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Dynamic Interrelation of Births and Deaths: Evidence from Plant Level Data

Wen-Cheng Lu
Department of Economics

Jong-Rong Chen
Institute of Industrial Economics

Ying-Tang Huang
Institute of Industrial Economics

Abstract

In this paper, the dynamic panel data method is used to investigate the dynamic interrelation of plant births and plant deaths. The dynamic panel data method considers the endogenous problem and individual effects. Empirical findings support the multiplier effect. In addition, exit does not cause entry, whereas entry causes exit.

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1. Introduction

One of the most prominent empirical and theoretical regularities to emerge in industrial organization is the dynamic interrelation of firm births and deaths. The relationship is also called the firm survival issue and has been observed in large multi-industry samples from manufacturing censuses in several countries. Dunne *et al.* (1988, 1989), Baldwin *et al.* (2000), Evans (1987a, 1987b) and Hall (1987) use different samples to obtain similar results and fruitful policy implications. The firm dynamic issue involves many economic dimensions such as R&D and financial constraints. Therefore, we briefly recall the existing literature on firm dynamics as follows.

First, in product life cycle theory, the study highlights on time domain. Vernon (1966) argues that how new product innovations are introduced in the market and how they continued to expand and mature. An older generation product will be replaced by new products. In the introductory period, the market share is unstable and the firms can earn higher profit. Many new firms will enter, and entry rate is higher than the exit rate. More firm exits accompany industrial maturity. In the declining period, innovation opportunities are narrow, and the exit rate is higher than the entry rate. Therefore, a dependent relation between firm exit and firm entry will exist.

Second, Economic base theory (EBT) is another way to demonstrate the relation between firm exits and firm entries in the geographic (regional) scope. Some regional (industrial) economic activity will affect other regional (industrial) economic activity. Mayo and Flynn (1989) apply regional firm entries and exits data to test and verify EBT. Gerking and Isserman (1981) also show an interrelationship between firm entries and firm exits considering regional effect.

Third, the Orr-type model indicates that entries (exits) are the function of barriers to entry (exit) and market condition. Barriers to entry usually are measured by minimum efficient scale, R&D intensity and advertising, while market condition is measured by industrial growth and price-cost margin. In the empirical studies, the Orr-type model often has the following limitations: 1.The Orr-type model often assumes that firm entry behavior is symmetric to firm exit behavior. 2. It ignores complex incontemporary dynamic relations. Johnson and Parker (1994) offer two opposite concepts concerning the interrelation of entries and exits—multiplier effect and competition effect. They explain that the multiplier effect is a previous entry causing entry in the next period whereas a previous entry will slow down the incidence of deaths. The relation between previous entry (exit) and present entry (exit) is positive whereas previous entry (exit) will negatively affect present exit (entry). The competition effect suggests a negative relationship between previous entry (exit) and present entry (exit); while previous entry (exit) increases present exit (entry). There are many examples of the multiplier effect and competition effect.[1]

However, the recent research focuses on firm heterogeneous. The interest of this approach is fourfold. First, financial constraint and borrowing cost will connect with firm growth and survival. Firm growth is restricted by cash-flow and investments. The distribution of firm size will be a skewed distribution (Cabral and Mata, 2003).

[1] An example of the multiplier effect is the demonstration effect. If a firm enters a market and stays there, other firms may find extra market space to enter. Product life cycle is an example of the competition effect. When a industry becomes mature, a firm will suffer price competition. Efficient firms will survive in a given industry.

Borrowing cost distribution also evolves with age as a determinant of industry evolution (Diamond, 1989). Second, knowledge accumulation will reduce the exit hazard. Firms may accumulate knowledge through learning by doing over time and new firms will take the place of older ones. Knowledge or technology accumulation is also viewed as a determinant of firm dynamics and industrial evolution. Third, Klepper and Thompson (2002) provide a model in which industries are composed of distinct, but intrinsically unobservable, submarkets. Firm survival is increasing with the number of submarkets. The number of firms is correlated with firm age, which is called age-dependence. Highfield and Smiley (1987) identifies the macroeconomic and microeconomic factors that influence the rate of creation of new firms. The cross-sectional or microeconomic factors including higher growth rates in sales, higher research and development intensity, and higher profit rates lead to the higher rates of entry into different industries. The macroeconomic influence showed that lower rates of growth of GNP, lower inflation rates and greater growth in the unemployment rate were followed by the increase in the rate of new incorporations. However, only a few studies that provide formally time-series evidence about the dynamic interrelationship of births and deaths. In this paper, we fill a gap of empirical studies about this issue.

This paper uses plant data to study the dynamics, embedding the plant birth and deaths behavior in the multiplier and competition effects. We also use the dynamic panel data model to estimate parameters to consider the endogenous problem and the individual effect. The rest of this paper is organized as follows. In section 2 we describe our empirical models. In section 3 we account for our entry and exit data at plant level. Next, we provide the empirical results and model diagnostics in section 4. Finally, section 5 demonstrates our empirical conclusions on this issue.

2. Empirical Model

Most studies have been conducted in a static environment, and applying the OLS method (see Reynolds, Storey and Westhead, 1994). In recent years attention is turning to the interdependencies of births and deaths, and in some cases, investigations have been carried out even in a dynamic setting. For example, Kangasharju and Moisio (1998) use vector autoregressions (VAR) and an instrumental variable estimator. The important findings are that firm births equation has a two year lag structure and firm deaths cause firm births. Firm deaths also cause subsequent deaths.

According to the previous empirical literature, the concise statement of dynamic interrelationship between firm exits and firm entries can be shown as the following:

$$Entry_t = C_0 + \sum_{p=1}^{n} \beta_p Entry_{i,t-p} + \sum_{p=1}^{n} \gamma_p Exit_{i,t-p} \tag{1}$$

$$Exit_t = C_1 + \sum_{q=1}^{m} \alpha_q Entry_{i,t-q} + \sum_{q=1}^{m} \eta_q Exit_{i,t-q} \tag{2}$$

$Entry_{t-1}$ and $Exit_{t-1}$ represent firm entries and firm exits at time *t-1*, respectively. $Entry_t$ and $Exit_t$ stand for firm entries and firm exits at time *t*. The simple distinction of multiplier effect and competition effect is follow:

1. Intertemporal relation of multiplier effect:

$$Entry_{t-1} \xrightarrow{+} Entry_t \qquad Entry_{t-1} \xrightarrow{-} Exit_t \tag{3}$$

$$Exit_{t-1} \xrightarrow{+} Exit_t \qquad Exit_{t-1} \xrightarrow{-} Entry_t \tag{4}$$

2. Intertemporal relation of competition effect:

$$Entry_{t-1} \xrightarrow{-} Entry_t \quad Entry_{t-1} \xrightarrow{+} Exit_t \tag{5}$$

$$Exit_{t-1} \xrightarrow{-} Exit_t \quad Exit_{t-1} \xrightarrow{+} Entry_t \tag{6}$$

The next problem we have addressed is to estimate the parameters correctly. Baltagi (2001) points out that the OLS estimator is biased and inconsistent because the lagged dependent variable is corrected with the disturbance term. Empirically, equation (1) and equation (2) have to be estimated by the dynamic panel data method. Arellano and Bond (1991) show that their instrumental variable method can overcome individual effects and the endogenous problem. We use the econometric method of Arellano and Bond (1991) to estimate the parameters. The results are presented in Table I.

3. Data Description

The plant data are panel data and are derived from the Taxation Information Center of the Ministry of Finance and Industrial Development Bureau, M.O.E.A. in Taiwan. In this source, factory opening registrations and factory license revocations are listed in their publications. Our dataset contains the following industries: apparel, chemical products, rubber products, plastic products, metal products, machinery, transport equipment, and precision instruments. Considering the sample completeness, we focus our analysis on those 8 industries. The time period of our monthly sample is from 1989:1 to 1998:12. Plant entry and exit are computed by entry and exit rates respectively.[2]

4. Empirical Results

It is important to investigate forces underlying the opening of new firms and closing of incumbent firms, both for understanding industrial change, and economic policy making. Kangasharju and Moisio (1998) find that exit causes entry, whereas entry does not cause exit. However, Johnson and Parker (1994) find that entry causes exit, whereas exit does not cause entry. The results in Table I show that dynamics play an important role in all the equations. The empirical results ($\beta_p > 0$ and $\gamma_p < 0$) support the multiplier effect. To get robust results, we estimate our model for the cases of p =2 and q =2, as well as p = 3 and q = 3. We also use the statistics m_1, m_2, and Sargan test to diagnose our models. The statistics m_1 and m_2 test for first-order and second-order residual autocorrelation in the first-differenced residuals. Under the null hypothesis of no serial correlation, these tests have a standard Normal distribution. Sargan test of over-identifying restrictions has a χ^2 distribution under the null of validity of both specification and instruments. In general, the estimated model seems adequate, i.e. imposing a different lag structure does not lead to different results. The relation between previous entry (exit) and present entry (exit) is positive. In other words, previous entry (exit) causes present entry (exit). We find that exit does not cause entry, whereas entry causes exit. Our results are robust to general heteroscedasticity patterns across individuals and over time.

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2 Entry rate is defined as $\frac{\text{the number of entries}}{\text{the number of already existing plants}}$. Exit rate is also defined as $\frac{\text{the number of exits}}{\text{the number of already existing plants}}$.

5. **Conclusion**

The structure of Taiwanese industry differs substantially from that of other developed countries. Many of the major electronics manufacturers in other developed countries are large, diversified enterprises with internationally recognized brand names, a global presence, and, in many cases, a network of affiliates and suppliers. In contrast, Taiwan's industry is dominated by smaller, more specialized firms. As pointed out by Aw et al. (1997), the Taiwanese industry is characterized by a very high degress of entry and exit which gives some empirical grounding to the notion of flexible Taiwanese markets. The entry and exit behavior in a given industry in Taiwan may be different from previous empirical studies. In this paper, we use the dynamic panel data method to estimate the dynamic interrelation of firm births and firm deaths to distinguish previous static empirical literatures. The dynamic panel data method can provide the estimation of the parameters considering the endogenous problems and individual effects. Our findings support multiplier effect, in other words, the relation between previous entry (exit) and present entry (exit) is positive and exit does not cause entry, whereas entry cause exit.

5. References

Arellano, M., and S. Bond (1991) “Some Tests of Specification of Panel Data: Monte Carlo Evidence and an Application to Employment Equations” *Review of Economic Studies*, **58**, 277-297.

Aw, B. Y., X. Chen, and M. J. Robert (1997) “Firm-level Evidence on Productivity Differentials, Turnover, and Exports in Taiwanese Manufacturing” NBER Working paper 6234.

Baldwin, J., L. Bian, R. Dupuy, and G. Gellatly (2000) “Failure Rates for New Canadian Firms: New Perspectives on Entry and Exit” mimeo, Statistics Canada.

Baltagi, B. H. (2001) *Econometric Analysis of Panel Data*, New York: Wiley.

Cabral, L.M.B., and J. Mata (2003) “On the Evolution of the Firm Size Distribution: Facts and Theory” *American Economic Review*, **93**, 1075-1090.

Diamond, D.W. (1989) “Reputation Acquisition in Debt Markets” *Journal of Political Economy*, **97**, 828-862.

Dunne, T., M. J. Roberts, and L. Samuelson (1988) “Patterns of Firm Entry and Firm Exit in U.S. Manufacturing Industries” RAND *Journal of Economics*, **19**, 495-515.

Dunne, T., M. J. Roberts, and L. Samuelson (1989) “The Growth and Failure of U.S. Manufacturing Plants” *Quarterly Journal of Economics*, **104**, 671-698.

Evans, D. S. (1987a) “Tests of Alternative Theories of Firm Growth” *Journal of Political Economy*, **95**, 657-674.

Evans, D. S. (1987b) “The Relationship between Firm Growth, Size, and Age: Estimates for 100 Manufacturing Industries” *Journal of Industrial Economics*, **35**, 567-581.

Gerking, S. D., and A. M. Isserman (1981) “Bifurcation and the Time Pattern of Impacts in the Economic Base Model” *Journal of Regional Science*, **21**, 452–467.

Hall, B. H. (1987) “The Relationship between Firm Size and Firm Growth in the U.S. Manufacturing Sector” *Journal of Industrial Economics*, **35**, 583-606.

Highfield, R., and R. Smiley (1987) “New Business Starts and Economic Activity- An Empirical Investigation” *International Journal of Industrial Organization*, **5**, 51-66.

Johnson, P., and S. Parker (1994) “The interrelationship between births and Deaths” *Small Business Economics*, **6**, 283-290.

Kangasharju, A., and A. Moisio (1998) “Births-Deaths Nexus of Firms: Estimating VAR with Panel Data” *Small Business Economics*, **11**, 303-313

Klepper, S., and P. Thompson (2002) “Submarket and the Evolution of Industry” mimeo, Carnegie Mellon University.

Mayo, J., and J. Flynn (1989) “Firm Entry and Exit: Causality Tests and Economic- Base Linkages” *Journal of Regional Science*, **29**, 645-662.

Reynolds P. D., D.J. Storey, and P. Westhead (1994) “Cross-national Comparisons of the Variation in New Firm Formation Rates” *Regional Studies*, **28**, 443-456.

Vernon, R., (1966) “International Investment and International Trade in the Product Life Cycle” *The Quarterly Journal of Economics*, **80**, 190-207.

Table I. Empirical results

	Entry	*Entry*	*Entry*	*Exit*	*Exit*	*Exit*
$Entry_{t-1}$	0.111*** (0.033)	0.092*** (0.032)	0.094*** (0.033)	0.029 (0.068)	-0.009 (0.069)	-0.015 (0.069)
$Entry_{t-2}$	-	0.167*** (0.032)	0.017*** (0.033)		0.298*** (0.069)	0.299*** (0.069)
$Entry_{t-3}$	-	-	0.007 (0.034)			0.059 (0.069)
$Exit_{t-1}$	-0.001 (0.015)	-0.003 (0.015)	0.009 (0.016)	0.130*** (0.032)	0.145*** (0.033)	0.134*** (0.033)
$Exit_{t-2}$		-0.008 (0.015)	-0.008 (0.016)		0.051 (0.032)	0.051 (0.033)
$Exit_{t-3}$		-	0.048*** (0.016)			0.0399 (0.032)
Constant	-0.002*** (0.000)	-0.002*** (0.000)	-0.002*** (0.000)	0.001*** (0.000)	0.001*** (0.000)	0.001*** (0.000)
m_1	-21.28 (0.00)	-28.23 (0.00)	-28.39 (0.00)	-19.09 (0.00)	-26.77 (0.00)	-29.57 (0.00)
m_2	4.44 (0.00)	0.23 (0.82)	0.54 (0.59)	0.75 (0.46)	-1.19 (0.23)	-1.62 (0.11)
Sargan Test	922.24	935.86	910.43	966.47	929.26	935.68

Note: '***' denotes significance at the 1% level. Figures in parentheses under estimates and test statistics are standard errors and p-value respectively.