and separation rates), and its relation to job reallocation.[2] Hamermesh *et al.* (1994, 1996), Lane *et al.* (1996), and Serrano (1998) analyse the relationship between net employment changes and hirings/separations and the simultaneity of hirings and separations at the firm level. Their results suggest that hiring is not restricted to expanding firms, separations are not restricted to shrinking firms, and the large majority of worker turnover is attributable to worker-initiated and firm-initiated turnover across continuing position. Albæk and Sørensen (1998) find that job reallocation is symmetric and worker turnover is pro-cyclical over the business cycle in Denmark. They conclude that the cyclical behaviour of worker turnover is driven by workers finding better jobs in booms rather than plants purging bad matches in recessions, i.e. the dynamics of job separations is dominated by a pro-cyclical quit rate. Abowd *et al.* (1999) use matched data from France to suggest that the hiring rate is more important than the separation rate for adjusting employment. Most French establishments engage in simultaneous hiring and separation, increasing the hiring rate when there is job creation and decreasing the hiring rate when there is job destruction.

Other researchers have considered the relationship of job/worker turnover to innovation and trade exposure. Klette and Førre (1998) find that, in Norway, net job creation is no higher in high-tech industries. Pacelli *et al.* (1998) find that separations are inversely related to an industry's innovation intensity, supporting the hypothesis that more innovative firms cultivate more durable employer-employee relationships. The link between trade-related variables and job turnover is not well established. In general, after controlling for industry effects and common macroeconomic shocks, foreign competition and exporting opportunity show little effect on entry and exit rates (Roberts, 1996b; Roberts and Tybout, 1996; Tybout, 1996). An exception is Morocco, where Haddad *et al.* (1996) find that export promotion programmes appear to have tilted entry patterns towards export-oriented sectors

III. DATA AND MEASUREMENT

The data are from the annual labour turnover surveys conducted by the Statistical Bureau of Taiwan. Attention is restricted to plants in the manufacturing sector over the period 1981–1994. Due to a substantial reduction in the sample sizes for 1990, this year is excluded from the study. The level of observation is the plant. Since the survey includes retrospective questions on year-end employ-

[1] See, e.g. Leonard (1987), Dunne *et al.* (1989), Davis and Haltiwanger (1992), Davis *et al.* (1996), and Foote (1998) for the USA, Baldwin and Picot (1995) for Canada, Konings (1995a, 1995b) and Blanchflower and Burgess (1996) for the UK, Boeri (1992) for Germany, Broersma and Gautier (1997) for the Netherlands, and Borland (1996) for Australia. Baldwin, Dunne and Haltiwanger (1998) compare employment flows in the USA and Canada. Roberts (1996a) compares employment flows for three developing countries: Chile, Columbia, and Morocco. Konings *et al.* (1996) analyse labour market adjustment in Poland. Bilsen and Konings (1998) investigate job flows and firm level employment growth in three transition countries: Bulgaria, Hungary, and Romania.

[2] Job turnover counts jobs, while worker turnover counts individuals. Job turnover, a discrete-time measure, is calculated by taking first differences of employment stocks, while worker turnover records all hirings and separations in a given time period.

ment as well as hirings and separations of workers during the year, the job creation and job destruction rates are possible to compute. In contrast to most previous studies, the dataset includes job flows and worker flows from the same source, which makes job turnover and worker turnover statistics comparable.[3] However, it is important to emphasize that the dataset contains mainly continuing plants. As a result, the reported job creation and destruction rates as well as hiring and separation rates should be interpreted as lower bounds to the true rates. Also, it is not possible to analyse the contribution of entry and exit to worker and job reallocation.

The definitions of job creation and destruction are similar to those originally proposed by Davis and Haltiwanger (1992). Job creation (POS) is measured as the sum of employment gains at all plants. Job destruction (NEG) is measured as the sum of employment losses at all plants. Both measures are converted to rates by dividing through the size of the sector, defined as the average employment at the beginning and the end of the period. The job reallocation rate (SUM) is the sum of job creation and destruction rates. The net employment growth rate (NET) is the difference between the rates of job creation and destruction. A major focus of the work involving gross job flows is the cyclical correlation between reallocation intensity (as measured by SUM) and aggregate economic activity (as measured by NET). The sign of this correlation is positive if and only if the variance of job creation is larger than that of job destruction. Finally, gross flows of workers refer to hirings (H) and separations (S) of workers; total worker turnover (T) is defined as the sum of the two. Dividing these by average employment of all plants at the beginning and the end of the period gives the corresponding gross worker flow rates.

IV. BASIC PATTERNS OF JOB AND WORKERS FLOWS IN TAIWAN MANUFACTURING SECTOR

This section provides an overview of job and worker flows in the Taiwanese manufacturing sector. The first part of the section examines the time-series fluctuations of job creation, job destruction, hiring and separation. The second part reports job flows within and between industries.

Time variation of job and worker flows

The analysis begins by examining the time-series patterns of job creation, job destruction, hiring and separation. Table 1 reports gross and net flow rates of jobs and workers over the period from 1981–1994. One of the central facts captured by Table 1 is the phenomenon of simultaneous job creation and destruction. In 1983, when net manufacturing employment expanded by a robust 7.2%, the job destruction rate was 3.2%. In 1985, when manufacturing employment declined 1.6%, the job creation rate was 6.3%. The job reallocation rate ranges

Table 1. *Annual job and worker flow rates for Taiwan manufacturing sector*

Year	Job creation (POS	Job destruction (NEG)	Job reallocation (SUM)	Net change (NET)	Hiring (H)	Separation (S)	Worker turnover (T)	Sample size (N)
1981	0.057	0.051	0.108	0.007	0.359	0.353	0.712	3329
1982	0.053	0.077	0.131	−0.024	0.307	0.331	0.638	3602
1983	0.105	0.032	0.137	0.072	0.410	0.338	0.747	3708
1984	0.084	0.057	0.141	0.027	0.396	0.368	0.764	3725
1985	0.063	0.079	0.143	−0.016	0.307	0.323	0.631	4874
1986	0.098	0.034	0.132	0.063	0.446	0.383	0.829	4470
1987	0.078	0.043	0.121	0.036	0.473	0.438	0.911	4442
1988	0.071	0.053	0.125	0.018	0.431	0.413	0.844	4973
1989	0.059	0.063	0.122	−0.004	0.392	0.396	0.788	4503
1991	0.062	0.053	0.115	0.010	0.320	0.310	0.631	4861
1992	0.048	0.061	0.110	−0.013	0.293	0.305	0.598	4916
1993	0.052	0.046	0.098	0.007	0.278	0.271	0.550	4637
1994	0.053	0.037	0.089	0.016	0.256	0.240	0.496	4663
Mean	0.068	0.053	0.121	0.015	0.359	0.344	0.703	
Std	0.018	0.015	0.016	0.029	0.070	0.056	0.124	

Pearson correlation (POS, NEG): −0.52. Pearson correlation (SUM, NET): 0.23. Std (POS)/Std (NEG): 1.22. Pearson correlation (H, S): 0.92. Pearson correlation (T, NET): 0.50. Std (H)/Std (S): 1.25.

[3] Other studies that analyse job and worker turnover data from a common source include: Anderson and Meyer (1994) in the USA; Boeri (1994) in Germany; Hamermesh, Hassink and van Ours (1996) in the Netherlands; Albæk and Sørensen (1998) in Denmark; Serrano (1998) in Spain; and Abowd *et al.* (1999) in France.

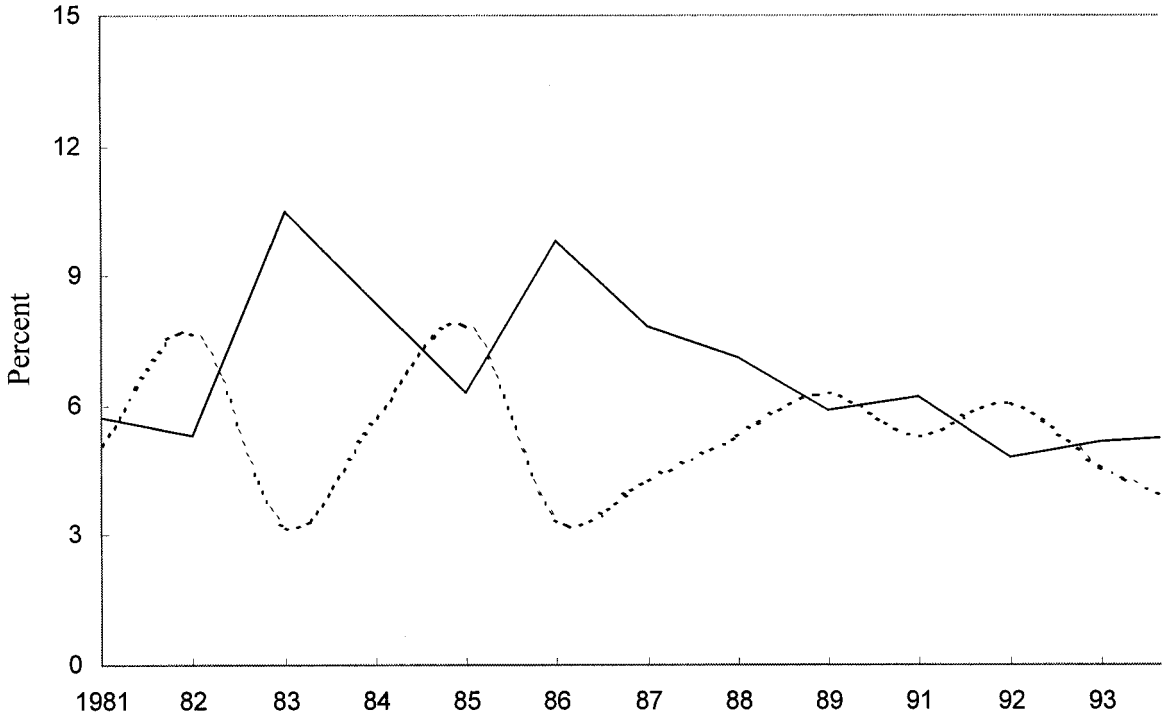

Fig. 1. *Job creation and job destruction in Taiwan*
Note: Solid line represents job creation; dashed line represents job destruction.

from a high of 14.3% in 1985 to a low of 8.9% in 1994. For manufacturing as a whole, job creation and destruction rates average 6.8% and 5.3%, respectively. The annual average job reallocation rate is 12.1%. The manufacturing sector as a whole grew at an average rate of 1.5% per year.

Figure 1 depicts the movements of job creation and destruction. It shows that job creation and job destruction are negatively correlated. Over the period, job destruction shows no tendency to vary more than job creation. This is evident from the higher time-series standard deviation of job creation (0.018) than of job destruction (0.015) reported at the bottom of Table 1. These standard deviations imply that the time-series variance of job creation is about one and one-half times larger than the variance of job destruction. The asymmetry in the time-series volatility of creation and destruction reflects the pro-cyclical nature of job reallocation. The correlation coefficient between the net employment growth rate and the job reallocation rate is 0.23.

The last three columns in Table 1 illustrate the striking differences between total worker flows and job flows. It is apparent that both hiring and separation rates are much higher than job creation and destruction rates. The simultaneity of hirings and separations also exists over the entire period. For the manufacturing sector as a whole, the hiring and separation rates average 35.9% and 34.4%, respectively. The gross worker turnover rate ranges from 49.6% in 1994 to 91.1% in 1987. Worker turnover is about five to seven times the rate of job reallocation.

There are two components to worker turnover. The first element arises as a consequence of firms creating and destroying job positions (job reallocation), leading to changes in the level of employment. The second occurs independently of job flows, with no effect on firms' employment levels. This sort of worker turnover is due to job-match creation and destruction as workers begin or leave a position. In the sample, the share of worker turnover caused by gross job reallocation, which can be interpreted as 'involuntary worker turnover' is relatively small, varying between 13.3% and 22.7%. Total job reallocation does not appear to be the major source of worker turnover. Instead, job-match creation and destruction, attributable to worker-initiated and firm-initiated turnover across continuing positions, is responsible for the largest fraction. This result suggests that Taiwanese labour turnover is somewhat more dynamic than in the developed economies. Davis and Haltiwanger (1992) and Anderson and Meyer (1994) find that job reallocation accounts for between one-third and one-half of worker flows in the USA. Similar results have been obtained for Germany by Boeri (1994), for the Netherlands by Hamermesh, Hassink and van Ours (1994), and for Spain by Serrano (1998).

The cyclical property of job flows is similar to those reported by Roberts (1996a) for three developing countries

(Columbia, Chile, and Morocco), but contrary to the findings for Canada, the USA, and several European countries. Since the dataset contains mainly continuing plants, the magnitude of the gross job flow rates reported here is much smaller than those of the three developing countries.[4]

Table 1 also shows that the time-series standard deviation of hiring is larger than that of separation. The simple correlation between net employment growth and worker turnover rate is 0.50. This implies that the pro-cyclical variation in the worker turnover series is stronger than the variation in the job reallocation series. In addition, hiring and separation are significantly positively correlated (0.92), indicating that separation rates tend to be higher when hiring rates are higher. One possible explanation is that replacement hiring is driven by workers quitting.[5] The pro-cyclicality of total worker turnover is consistent with the findings in Anderson and Meyer (1994) for the USA, Albæk and Sørensen (1998) for Denmark, and Abowd *et al.* (1999) for France.

Cross-industry variation in average annual job and worker flows

To investigate differences in industry-level employment adjustment patterns, the same job-flow and worker-flow rates are calculated for two-digit industries. Table 2 presents the average annual rates for job creation, job destruction, job reallocation, net job change, hiring, separation and worker turnover. The last three columns report the correlation coefficients between measures of job creation and job destruction, job reallocation and net employment growth, and the relative standard deviations of job creation and destruction.

Large sectoral differences are apparent. High worker turnover sectors are also high job creation and destruction sectors. The annual average job creation rate varies from 2% in Petroleum and Coal to 8.9% in Electrical Machinery. The annual average job destruction rate varies from 0.8% in Petroleum and Coal to 7.1% in Electrical Machinery. Worker turnover is three to seven times as great as job reallocation.

Low levels of net employment change mask a great deal of labour market activity. Three stagnant two-digit industries (textiles, chemical matter, and precision instruments) experience significant gross job creation and destruction simultaneously. The average job creation rate ranges from 3.7% in chemical matter to 8.6% in precision instruments. The average job destruction rate ranges from 3.6% in chemical matter to 8% in precision instruments. The hiring and separation rates are even higher among these sectors, varying between 19.5% and 44%.

Examining the last three columns in Table 2, it is found that time-series of job creation and destruction are all negatively correlated. With the exception of six two-digit industries (textiles, chemical matter, nonmetallic mineral products, basic metal, machinery and equipment, and precision instruments), the simple correlations between job reallocation and net growth rate are all positive. This occurs because the time-series standard deviation of job creation is larger than that of job destruction. Therefore, a pro-cyclical pattern of employment reallocation exists in most two-digit manufacturing industries. Similarly, hiring is more cyclically volatile than separation in most industries.[6]

To evaluate the contribution of within-sector and between-sector job flows, excess job reallocations are decomposed at the total manufacturing level into the components due to employment shifts between and within industries. Specifically, excess job reallocation is defined as the difference between total job reallocation and the absolute value of net employment growth for the period $(SUM - |NET|)$. The component due to between-sector shifts is measured by summing across sectors the deviation of the absolute growth rate for the sector from the absolute growth rate for total manufacturing $(\sum_i |NET_i| - |NET|)$. The component due to within-sector shifts is measured as the sum across sectors of the excess job reallocation in each sector $(\sum_i (|SUM_i| - |NET_i|))$.

The between- and within-sector components of excess job reallocation are calculated for every year using both the two-digit and four-digit annual series. Within-sector shifts account for 73% of excess job reallocation among two-digit industries. Even when sectors are defined by four-digit industry, within-sector shifts still account for 56% of excess job reallocation.[7] Therefore, the high rates of job reallocation should be interpreted as reflecting primarily employment shifts among establishments in the same industry. This finding of substantial heterogeneity in employment patterns across plants within the same industry

[4] Roberts (1996a) finds that the job reallocation rate lies in the range of 26.2–30.6% for the three developing countries.
[5] Akerlof *et al.* (1988) and Albæk and Sørensen (1998) find that quits are pro-cyclical and layoffs are countercyclical in the USA and Denmark.
[6] To save space, we do not report the relative standard deviation of hiring and separation in Table 2.
[7] Dunne *et al.* (1989) find that over 70% of employment turnover occurs across plants within the same two-digit industry in the USA. Davis and Haltiwanger (1992) find that about 12% of excess job reallocation in the USA is accounted for by shifts between four-digit industries. Similarly, Baldwin *et al.* (1998) find between-industry shifts (two-digit) account for only 3.6% of excess job reallocation in the USA and 2.5% of excess job reallocation in Canada. For developing countries, Roberts (1996a) shows that more than 80% of employment turnover occurs within four-digit industries in Columbia, Chile and Morocco.

Table 2. *Means and correlations for job and worker flows by industry, Taiwan*

Industry	$\overline{POS}$	$\overline{NEG}$	$\overline{SUM}$	$\overline{NET}$	$\overline{H}$	$\overline{S}$	$\overline{T}$	corr(POS, NEG	corr(SUM, NET)	*Std(POS)/ Std(NEG)*
Food (20)	0.059	0.032	0.092	0.028	0.244	0.216	0.460	−0.285	0.516	1.733
Beverages and tobacco (21)	0.038	0.025	0.064	0.013	0.146	0.133	0.279	−0.183	0.420	1.553
Textiles (22)	0.050	0.052	0.102	−0.002	0.364	0.367	0.731	−0.421	−0.263	0.783
Apparel (23)	0.066	0.050	0.117	0.016	0.363	0.347	0.710	−0.673	0.543	1.587
Leather and fur (24)	0.081	0.064	0.146	0.017	0.404	0.388	0.792	−0.433	0.566	1.796
Wood products and furniture (25)	0.071	0.059	0.130	0.012	0.398	0.386	0.784	−0.490	0.117	1.108
Paper and printing (26)	0.050	0.033	0.084	0.018	0.213	0.195	0.408	−0.404	0.260	1.276
Chemical matter (27)	0.037	0.036	0.073	0.001	0.196	0.195	0.391	−0.467	−0.425	0.667
Chemical products (28)	0.061	0.028	0.089	0.032	0.255	0.223	0.478	−0.096	0.312	1.379
Petroleum and coal (29)	0.020	0.008	0.028	0.012	0.048	0.036	0.084	−0.340	0.825	3.068
Rubber (30)	0.064	0.041	0.104	0.023	0.398	0.374	0.772	−0.302	0.589	1.913
Plastics (31)	0.079	0.052	0.131	0.028	0.391	0.364	0.755	−0.463	0.316	1.338
Nonmetallic mineral products (32)	0.062	0.051	0.113	0.011	0.266	0.255	0.521	−0.285	−0.109	0.901
Basic metal (33)	0.045	0.036	0.081	0.009	0.154	0.145	0.300	−0.044	−0.076	0.926
Fabricated metal products (34)	0.078	0.054	0.132	0.023	0.369	0.346	0.715	−0.350	0.259	1.283
Machinery and equipment (35)	0.071	0.051	0.122	0.020	0.310	0.289	0.599	−0.740	−0.559	0.645
Electrical machinery (36)	0.089	0.071	0.160	0.018	0.485	0.467	0.952	−0.658	0.147	1.118
Transport equipment (37)	0.057	0.041	0.099	0.016	0.244	0.228	0.472	−0.682	0.143	1.111
Precision instruments (38)	0.083	0.080	0.164	0.003	0.440	0.437	0.877	−0.531	−0.136	0.890
Miscellaneous (39)	0.086	0.068	0.155	0.018	0.482	0.464	0.946	−0.230	0.457	1.619
All manufacturing	0.068	0.053	0.121	0.015	0.359	0.344	0.703	−0.521	0.228	1.219

Note: Industry averages are constructed as the mean for the two-digit industry over 1981–1994. The SIC code numbers are based on Taiwan classifications in 1981.

is consistent with the results of Dunne *et al.* (1989), Davis and Haltiwanger (1992), Roberts (1996a), and Baldwin *et al.* (1998).

V. NET EMPLOYMENT CHANGES, FIRM HETEROGENEITY AND JOB AND WORKER FLOWS

The results in the previous section suggest that job reallocation is driven fundamentally by plant-level heterogeneity in labour demand. The first part of this section investigates the relationship between net employment growth and the flow of workers in and out of plants. The second part examines the gross job and worker flows by plant size and ownership type.

Net employment changes, hirings and separations

Table 3 describes the relationship between employment growth, hirings and separations at the plant level. Establishments are classified by whether they have growing or declining employment. There are two main findings. First, the hiring rate is substantially higher among expanding establishments than among contracting establishments. On average, growing plants have a hiring rate more than twice as large as that of declining plants. However, while the separation rate is higher among contracting establishments than among expanding establishments, the difference is relatively small. Second, growing plants account for two-thirds of all hirings and somewhat surprisingly declining plants account for only about half of all separations. The last two columns show that one in three hires are by plants that are reducing employment. Similarly, expanding plants account for about one in two separations. This demonstrates that separations and hires occur simultaneously – jobs are destroyed by plants doing substantial hiring, and are created by plants that are shrinking.

Figure 2 displays the distribution of hires by establishment growth rates.[8] The major part of hires takes place in plants with moderate growth rate, e.g. plants with growth rates in the interval (−0.1, 0.3) account for 70.6% of all

Table 3. *Worker flows in expanding and contracting plants*

Plant growth	Hiring	Separation	Hiring share	Separation share
Expanding	0.605	0.367	0.657	0.490
Contracting	0.287	0.454	0.328	0.494

[8] The measure of growth rate is adopted from Davis and Haltiwanger (1992). The size of establishment j is measured at time t, denoted by x_{jt}, as the simple average of employment at time t and $t-1$. The growth rate of establishment j at time t, denoted by g_{jt}, is the change in establishment employment from $t-1$ to t, divided by x_{jt}. This growth rate measure is symmetric about zero, and it lies in the closed interval $[-2, 2]$ with deaths (births) corresponding to the left (right) endpoint.

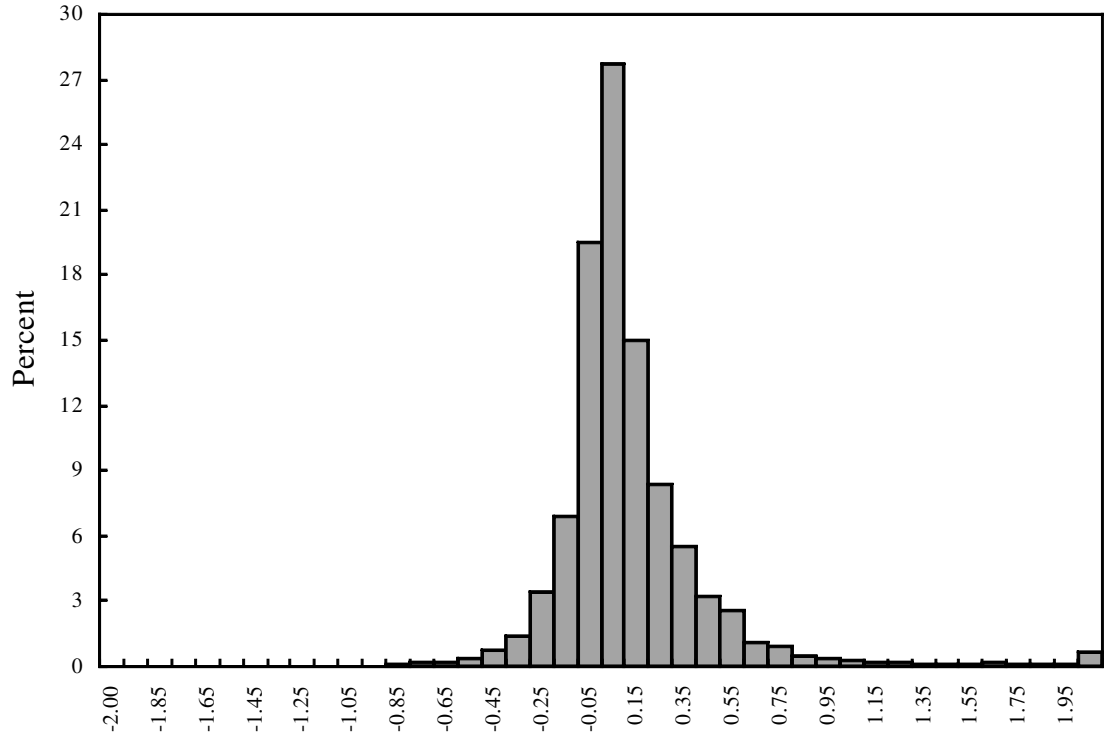

Fig. 2. *Percentage of hires by plant*

hires, but establishments with decreasing employment account for 13.3% of all hires. Figure 3 reveals a similar distribution of separations. Most of the distribution is concentrated around the centre: 65.6% of separations takes place in plants with growth rates in the interval (−0.3, 0.1), and a large share, 25.4%, of all separations takes place in expanding plants. These figures show further evidence of the importance of worker heterogeneity. The large share of separations from expanding plants supports the view that replacement hires are dominated by workers leaving to obtain better job matches. This finding is consistent with the evidence found in Denmark by Albæk and Sørensen (1998).

Plant size, ownership type and job and worker flows

To examine the role of plant heterogeneity in the determination of job and worker turnover, two observable plant characteristics are considered: plant size and ownership type. Table 4 and Table 5 display job flows and worker flows according to six employment-size classes and two ownership categories.[9,10]

As presented in Table 4, job creation rates decline monotonically with plant size. The job creation rate averages 24.5% of employment per year for plants with fewer than 10 employees and 5.2% for plants with 500 or more employees. Thus, small plants create new jobs at a much higher gross rate than large plants. A similar pattern prevails for job destruction, but the difference is relatively small. The job destruction rate averages 6.5% of employment per year for plants with fewer than 10 employees and 4.9% for plants with 500 or more employees. Thus, small plants also destroy jobs at a higher rate than large plants.

Although job creation and job destruction rates are higher in small establishments, large plants play the dominant role in job creation and destruction. The fifth and sixth columns report that plants with more than 100 employees account for 77% of job creation and 85% of job destruction. This is not surprising since the employment shares of large plants are larger than small ones. Over the 1981–1994 period as a whole, plants with more than 100 employees account for 88% of manufacturing employment. These results are similar to those found by Davis *et al.* (1996) in the USA and Broersma and Gautier

[9] Ideally the plant age should also be included in the analysis, but this variable is not available in the dataset.
[10] Average size is used rather than initial plant size to avoid Galton's fallacy of regression towards the mean: if initial size is used, then firms that have a transitory low initial size will on average seem to grow faster than those with transitory high initial size. See, e.g. Friedman (1992), Leonard (1986), and Davis *et al.* (1996).

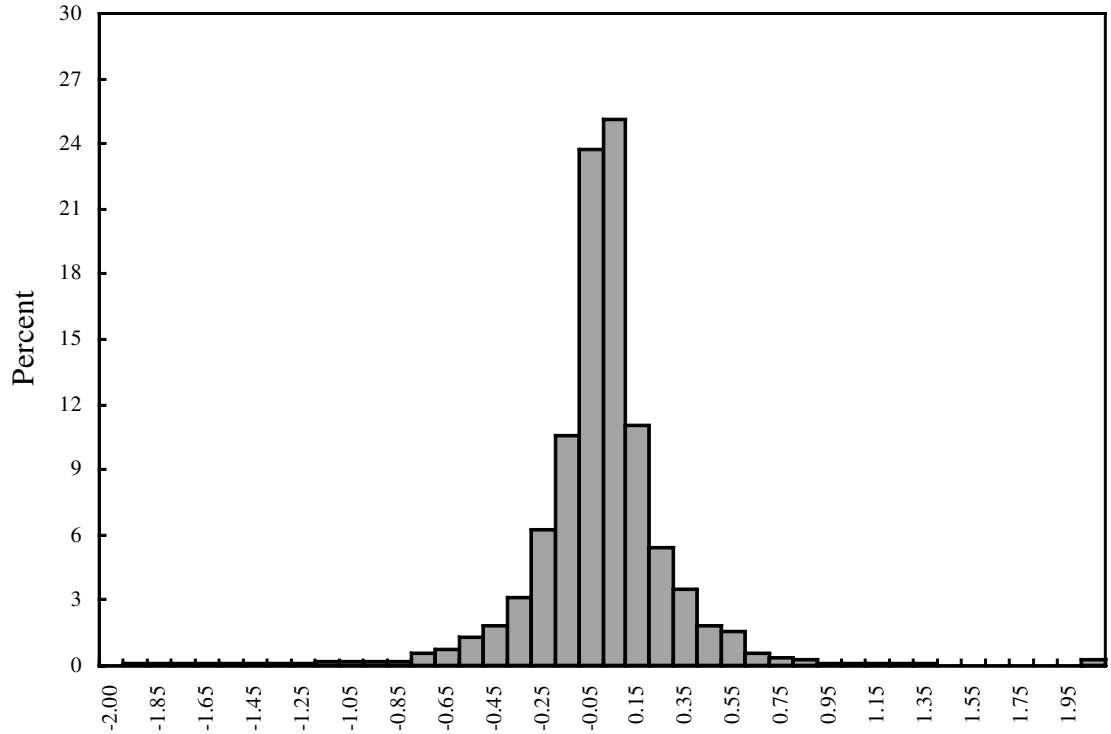

Fig. 3. *Percentage of separations by plant*

Table 4. *Job flows according to size and ownership type*

	Job creation	Job destruction	Job reallocation	Net change	Job creation share	Job destruction share	Employment share
Employment							
< 10	0.245	0.065	0.310	0.180	0.011	0.005	0.004
10–29	0.163	0.072	0.235	0.091	0.049	0.028	0.021
30–99	0.118	0.063	0.181	0.054	0.173	0.122	0.101
100–299	0.074	0.055	0.129	0.019	0.290	0.282	0.265
300–499	0.060	0.050	0.110	0.011	0.140	0.153	0.158
> 500	0.052	0.049	0.101	0.003	0.337	0.410	0.455
Ownership type							
Public	0.016	0.034	0.050	−0.018	0.022	0.060	0.089
Private	0.074	0.055	0.129	0.019	0.943	0.896	0.871

Table 5. *Worker flows according to size and ownership type*

	Hiring	Separation	Worker turnover	Hiring share	Separation share
Employment					
< 10	0.565	0.385	0.650	0.005	0.004
10–29	0.474	0.382	0.677	0.027	0.022
30–99	0.442	0.387	0.754	0.123	0.113
100–299	0.386	0.367	0.829	0.286	0.283
300–499	0.344	0.333	0.856	0.151	0.153
> 500	0.327	0.324	0.950	0.408	0.424
Ownership type					
Public	0.054	0.072	0.126	0.014	0.019
Private	0.392	0.373	0.765	0.948	0.941

(1997) in the Netherlands but contrast with those reported by Konings (1995b), who finds a positive relationship between the job destruction rate and size in the UK.

The private and public sectors differ with respect to job creation and destruction. The annual job creation and destruction rates in the private sector are 7.4% and 5.5% respectively, far higher than the corresponding values in the public sector. In addition, most jobs are created and destroyed in the private sector. The private sector accounts for 94.3% of job creation and 89.6% of job destruction. The large gross job flows are consistent with the findings in Konings *et al.* (1996) for Polish manufacturing and Bilsen and Konings (1998) for Bulgaria, Hungary and Romania.

Table 5 shows a different picture in worker turnover by plant size. Although hiring rates decline monotonically with plant size, separation rate shows no systematic relationship to plant size. The hiring rate averages 56.5% for plants with fewer than 10 employees and 32.7% for plants with 500 or more employees. In terms of separation rates, plants with 30-99 employees have the highest rates of separation (38.7%), whereas plants with more than 500 employees have the lowest separation rates (32.4%). This result contrasts with those found by Lane *et al.* (1996) in the USA, which shows that small firms have hiring and separation rates almost twice as great as their large counterparts.

There is also a dramatic difference in worker turnover by ownership type. The rates of hiring and separation in the private plants are 39.2% and 37.3%, respectively, much larger than the corresponding values in public plants, 5.4% and 7.2%, respectively. The private sector accounts for more than 90% of total worker turnover.

VI. THE DETERMINANTS OF INDUSTRY-LEVEL JOB AND WORKER FLOWS

The patterns of job and worker flows can be explored more formally within a regression framework. The regressions take the form:

$$Y_{it} = f(\mathrm{GRQ}_{it}, \mathrm{EX}_{it}, \mathrm{YEAR}_t, \mathrm{IND}_i) \qquad (1)$$

where Y_{it} represents (POS, NEG, H, or S) for two-digit industry i in period t. The explanatory variables are dummies for year (YEAR), to serve as a proxy for changing macroeconomic conditions, the growth in industrial production (GRQ) to summarize industry-level demand conditions, export share of output (EX) to measure the degree of exposure to international trade, R&D intensities (RD) to capture technological factors like scale economies and sunk entry costs, and industry dummies (IND) to control for other industry-specific effects.

Table 6 reports the ordinary least squares regression results. Examining columns one and two, it is found that the real growth of output is positively correlated with job creation rate and negatively correlated with job destruction rate. There is a significant positive relationship between export shares and job creation rates. This implies that job creation is higher in export-oriented industries, consistent with the evidence found in Morocco by Haddad *et al.* (1996). In contrast, R&D intensity is not significantly associated with rates of job creation and job destruction. Similarly, Klette and Førre (1998) found no direct relationship between job creation and R&D intensity in Norway. Finally, the significant coefficients on the year dummies indicate that the macroeconomic environment is an important predictor of job creation and destruction rates.[11]

Turning to the regressions of worker-flow rates, the third and fourth columns in Table 6 report that both the hiring rate and separation rate are positively correlated with output growth. There is a strong positive correlation between share of exports and rates of hiring and separation, suggesting that worker turnover rates are higher in export-oriented industries. This indicates that export-oriented industries have a looser employer-employee relationship. One possible explanation is that the dominance of small-scale firms, combined with a well developed network of subcontracting relationships and trading firms in the Taiwan manufacturing sector, allows firms to reduce the transaction costs of entering and exiting the international market.[12]

VII. CONCLUSION

This paper analyses job and worker flows in the Taiwan manufacturing sector for the period 1981–1994. It is the first study of a newly industrializing economy to use comprehensive and representative plant-level data to analyse these flows simultaneously. At all phases of the business cycle and even within manufacturing sectors, there is simultaneous job creation and job destruction, as well as simultaneous hiring and separation. While job creation and job destruction are negatively correlated, hiring and separation are positively correlated over the business cycle. The overall picture is one of a relatively stable process of job destruction and separation with a more cyclical process of job creation and hiring. Thus, job reallocation and worker turnover are both pro-cyclical. The cyclical properties of job flows closely mirror findings for three developing countries (Chile, Colombia, and Morocco), but are

[11] To save space, we do not report the coefficients of the industry dummies.
[12] Aw *et al.* (1997) find high rates of entry and exit in export-oriented industries for the Taiwanese manufacturing sector.

Table 6. *Regression coefficients with rate of job creation, job destruction, hiring and separation as the dependent variable*

	Job creation (POS)	Job destruction (NEG)	Hiring (H)	Separation (S)
Constant	0.0424 (3.03)***	0.0852 (5.55)***	0.2806 (4.89)***	0.3234 (6.40)***
GRQ	0.0855 (4.91)***	−0.0932 (−5.63)***	0.2638 (4.58)***	0.0850 (1.95)**
EX	0.0262 (2.59)***	0.0021 (0.20)	0.1098 (3.04)***	0.0858 (2.71)***
RD	−0.2809 (−0.79)	−0.1352 (−0.34)	−0.6851 (−0.68)	−0.5394 (−0.67)
Y83	0.0227 (3.18)***	−0.0245 (−3.67)***	0.0372 (1.88)*	−0.0099 (−0.74)
Y84	0.0131 (2.42)**	−0.0094 (−1.41)	0.0593 (3.32)***	0.0367 (2.69)***
Y85	0.0046 (0.74)	−0.0077 (−1.07)	0.0098 (0.52)	−0.0025 (−0.20)
Y86	0.0170 (2.35)**	−0.0214 (−3.52)***	0.0720 (3.66)***	0.0336 (2.62)***
Y87	0.0055 (0.92)	−0.0201 (−3.51)***	0.1035 (5.08)***	0.0779 (4.96)***
Y88	0.0107 (1.93)**	−0.0200 (−3.27)***	0.0940 (4.97)***	0.0634 (3.90)***
Y89	−0.0014 (−0.24)	−0.0135 (−1.97)**	0.0688 (4.23)***	0.0567 (4.45)***
Y91	−0.0036 (−0.56)	−0.0191 (−3.31)***	0.0092 (0.59)	−0.0064 (−0.55)
Y92	−0.0103 (−1.98)**	−0.0137 (−2.17)**	0.0064 (0.39)	0.0031 (0.25)
Y93	−0.0013 (−0.25)	−0.0208 (−3.28)***	0.0036 (−0.21)	−0.0230 (−1.63)*
Y94	−0.0073 (−1.48)	−0.0267 (−4.53)***	−0.0331 (−1.82)*	−0.0525 (−3.18)***
F	11.27***	9.12***	40.79***	151.26***
FY	4.57***	2.20***	11.68***	15.13***
FI	6.15***	7.53***	30.12***	43.43***
$\bar{R}^2$	0.59	0.53	0.85	0.88

Note: All regressions include 11 year dummies and 19 industry dummies for two-digit SIC industries. Figures in parentheses are *t*-statistics. Regressions are estimated by ordinary least squares using heteroscedastic-consistent covariance matrix. FY and FI represent the F-tests on year and industry effects, respectively. *** and ** represent statistical significance at 1% and 5%, respectively.

contrary to those for industrial countries. However, the pro-cyclicity of worker turnover is consistent with evidence for the United States and Denmark. On average, job reallocation accounts for only 17.2% of worker turnover, suggesting the majority of observed worker turnover reflects rotations of positions that are neither created or destroyed. This indicates that labour turnover is much more dynamic in Taiwan than in Western economies.

Examining employment flows at the two-digit industry level reveals that more than 70% of excess job reallocation occurs within the same industry. Similar results hold when sectors are defined in terms of four-digit industry. This result supports the view that job reallocation is driven by plant-level heterogeneity in labour demand. The magnitude of job and worker flows differ systematically across plants by size and ownership type. Job creation and destruction rates are substantially higher among small and private-sector plants. Hiring rates decline monotonically with plant size, but separation rate shows no systematic relationship to plant size. Private plants are more dynamic than public plants in terms of worker turnover.

Using pooled cross-sectional time-series data, variation in the growth of industry output, which is likely to reflect industry-level fluctuations in demand, is an important factor in explaining job and worker turnover. Controlling for year and industry effects, the real growth of output is positively correlated with job creation and negatively correlated with job destruction. At the same time, output growth is positively correlated with hiring and separation. Job creation is higher in export-oriented industries. There is also a strong positive correlation between export shares and hiring and separation rates, suggesting a looser employer-employee relationship in export-oriented industries.

REFERENCES

Abowd, J. M., Corbel, P. and Kramarz, F. (1999) The entry and exit of workers and the growth of employment: an analysis of French establishments, *Review of Economics and Statistics*, **81**, 170–89.

Akerlof, G. A., Rose, A. K. and Yellen, J. L. (1988) Job switching and job satisfaction in the US labour market, *Brookings Papers on Economics Activity*, **2**, 495–594.

Albæk, D. and Sørensen, B. E. (1998) Worker flows and job flows in Danish manufacturing, 1980–1991, *Economic Journal*, **108**, 1750–71.

Anderson, P. M. and Meyer, B. D. (1994) The extent and consequences of job turnover, *Brookings Paper on Economic Activity: Microeconomics*, 177–248.

Aw, B. Y., Chen, X. and Roberts, M. J. (1997) Firm-level evidence on productivity differentials, turnover, and exports in Taiwanese manufacturing, NBER Working Paper No. 6235.

Baldwin, J. and Picot, G. (1995) Employment generation by small producers in the Canadian manufacturing sector, *Small Business Economics*, **7**, 317–31.

Baldwin, J., Dunne, T. and Haltiwanger, J. (1998) A comparison of job creation and job destruction in Canada and the United States, *Review of Economics and Statistics*, **80**, 347–56.

Bilsen, V. and Konings, J. (1998) Job creation, job destruction and growth of newly established, privatized, and state-owned enterprises in transition economies: survey evidence from Bulgaria, Hungary, and Romania, *Journal of Comparative Economics*, **26**, 429–45.

Blanchflower, D. G. and Burgess, S. M. (1996) Job creation and

job destruction in Great Britain in the 1980s, *Industrial and Labour Relations Review*, **50**, 17–38.

Boeri, T. (1992) Employment growth, incumbents and entrants: evidence from Germany, *International Journal of Industrial Organization*, **10**, 545–65.

Boeri, T. (1994) Why are establishments so heterogeneous? *Small Business Economics*, **6**, 409–20.

Borland, J. (1996) Job creation and job destruction in manufacturing idustry in Australia, *Economic Record*, **72**, 46–62.

Broersma, L. and Gautier, P. (1997) Job creation and job destruction by small firms: an empirical investigation for the Dutch manufacturing sector, *Small Business Economics*, **9**, 211–24.

Davis, S. J. and Haltiwanger, J. C. (1992) Gross job creation, gross job destruction, and employment reallocation, *Quarterly Journal of Economics*, **107**, 819–63.

Davis, S. J., Haltiwanger, J. C. and Schuh, S. (1996) *Job Creation and Destruction*, MIT Press, Cambridge, MA.

Dunne, T., Roberts, M. J. and Samuelson, L. (1989) Plant turnover and gross employment flows in the US manufacturing sector, *Journal of Labour Economics*, **7**, 48–71.

Foote, C. L. (1998) Trend employment growth and the bunching of job creation and destruction, *Quarterly Journal of Economics*, **113**, 809–34.

Friedman, M. (1992) Do old fallacies ever die? *Journal of Economic Literature*, **30**, 2129–32.

Haddad, M., Melo, J. and Horton, B. (1996) Morocco, 1984–1889: trade liberalization, exports, and industrial performance, in *Industrial Evolution in Developing Countries: Micro Patterns of Turnover, Productivity, and Market Structure* (Eds) M. J. Roberts and J. R. Tybout, Oxford University Press, New York.

Hamermesh, D. S., Hassink, W. H. J. and van Ours, J. C. (1994) New facts about factor-demand dynamic employment, jobs and Workers, NBER Working Paper No. 4625.

Hamermesh, D. S., Hassink, W. H. J. and van Ours, J. C. (1996) Job turnover and labour turnover: a taxonomy of employment dynamics, *Annales d'Economie et Statistique*, **41-2**, 21–40.

Klette, T. J. and Førre, S. E. (1998) Innovation and job creation in a small open economy – Evidence from Norwegian manufacturing plants 1982–1992, *Economic Innovation and New Technology*, **5**, 247–72.

Konings, J. (1995a) Gross job flows and the evolution of size in UK Establishments, *Small Business Economics*, **7**, 213–20.

Konings, J. (1995b) Job creation and job destruction in the UK manufacturing sector, *Oxford Bulletin of Economics and Statistics*, **57**, 5–24.

Konings, J., Lehmann, H. and Schaffer, M. E. (1996) Job creation and job destruction in a transition economy: ownership, firm size, and gross job flows in Polish manufacturing 1988–1991, *Labour Economics*, **3**, 299–317.

Lane, J., Stevens, D. and Burgess, S. (1996) Worker and job flows, *Economics Letters*, **51**, 109–13.

Leonard, J. S. (1986) On the size distribution of employment and establishments, NBER Working Paper No. 1951.

Leonard, J. S. (1987) In the wrong place at the wrong time: the extent of frictional and structural unemployment, in *Unemployment and the Structure of Labour Markets* (Eds) K. Lang and J. S. Leonard, Blackwell, New York, pp. 141–63.

Pacelli, L., Rapiti, F. and Revelli, R. (1998) Employment and mobility of workers in industries with different intensity of innovation: evidence on Italy from a panel of workers and firms, *Economic Innovation and New Technology*, **5**, 273–300.

Roberts, M. J. (1996a) Employment flows and producer turnover, in *Industrial Evolution in Developing Countries: Micro Patterns of Turnover, Productivity, and Market Structure* (Eds) M. J. Roberts and J. R. Tybout, Oxford University Press, New York.

Roberts, M. J. (1996b) Colombia, 1977–1985: producer turnover, margins, and trade exposure, in *Industrial Evolution in Developing Countries: Micro Patterns of Turnover, Productivity, and Market Structure* (Eds) Mark J. Roberts and J. R. Tybout, Oxford University Press, New York.

Roberts, M. J. and Tybout, J. R. (1996) Industrial evolution in developing countries: a preview, *Industrial Evolution in Developing Countries: Micro Patterns of Turnover, Productivity, and Market* Structure (Eds) M. J. Roberts and J. R. Tybout, Oxford University Press, New York:

Serrano, C. G. (1998) Worker turnover and job reallocation: the role of fixed-term contracts, *Oxford Economic Papers*, **50**, 709–25.

Tybout, J. R. (1996) Chile, 1979–1986: trade liberalization and its aftermath, *Industrial Evolution in Developing Countries: Micro Patterns of Turnover, Productivity, and Market Structure* (Eds) M. J. Roberts and J. R. Tybout, Oxford University Press, New York.