行政院國家科學委員會補助專題研究計畫成果報告

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Worker Turnover, Job Reallocation and Productivity Growth in Taiwanese Manufacturing

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中文摘要

本研究係利用 1981-1994 **年臺灣「受雇員工動向調查」的廠商資料，來檢視就業波動的型態。實証結果發現，不論是以總合資料或二欄位的產業別資料，皆顯示工作重配置**(job reallocation)**和員工異動**(worker turnover)**有順景氣循環**(procyclical)**的現象。工作重配置僅佔員工異動中** 17%**的比重，這表示大多數的員工異動係來自於既有工作的更替，而非創造或汰減工作機會。廠商之間的工作與員工異動型態有明顯差異。小型廠商和民營廠商的就業創造率**(job creation rate)**和就業汰減率**(job distraction rate)**較高；而民營廠商的員工異動率也比公營廠商為高。整體而言，工作重配置對產業生產力的影響並不大。**

Abstract

We examine the time-series patterns of job and worker flows in a newly industrializing economy (NIE). Using plant-level data from Taiwan manufacturing sector, this paper analyses the cyclical behavior of job reallocation and its relation with worker turnover. We find that job reallocation and labor turnover are procyclical, at both the aggregate and (two-digit) industry levels. The share of worker turnover caused by gross job reallocation is 17 percent, 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, we find that job creation is higher in export-oriented industries and a looser employer-employee relationship also exists in these industries. Overall, job reallocation contributes little to the increase in sectoral productivity.

Keywords: worker turnover, job reallocation, productivity growth

1. Introduction

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

We address four main issues. First, we examine the time-series patterns of job flows and worker flows. We are particularly interested in the cyclical properties of job and worker flows and the fraction of worker turnover that is due to job reallocation. Second, we investigate the relationship between net employment growth, hiring and separation rates at the plant level. We compare the rates of job and worker flows using two observable plant characteristics: plant size and ownership type. Third, using a regression framework, we explore the roles of innovation and trade exposure in the determination of job-flow and worker-flow rates. Fourth, we investigate the contribution of job reallocation to the industry-level total factor productivity growth. A limitation of our study is that we are unable to analyze the contribution of entry and exit to worker and job reallocation, because complete information on newly created and exiting plants is not available.

Our 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 procyclical. Worker turnover also exhibits a procyclical pattern.

Job reallocation and worker turnover are also procyclical 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 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 high job creation rate and lower job destruction rate. 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.

Controlling for year and industry effects, job creation is positively correlated with industry-level productivity growth and job destruction is negatively correlated with industry-level total factor productivity growth. Total job reallocation has little effect on productivity growth.

The remainder of the paper is organized as follows. Section 2 summarizes some of the results of previous studies investigating these issues in other countries. Section 3 describes the data sources and measurements of employment flows. Section 4 describes the basic patterns of job and worker flows in manufacturing sector in Taiwan. In Section 5, we report and discuss the relationship between employment changes and firm size and ownership type. Section 6 discusses the determinants of industry-level job and worker flows. The contribution of job reallocation on industry-level productivity growth is also included. Section 7 concludes the paper.

2. Previous Results

Much previous research has focused on job reallocation, which occurs through job creation and destruction. With the exception of Roberts (1996a), Konings, Lehmann and Schaffer (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

[1] See, e.g., Leonard (1987), Dunne, Roberts and Samuelson (1989), Davis and Haltiwanger (1992), Davis, Haltiwanger and Schuh (1993, 1996), and Foote (1998) for the U.S., Baldwin and Picot (1995) for Canada, Koings (1995a, 1995b) and Blanchflower and Burgess (1996) for the U.K., 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 US and Canada. Roberts (1996a) compares employment flows for three developing countries: Chile, Columbia, and Morocco. Konings, Lehmann and Schaffer (1996) analyze the labor market

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. However, this countercyclical pattern is not evident in developing countries. 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 labor turnover, the sum of hiring and separation rates), and its relation to job reallocation.[2] Hamermesh, Hassink and van Ours (1994, 1996), Lane, Stevens and Burgess (1996), and Serrano (1998) analyze 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 attributed to worker-initiated and firm-initiated turnover across continuing position. Albæk and Sørensen (1998) find that job reallocation is symmetric and worker turnover is procyclical over the business cycle in Denmark. They conclude that the cyclical behavior 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 procyclical quit rate. Abowd, Corbel and Kramarz (1999) use matched data from France to suggest that the hiring rate is 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 has 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, Rapiti and Revelli (1998) find that separations are inversely related to an industry's innovation intensity, supporting the hypothesis that more innovative firms

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adjustment in Poland. Bilsen and Konings (1998) investigate the 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.

cultivate more durable employer-employee relationship. The link between trade-related variables and job turnover is not well established. In general, after controlling 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, 1996a). An exception is Morocco, where Haddad, Melo, and Horton (1996) find that export promotion programs appear to have tilted entry patterns toward export-oriented sectors

Changes in output-market structure, such as firm entry, exit, and reallocation of market share, can be a source of competitive pressure and a source of sectoral productivity growth. Recent evidence on the link between employment turnover and productivity is mixed. Baily, Hulten, and Campbell (1992) find that entry and exit play only a very small role in industrial productivity growth in the United States. Griliches and Regev (1992) use plant-level data from Israel and find that the effect of turnover on aggregate productivity is small. Liu and Tybout (1996) examine the roles of entry, exit, and market share reallocations in generating productivity growth for Columbia. They find that turnover contributes very little to productivity growth in short run, but the cumulative effects over longer horizens are substantial. However, using the same database as Baily, Hulten, and Campbell (1992), Olley and Pakes (1992) find that turnover and changing market shares among incumbents are the main reason for productivity growth in the telecommunation industry. Tybout (1996b) suggests that net exit increases incumbents' market share improved aggregate productivity during Chile's severe recession of the early 1980s, and that rapid net entry reduced incumbents' market shares and lowered aggregate productivity in Morocco's expansion of the mid 1980s.

3. Data and Measurement

The data are from the annual labor turnover surveys conducted by the Statistical Bureau of Taiwan. We restrict our attention to plants in the manufacturing sector over the period 1981-1994. Due to a substantial reduction in the sample sizes for the year of 1990, this year is excluded from the study. The level of observation is the plant. Since the survey includes retrospective questions on year-end employment as well as hirings and separations of workers during the year, we are able to compute the job creation and job destruction rates. In contrast to

most previous studies, our 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 our 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, we are unable to analyze the contribution of entry and exit to worker and job reallocation.

Our 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. Job reallocation rate (SUM) is the sum of job creation and destruction rates. Net employment growth rate (NET) is simply 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.

4. 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.

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[3] Other studies that analyze job and worker turnover data from a common source include: Anderson and Meyer (1994) in the United States; 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, Corbel and Kramarz (1999) in France.

4.1 Time Variation of Job and Worker Flows

We begin our analysis 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 to 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 percent, the job destruction rate was 3.2 percent. In 1985, when manufacturing employment declined 1.6 percent, the job creation rate was 6.3 percent. The job reallocation rate ranges from a high of 14.3 percent in 1985 to a low of 8.9 percent in 1994. For the manufacturing as a whole, job creation and destruction rates average 6.8 percent and 5.3 percent, respectively. The annual average job reallocation rate is 12.1 percent. The manufacturing sector as a whole grew at an average rate of 1.5 percent 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 procyclical 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 percent and 34.4 percent, respectively. The gross worker turnover rate ranges from 49.6 percent in 1994 to 91.1 percent 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 the level of firms' employment positions. This sort of worker turnover is due to job-match creation and destruction

as workers begin or leave a position. In our 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 percent and 22.7 percent. 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 labor 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 United States. 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 United States, and several European countries. Since our 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 procyclical 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 procyclicality of total worker turnover is consistent with the findings in Anderson and Meyer (1994) for the United States, Albæk and Sørensen (1998) for Denmark, and Abowd, Corbel, and Kramarz (1999) for France.

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[4] Roberts (1996a) finds that the job reallocation rate lies in the range of 26.2-30.6 percent for the three developing countries

[5] Akerlof, Rose and Yellen (1988) and Albæk and Sørensen (1998) find that quits are procyclical and layoffs are countercyclical in the United States and Denmark.

4.2 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 percent in Petroleum and Coal to 8.9 percent in Electrical Machinery. The annual average job destruction rate varies from 0.8 percent in Petroleum and Coal to 7.1 percent 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 labor 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 percent in Chemical Matter to 8.6 percent in Precision Instruments. The average job destruction rate ranges from 3.6 percent in Chemical Matter to 8 percent in Precision Instruments. The hiring and separation rates are even higher among these sectors, varying between 19.5 percent and 44 percent.

Examining the last three columns in Table 2, we find 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 correlation between job reallocation and net growth rate is all positive. This occurs because the time-series standard deviation of job creation is larger than that of job destruction. Therefore, a procyclical pattern of employment reallocation exists in most two-digit manufacturing industries. Similarly, hiring is more cyclically volatile than separation in most industries.[6]

[6] To save the space, we do not report the relative standard deviation of hiring and separation in Table 2.

To evaluate the contribution of within-sector and between-sector job flows, we decompose excess job reallocation at the total manufacturing level into the components due to employment shifts between and within industries. Specifically, the excess job reallocation is defined as the difference between the 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 ($\sum_i (|SUM_i| - |NET_i|)$).

We calculate the between- and within-sector components of excess job reallocation for every year using both the two-digit and four-digit annual series. Within-sector shifts account for 73 percent of excess job reallocation among two-digit industries. Even when we define sectors in terms of four-digit industry, within-sector shifts still account for 56 percent 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 is consistent with the results of Dunne, Roberts and Samuelson (1989), Davis and Haltiwanger (1992), Roberts (1996), and Baldwin, Dunne and Haltiwanger (1998).

5. 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 labor demand. The first part of this section investigates the

[7] Dunne, Roberts and Samuelson (1989) find that over 70 percent of the employment turnover occurs across plants within the same two-digit industry in the United States. Davis and Haltiwanger (1992) find that about 12 percent of excess job reallocation in the United States is accounted for by shifts between four-digit industries. Similarly, Baldwin, Dunne and Haltiwanger (1998) find between-industry shifts (two-digit) account for only 3.6 percent of excess job reallocation in the United States and 2.5 percent of excess job reallocation in Canada. For

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.

5.1 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 and 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 percent of all hires, but establishments with decreasing employment account for 13.3 percent of all hires. Figure 3 reveals a similar distribution of separations. Most of the distribution is concentrated around the center: 65.6 percent of separations takes place in plants with growth rates in the interval (-0.3, 0.1], and a large share, 25.4 percent, of all separations takes place in expanding plants. These figures show further

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developing countries, Roberts (1996) shows that more than 80 percent of employment turnover occurs within the same four-digit industry in Columbia, Chile and Morocco.

[8] The measure of growth rate is adopted from Davis and Haltiwanger (1992). We measure the size of establishment j at time t, denoted by x_{jt}, as the simple average of establishment at time t and t-1. The growth rate of establishment j at time t, denoted by g_{jt}, as 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.

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).

5.2 Plant Size, Ownership Type and Job and Worker Flows

To examine the role of plant heterogeneity in the determination of job and worker turnover, we consider two observable plant characteristics: 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 percent of employment per year for plants with fewer than 10 employees and 5.2 percent 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 percent of employment per year for plants with fewer than 10 employees and 4.9 percent 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 percent of job creation and 85 percent 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 percent of manufacturing employment. These results are similar to those found by Davis, Haltiwanger and Schuh (1996b) in the U.S. and Broersma and Gautier (1997) in the

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[9] Ideally we should also include the plant age into the analysis, but this variable is not available in our dataset.

[10] We use average size rather than initial plant size to avoid Galton's fallacy of regression towards to the mean: if initial size are 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, Haltiwanger and Schuh (1996b).

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

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 percent and 5.5 percent 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 percent of job creation and 89.6 percent of job destruction. The large gross job flows are consistent with the findings in Konings, Lehmann and Schaffer (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 percent for plants with fewer than 10 employees and 32.7 percent 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 percent), whereas plants with more than 500 employees have the lowest separation rates (32.4 percent). This result contrasts with those found by Lane, Stevens and Burgess (1996) in the United States, 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 percent and 37.3 percent, respectively, much larger than the corresponding values in public plants, 5.4 percent and 7.2 percent, respectively. The private sector accounts for more than 90 percent of total worker turnover.

6. The Determinants of Industry-Level Job and Worker Flows and the Effects of Productivity Growth

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

$$Y_{it} = f(GRQ_{it}, Ex_{it}, YEARt, IND_i) \qquad (1)$$

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, we find 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, Melo and Horton (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 powerful in explaining job creation and destruction rates.[11]

Turning to the regressions of worker-flow rates, the third and forth columns in Table 6 report 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 Taiwan manufacturing sector allows firms to reduce the transaction costs of entering and exiting the international market.[12]

To investigate the contribution of job reallocation to industry-level productivity growth, we estimate a set of regressions with total factor productivity growth as the dependent variable and job reallocation (job creation or job destruction), year and industry effects as regressors. The regressions take the following form:

$$TFPG_{it} = g(X_{it}, YEAR_t, IND_i) \qquad (2)$$

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

where $TFPG_{it}$ represents total factor productivity growth for two-digit industry i in period t. X_{it} represents (POS, NEG, or SUM) for each industry, YEAR represents a set of 12 year dummies, and IND represents a set of 14 industry dummies.[13] The regression results are presented in Table 7. After controlling for year and industry effects, job creation is significantly positively correlated with total factor productivity growth. In contrast, job destruction is significantly negatively correlated with total factor productivity growth. This implies that the productivity growth of most new entrants and expanding plants is higher than that of exits and contracting plants.[14] However, there is no direct relationship between job reallocation and total factor productivity growth. Hence, total job reallocation contributes little to the increase in sectoral productivity growth. These results are only partly consistent with the findings in Davis, Haltiwagner and Schuh (1996) for the United States. They find that job creation is higher in industries with higher total factor productivity growth, but job destruction is not systematically related to productivity growth. The small effect of job reallocation on sectoral productivity growth contrasts with the evidence reported by Aw, Chen and Roberts (1997).[15]

7. Conclusion

This paper analyzes job and worker flows in the Taiwanese 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 analyze 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

[13] Since the measures of total factor productivity growth are calculated by using 15 two-digit industries, we rearrange the job-flow and work-flow data into 15 industries.
[14] A limitation of our dataset is that we lack the complete information on entry and exit. Variables such as sales, capital stock, material and energy inputs are also not available. Hence we are unable to compare the productivity differences between entering, exiting, and continuing plants.
[15] By using a decomposition method, Aw, Chen and Roberts (1997) find that productivity differentials between entering and exiting firms are both major sources of sectoral productivity growth in Taiwan manufacturing.

more cyclical process of job creation and hiring. Thus, job reallocation and worker turnover are both procyclical. The cyclical properties of job flows closely mirror findings for three developing countries (Chile, Colombia, and Morocco), but are contrary to those for industrial countries. However, the procyclicity of worker turnover is consistent with evidence for the United States and Denmark. On average, job reallocation accounts for only 17.2 percent of worker turnover, suggesting the majority of observed worker turnover reflects rotations of positions that are neither created or destroyed. This indicates that labor 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 percent of excess job reallocation occurs within the same industry. Similar results hold when we define sectors in terms of four-digit industry. This result supports the view that job reallocation is driven by plant-level heterogeneity in labor 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. The 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 important in the determination of job and worker turnover. 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. Controlling for year and industry effects, job creation is positively correlated and job destruction is negatively correlated with total factor productivity growth. Overall, job reallocation contributes little to the increase in sectoral productivity.

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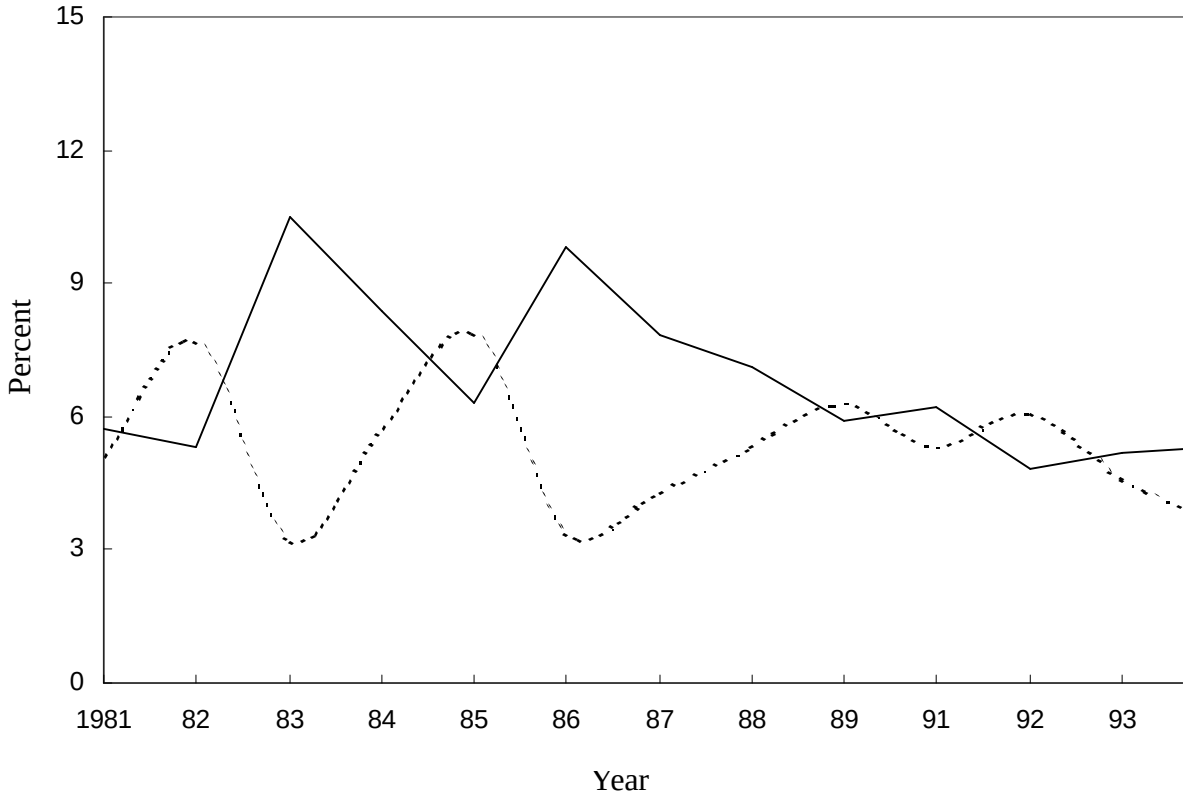

Figure 1 Job Creation and Job Destruction in Taiwan.

Note: Solid line represents job creation; dashed line represents job destruction.

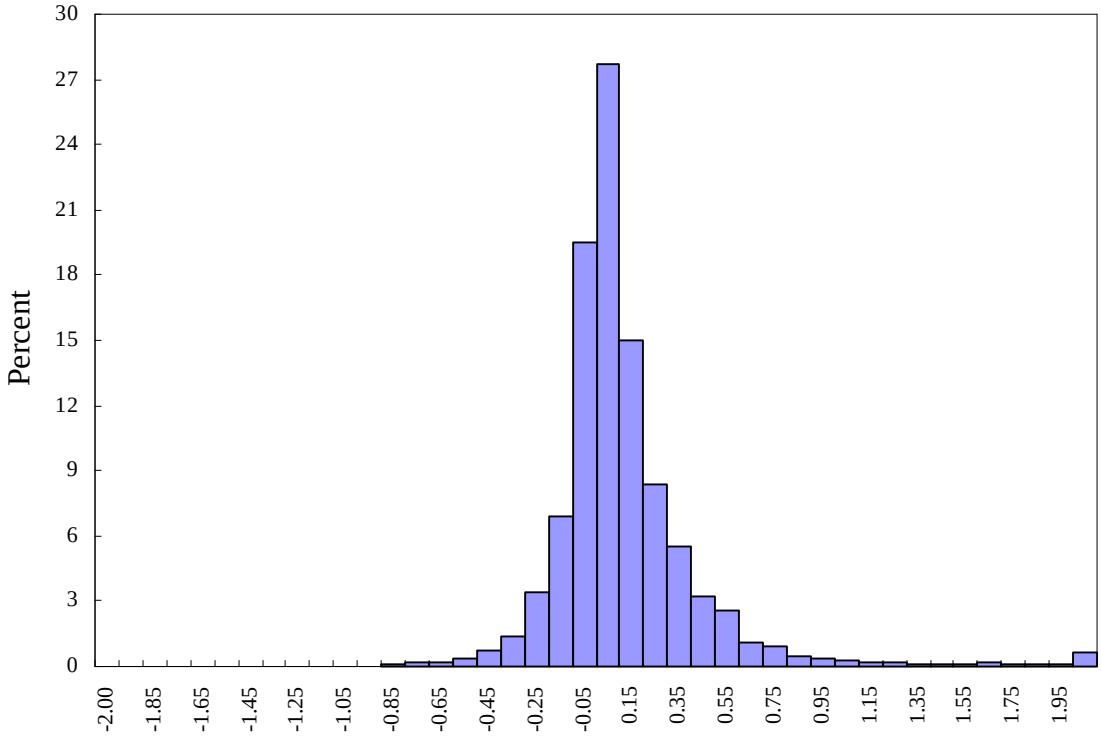

Figure 2 Percentage of Hires by Plant

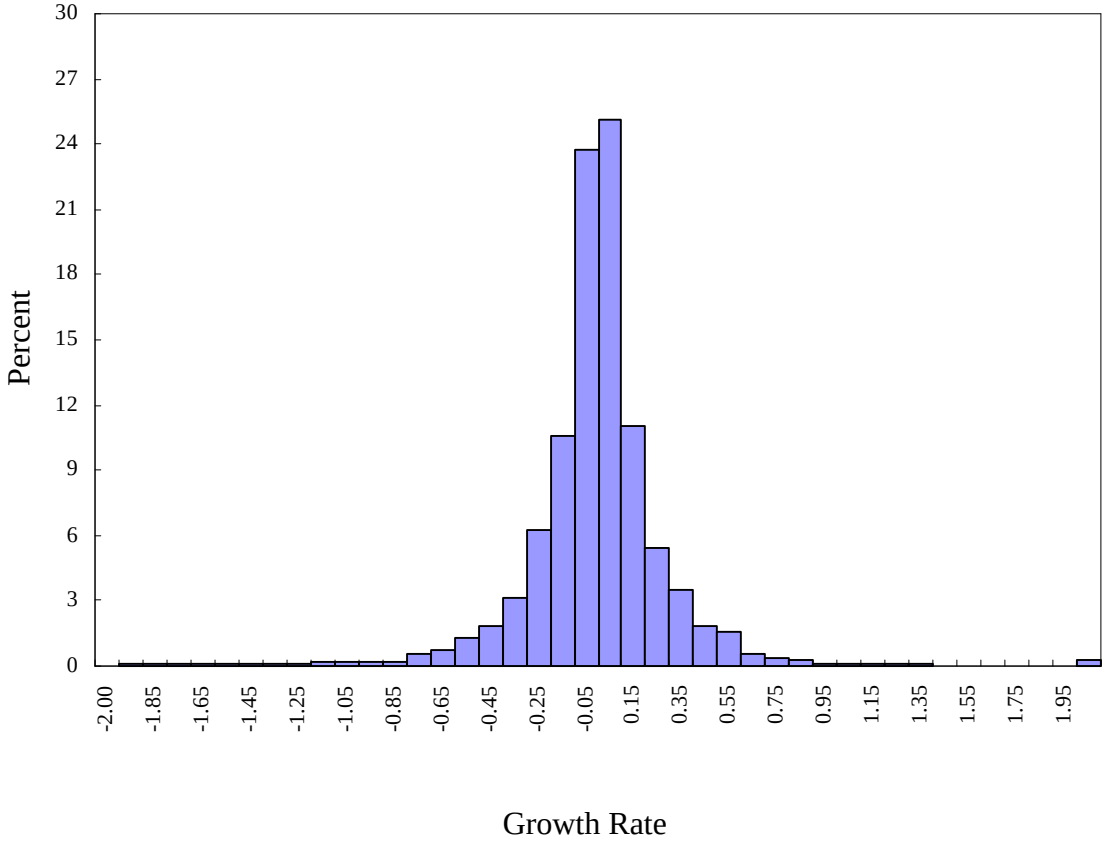

Figure 3 Percentage of Separations by Plant

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

Table 2. Means and Correlations for Job and Worker Flows by Industry, Taiwan

Industry	$\overline{POS}$	$\overline{NEG}$	$\overline{SUM}$	$\overline{NET}$	$\overline{H}$	$\overline{S}$	$\overline{T}$	$corr(POS, NEG)$	$corr(SUM, NET)$	$\frac{Std(POS)}{Std(NEG)}$
Food (20)	0.059	0.032	0.092	0.028	0.244	0.216	0.460	-0.285	0.516	1.733
Beverages & 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 & Fur (24)	0.081	0.064	0.146	0.017	0.404	0.388	0.792	-0.433	0.566	1.796
Wood Products & Furniture (25)	0.071	0.059	0.130	0.012	0.398	0.386	0.784	-0.490	0.117	1.108
Paper & 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 & 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.

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

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

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

Note: All regressions include 12 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 heteroskedastic-consistent covariance matrix.
*** and ** represent statistical significance at 1% and 5%, respectively

Table 7. Job Flows and Total Factor Productivity Growth

	Total Factor Productivity Growth (TFPG)		
Constant	-0.0519	0.0450	-0.0072
	(-0.68)	(0.84)	(-0.09)
POS	0.5524		
	(1.85)*		
NEG		-0.6160	
		(-1.94)**	
SUM			0.0050
			(0.02)
$\bar{R}^2$	0.11	0.11	0.10

Note: All regressions include 12 year dummies and 14 industry dummies for two-digit industries. Figures in parentheses are t-statistics. Regressions are estimated by ordinary least squares using heteroskedastic-consistent covariance matrix.** and * represent statistical significance at 5% and 10%, respectively.