Why do Fast Growing Sectors Not Experience Above-Average Entry of New Firms? *

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Abstract

Output growth is positively correlated with firm entry in the aggregate data, but not in sectoral data. That is, sectors whose growth is above average in a given year do not experience above average entry of firms. This is a puzzle for competitive models in which returns at the firm level are decreasing. In this paper I show that the puzzle can be resolved if we assume that sector's incumbents have market power. The intuitive reason is that the incumbents have a bigger incentive to secure their rents in the growing market and thereby to deter entry. The model also implies that technological innovation, and competitiveness and smallness of the product market foster entry and exit. These predictions are tested using US job-flow data.

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1 Introduction

The positive relation between business startups and output growth is a common feature of macro models that study competitive equilibrium with decreasing returns to scale at firm or plant-level. (Caballero and Hammour 1994 and 1996, and Horvath 1999) In the models of Caballero and Hammour, output growth comes from positive demand shocks. Existing firms suffer from severe decreasing return to scale while entrants are not. Hence, positive demand shocks induce new firm startups. In Horvath, output growth is associated with a high productivity. The positive relation between startups and output growth arises through a change in aggregate productivity. An episode of high aggregate productivity convinces both existing and potential entrants that they both have high productivity. Hence more firms stay and more new firms enter, and thereby the number of firms increase. Due to decreasing returns to scale at firm-level, aggregate TFP therefore increases and output growth follows.

The comovement of entry and output growth is confirmed at *aggregate* level indeed. For instance, Horvath finds that both GDP growth is positively associated with the number of firms that enter, as well as the number of establishments (Figures 4 and 5). The relation is weak and not confirmed at *industry* level however. First, Audretsch and Acs (1994) find that GDP growth is positively and significantly related with the number of firm startups while *industry growth* does not have any significant effects on industry startups (Table II). Second, a weak relation between industry growth and startup activities is also found in job flows data. Table 1 shows the correlation between industry growth and job creation rate by continuing and new plants for SIC 2-digit industries.[1] Contrary to the literature based on decreasing returns to scale, job creation by continuing plants is uniformly more sensitive to industry growth than job creation by new plants.[2] Continuing plants appear to meet industry growth flexibly and not to suffer from their decreasing returns to scale. Furthermore, the correlation between job creation by new plants and industry growth is even negative for nine industries in the sample.

The goals of this paper are to offer a model alternative to ones of competitive equilibrium with decreasing returns to scale and to study what drives business entry and exit. For this sake, I study a model of monopoly with constant returns to scale when incumbent and potential entrant compete for adopting the frontier technology. If the incumbent continues to hold the most advanced technology, there is no entry. If another firm obtains such technology, the firm enters the market and the incumbent loses the market. Hence, in this model, whether new firms emerge depend on the factors that condition the innovation rivalry between incumbent and entrant.

[1] Job creation rates for tobacco products industry (SIC21) are neither disclosed nor included in this table.

[2] This fact is found at various levels, from aggregate to industry, and in various countries. For instance, see Davis, Haltiwanger, and Schuh (1996) and Boeri and Cramer (1991).

TABLE 1
Industrywide Correlations between Job Creation Rate and Industry Growth from 1973 through 1993

	New Plants	Continuing Plants
Food And Kindred Products (20)	-0.0401	0.1710
Textile Mill Products (22)	0.0969	0.6509
Apparel And Other Textile Products (23)	-0.1393	0.4431
Lumber And Wood Products (24)	0.3477	0.8073
Furniture And Fixtures (25)	0.4063	0.7249
Paper And Allied Products (26)	0.0101	0.6178
Printing And Publishing (27)	0.1118	0.4877
Chemicals And Allied Products (28)	-0.2034	0.6434
Petroleum And Coal Products (29)	-0.1680	0.2168
Rubber And Misc. Plastics Products (30)	0.3736	0.7139
Leather And Leather Products (31)	0.0835	0.6077
Stone, Clay, And Glass Products (32)	0.3623	0.7620
Primary Metal Industries (33)	-0.0698	0.6688
Fabricated Metal Products (34)	0.1439	0.8308
Industrial Machinery And Equipment (35)	-0.2380	0.8387
Electronic & Other Electric Equipment (36)	-0.0967	0.7400
Transportation Equipment (37)	-0.1091	0.6479
Instruments And Related Products (38)	-0.2787	0.6733
Miscellaneous Manufacturing Industries (39)	0.4294	0.4516

Data Source: job creation rates from CES, US Bureau of Census; Industry growth is computed using NBER Manufacturing Productivity Database. Notes: The numbers in parentheses are 2-digit SIC codes; The job creation rates for tobacco products industry (21) are not disclosed.

Underlying the model is Gilbert and Newbury (1983) that study incentives for incumbent and entrant to acquire a new cost-reducing innovation. If a firm has a higher willingness to pay for acquiring the innovation than the other, it receives the license to the innovation. The product market is characterized by pure price competition: the firm with the lowest cost sets its price equal to the second lowest cost and monopolizes the market. Which firm, incumbent or entrant, acquires the license to the innovation depends on the size of innovation, the initial markup rate, and the size of the product market.

When the size of innovation is large and acquiring the license gives a large cost advantage to the licensee, the entrant tends to acquire the license. The reason for this result is that equilibrium price and quantity levels in the product market depend on which firm acquires the license. When the incumbent acquires the license, competition in the product market does not increase and the product price remains at an initial high level. Hence, the incumbent continues to produce a small quantity of goods. When the entrant acquires the license, competition in the product market becomes tougher. In the shadow of the incumbent's threats, the entrant reduces the price and produces more. As a consequence, a large scale innovation favors the entrant more than the incumbent since cost saving benefits are larger for a firm that produces more.

When the initial markup rate is high, the incumbent tends to acquire the license. A high initial markup implies that the incumbent has a large cost advantage over its shadow competitor and is earning a large profit. Hence, the incumbent is willing to pay more to maintain this profit.

When the size of the market is large, the incumbent tends to acquire the license. This is because the equilibrium price is higher when the incumbent acquires the license than when the entrant does. The larger, the market, the more the profitability of acquiring the license is. An increase in the profitability is however bigger for the incumbent than for the entrant since the incumbent can charge a higher markup than the entrant can, conditioned having acquired the license.

To summarize the arguments above, technological innovation, competitive product markets, and small market foster business entry and exit, and thereby job creation by entrants. Industry growth are unrelated to entry and exit.

Test of the Model The results of the model are tested using US job flows data from 1973 through 1993. Pooled multivariate regressions of nineteen manufacturing industries confirm that technological innovation and smallness of the product market both stimulate entry and exit. A scale of innovation, measured by TFP growth is positively related to job creation rates by new plants and job destruction rates by shutdown plants as predicted by the model. The size of the market, measured by industry shipment is negatively related to those two rates. Opposite to the prediction of the model, the markup rate is positively related to those two rates. One interpretation of this positive relation is herding and shakeout. When the markup rate is high, many firms may enter the market to pursue transitory profits. These firms may not yet know their potential efficiencies at the time of their entries and some of the firms will later on learn they are not viable in the market and exit. (Jovanovic 1982)

I also run regressions including industry growth and GDP growth as explanatory variables for sectoral job creation rates by new plants. Consistent to Audretsch and Acs (1994), the coefficient on GDP growth is significantly positive while the one on industry growth is not significant. Nonetheless, this paper does not attempt to explain where this positive relation arises from. One possible reason may be liquidity constraints that limit startup activities by entrepreneurs. In times of recession, net worth of collateral such as houses owned tend to decrease.[3] Thus, GDP growth may be negatively related to the degree of liquidity constraints. Formal tests of this hypothesis requires scrutiny of individual data on net worth and are beyond the scope of this paper.

Related Literature The positive relation between startups activities and technological innovation is largely documented. Micro evidence on job creation uniformly finds that reallocations of resources from shutdown plants to new plants are associated with productivity gains. (e.g. Foster, Haltiwanger, and Kirzen, 1998 at SIC 4-digit level, and Olley and Pakes, 1996 for telecommunication equipment industries). In case study level, Ghemawat (1991) details an episode of the PBX (private branching exchange) industry. The first generation of PBX transmits voice only and the three firms, AT&T, Rolm, and Northern Telecom had been dominating the voice-only PBX market. In late 1970s, InterCom -a startup, first adopted the voice-and-data PBX and curved the market share sharply.

At theoretical level, there is a long list of literature that attempts to explain why startups tend to acquire "drastic" innovations. Here, the word "drastic" means that innovation is large enough such that the adopter of the innovation will be free from the competitive pressure of the old technology. For instance, Reinganum (1983) studies the patent race in which incumbent and challenger simultaneously invest in R&D. She finds that if innovation is drastic, the challenger always invest more than the incumbent. Similarly, Gilbert and Newbury (1982) find that incumbent always has incentives to buy innovation more than challenger unless innovation is drastic. My model is different from these models in being able to analyze various factors that affect entry decisions of new firms. The original models of Reinganum, and Gilbert and Newbury are highly abstractive and focus on the drasticity of innovation as an only explanation of entry.

In relation to the empirical part of the current paper, many authors study data on job creation by new plants and destruction by shutdowns. (e.g. Dunne, Roberts, and Samuelson, 1989, Davis and Haltiwanger, 1990 for US, and Boeri and Cramer 1991 for Germany) These works study consequences of job creation and destruction rather than causes - that is the focus of this paper.

Organization of the Paper The rest of the paper is organized as follows: Section 2 describes the model and demonstrates the testable implications of the model. Section 3 tests the model. Section 4 concludes the paper.

[3]Kiyotaki and Moore (1997) studies a model of business cycle based on financial constraints of firms and shows that collateral values are procyclical. At empirical level, Black, de-Meza,and Jeffreys find that a 10 percent rise in the value of unreleased net housing equity increases the number of new VAT registrations by some 5 percent in UK.

2 The Model

In this section, I present a partial equilibrium model of technology adoption. Underlying the model is the work of Gilbert and Newbury (1982). They compare incentives to adopt a new technology between the incumbent monopolist and the potential entrant to the market and find that the entrant's incentive is always no more than the incumbent's incentive and explain why monopoly tends to persist.

I modify the original model of Gilbert and Newbury in a couple of ways. First, I assume that the incumbent incurs reorganization costs to adopt a large scale innovation while the entrant does not have to. As a result, the entrant's incentive is strictly greater than the incumbent's incentive for adoption of a large scale innovation unlike Gilbert and Newbury. Second, I assume that the product market is characterized by Bertrand competition and homogeneous demand. These specifications help make the prediction of the model sharper and simplify the test of the model later on.

It is important to emphasize that the assumption on the reorganization cost is not the only way to derive the results below. The reasons will become clear later on. Other possible specifications are discussed at the end of this section.

2.1 Market and Technology

There are two periods, $t = 0, 1$. Consider a market in which a single incumbent firm initially ($t = 0$) produces one type of homogeneous goods with a constant return to scale technology at unit cost of c. The incumbent owns the patent to this technology while other firms can potentially produce the same goods at unit cost that is higher than c. Let mc be the unit cost of the other firm, where $m > 1$. The good market is characterized by a pure Bertrand competition and the firm that posts the lowest price will monopolize the market. For simplicity, suppose that customers buy from the incumbent if there are more than one firms that quote the lowest price. The demand function of the good for each period is d_t/p_t, $t = 0, 1$, where d_t is the exogenous total expenditure on the goods and p_t is the unit price, at period t.[4]

Under the setup above, the incumbent optimally sets its price equal to mc at $t = 0$ since the total expenditure on the goods is fixed. Thus, m is equal to the initial mark-up rate. The incumbent's initial profit is therefore

$$d_0 - \frac{d_0}{mc}c = \left(1 - \frac{1}{m}\right) d_0.$$

[4]The fixed expenditure assumption supposes that the preference of consumers is of Cobb-Douglous form over different goods. In this case, expenditures on one type of good does not depend on the price of the good.

2.2 Innovation and Adoption of New Technology

At the beginning of the second period $(t = 1)$, a new cost-reduction technology exogenously arrives at hands of a third-party. From now on, I call the new technology "innovation" and the third-party "innovator". The innovator does not use the innovation by herself.[5] Instead, she auctions the innovation and licenses it to the firm who bids the highest fee. The participants to the auction consist of the incumbent and many potential entrants. The licensee can produce goods at a new low unit cost, $(1 - \alpha) c$, where $\alpha \in (\underline{\alpha}, 1)$ and $0 < \underline{\alpha} < 1$. Thus, a higher α corresponds to a larger scale innovation.

I assume that at the time of auction, both entrant and incumbent are symmetrically and perfectly informed of the exogenous variables including a future variable, d_1.

2.2.1 Adoption Cost

If the incumbent obtains the license and adopts the innovation, he incurs a fixed cost to reorganize its production process equal to $\theta(\alpha)$. I assume that $\theta(\cdot)$ is a non-decreasing function. On the other hand, an entrant does not incur such reorganization cost. Justifications for this asymmetry between incumbent and entrant is twofold. First, the incumbent may be slow in adopting the innovation due to bureaucracy. Change and reorganization typically requires approvals from various levels of existing units and this approval process takes time. This process delays the timing of adopting the new technology and reduces the present value of the profit. Adopting a large scale innovation is more profitable than a small scale innovation, then the loss from delaying the adoption is higher for a large scale innovation. On contrary, an entrant can start its business by a small size and presumably does not suffer from bureaucracy. Second, old workers in the incumbent firm may resist drastic change without job securities as their skills are specific to the old production process. Once the incumbent adopts the new production process, he may replace old workers with young who are more flexible in adjusting the new process. To prevent such replacement, old workers presumably require job securities and promises that the firm will retrain the existing workers. Such contracting processes take time and again the incumbent may have to delay the adoption of the new technology.

I assume that the reorganization cost $\theta(\alpha)$ is small relative to the profit from adopting the innovation. In this way, it is not necessary to separate the decisions of acquiring the license and of adopting the innovation.[6] Hence, the words "acquiring

[5] An example of such third-party is a university laboratory that licenses a new technology to private firms or effectively transfers the technology through research joint ventures.

[6] If the reorganization cost $\theta(\alpha)$ is large enough, the incumbent may "shelve" the innovation, similar to a result of Gilbert and Newbury. That is, the incumbent may not adopt the innovation even if it receives the license. In this case, an only reason to acquire the license is to deter the entrant from doing so and to avoid that the product market competition becomes tougher.

the license" and "adopting the innovation" mean the same hereafter.

2.2.2 Incentive to receive the license

How much a firm is willing to pay for receiving the license is equal to how much the firm gains by receiving the license. First, suppose that the incumbent receives the license, then the unit cost of other firms remains the original level, mc. Thus, like the initial market, the incumbent sets the price equal to mc so as to push out the other firms entirely from the market. As a consequence, the entrant's payoff is zero. Furthermore, the incumbent supplies d_1/mc units of goods in the product market equilibrium. Thus, his payoff is:

$$\pi^i(\alpha, d_1) = \left(1 - \frac{1-\alpha}{m}\right) d_1 - \theta(\alpha).$$

Second, suppose that the entrant receives the license and adopts the technology. In the product market equilibrium, she sets the unit price equal to c in order to dominate the market. The toughest rival in the market is now the incumbent and its original unit cost, c gives the threat to the entrant. Thus, she will lose the market if she sets the price higher than c. In equilibrium, the incumbent receives zero payoff. Furthermore, the equilibrium supply by the entrant is equal to d_1/c and thereby her payoff is:

$$\pi^e(\alpha, d_1) = \alpha d_1.$$

Note that the price is lower and the supply amount is bigger if the entrant rather than the incumbent adopts the innovation. This is due to a competition effect. In the current setup, the product market equilibrium is always monopoly in which either incumbent or entrant produces the entire amount of supply. Nonetheless, the monopolist is exposed to the potential competition from the firm that has the second best technology and the second lowest cost. The competition is tougher when the entrant adopts the innovation than when the incumbent does. Hence, the price and quantity distortion due to imperfect competition is less when the entrant adopts.

Note that the model has implications for both entry and exit as it assumes pure price competition in the product market. When the entrant adopts the innovation, it monopolizes the market and the incumbent exits. Thus, the model implies the perfect correlation between entry and exit.

2.3 Equilibrium Adopter

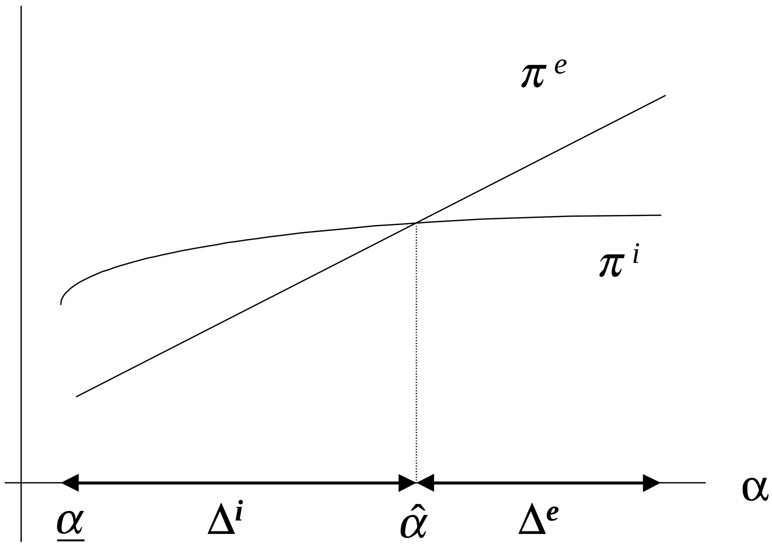
In equilibrium, the firm that is willing to pay more for the license acquires it and adopts the innovation. To be concrete, let

$$\begin{aligned}\triangle(\alpha, m, d_1) &= \pi^e(\alpha, d_1) - \pi^i(\alpha, m, d_1) \\ &= \theta(\alpha) - (1-\alpha)\left(1 - \frac{1}{m}\right) d_1.\end{aligned}$$

then, if $\triangle > 0$, the entrant adopts the innovation and if $\triangle \leq 0$, the incumbent adopts the innovation. To prepare for presenting the results of comparative statics, denote $\triangle^e$ as the set of $\{\alpha, m, d_1\}$ such that $\triangle > 0$ and $\triangle^i$ be such that $\triangle \leq 0$. The function, $\triangle$ is increasing in α, and decreasing in α and d_1 and therefore the following propositions immediately follow.

The first proposition concerns how degree of innovation affect who adopts it.

Proposition 1 *If $\{\alpha', m, d\} \in \triangle^e$ and $\alpha' < \alpha''$, then $\{\alpha'', m, d\} \in \triangle^e$. In other words, the other things equal, the incumbent adopts a small scale innovation while the entrant adopts a large scale innovation. (See Figure 1)*



In Figure 1, π_i is drawn assuming that θ is a convex function of α and that π^i is increasing. (The function π^i may decrease in α somewhere if θ is quickly increasing with α.) As the figure shows, the slope of π^e is always higher than the one of π^i. The reason for this is twofold. First, a larger innovation requires the incumbent alone to incur a higher reorganization cost θ. Hence, through this reorganization disincentive of the incumbent, a bigger α relatively favors the entrant. Second, a bigger α enables the entrant to save its production cost more than the incumbent. The equilibrium price of goods is lower and the equilibrium supply is bigger when the innovation is adopted by the entrant than when by the incumbent. Thus a large scale innovation, which implies a low unit cost, brings a bigger total cost saving opportunity to the entrant than to the incumbent as the entrant produces more than the incumbent does upon adoption. Therefore, through both reorganization and cost saving effects, a bigger α favors the entrant more than the incumbent.

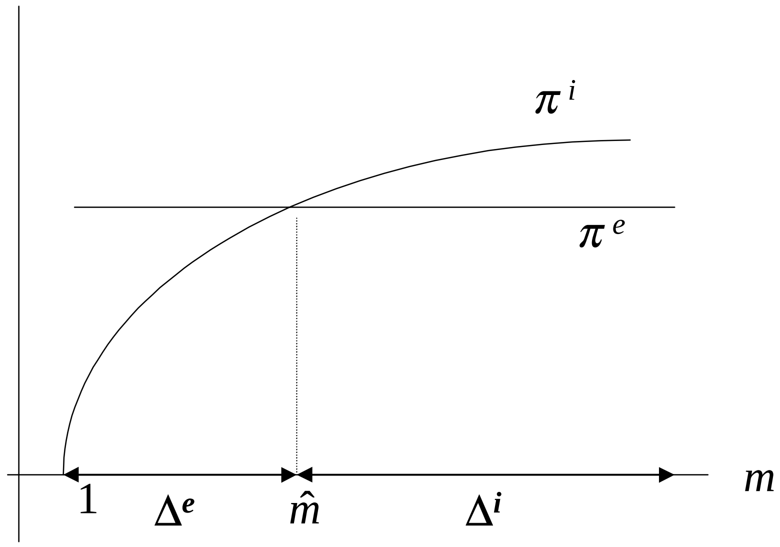
To compare the current model with Gilbert and Newbury, suppose $\theta(\alpha) = 0$, $\forall\alpha$. In this case, the payoff function of the incumbent is,

$$\pi^i = \left(1 - \frac{1-\alpha}{m}\right) d_1 > \alpha d_1 = \pi^e.$$

This inequality implies that the incumbent always has a higher willingness to pay for the innovation than the entrant does. This result is similar to the one of Gilbert and Newbury that the incumbent's incentive is always at least as much as the entrant's incentive. As a consequence, the initial incumbent monopolist keeps buying and adopting the innovation and the monopoly persists. Underlying this persistence of monopoly is the same for both the current model, and Gilbert and Newbury. Adoption of the innovation by the incumbent monopoly lessens the competitive pressure and increases the monopoly profit by enlarging the cost advantage of the incumbent. On the other hand, adoption by the entrant leads to a tougher competition in the product market and to a lower joint profit. Hence, adoption by the incumbent is more profitable than by the entrant. The incumbent is willing to pay for this monopoly premium and thereby the incumbent rather than the entrant always buys and adopts the innovation.

The second proposition concerns how the initial competitiveness of the product market affects who adopts the innovation.

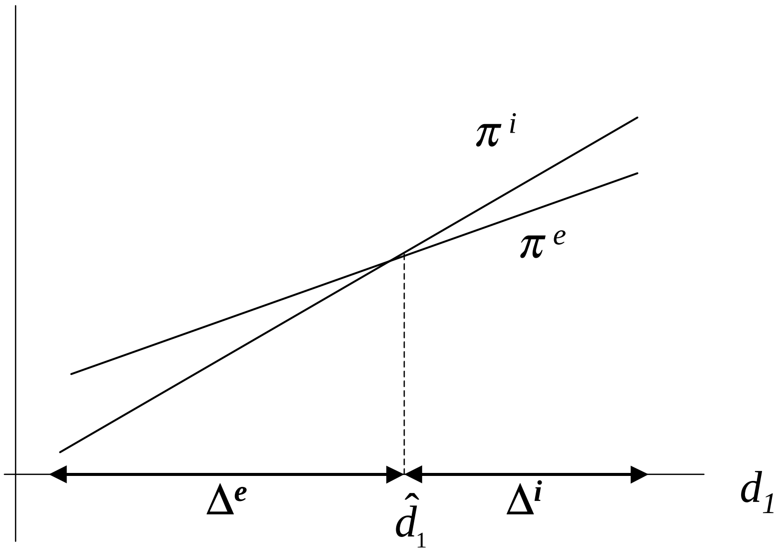
Proposition 2 *If* $\{\alpha, m', d_1\} \in \triangle^i$ *and* $m' < m''$, $\{\alpha, m'', d_1\} \in \triangle^i$. *In other words, the other things equal, the innovation is adopted by the incumbent if the initial markup is high and by the entrant if it is low. (See Figure 2)*



The intuition behind this proposition is as follows: when m is large, the incumbent initially has a large cost advantage over fringe firms and makes a high monopoly profit. By buying the innovation and keeping this cost advantage, the incumbent can continue to receive a high monopoly profit and thereby has more willingness to pay for the innovation.

The third proposition concerns the size effect of the product market on who adopts the innovation.

Proposition 3 *If* $\{\alpha, m, d_1'\} \in \triangle^i$ *and* $d_1' < d_1''$, $\{\alpha, m, d_1''\} \in \triangle^i$. *In other words, the other things equal, the incumbent adopts the innovation if the demand is high; the entrant adopts the innovation if the demand is low. (See Figure 3)*



The intuition behind this proposition is similar to the one for Proposition 2. When d_1 increases, the incumbent's payoff by adopting the innovation increases faster than the entrant's payoff. This is because the incumbent can set a higher price than the entrant does upon adoption: an increase in supply amounts accompanying the increase in d_1 is smaller for the incumbent and so is an increase in the total cost of production.

2.4 Assumptions Alternative to Reorganization Costs

As described in the discussion of Proposition 1, the incumbent always has a bigger incentive to adopt the innovation than the entrant. This is the reason why I introduced the reorganization cost to reduce the incumbent's incentive and to have a case in which the entrant may adopt the innovation. Other ways to derive such a case are to consider the factors that increase the entrant's incentive from one in the frictionless case ($\theta(\alpha) = 0$). I now present two examples of such factors.

2.4.1 Private Benefit or Animal Spirits of Entrepreneurs

Suppose that the entrant is a new firm started up by an entrepreneur. By owning and running firm, the entrepreneur may receive a psychological benefit such as a sense of independence or of realizing his/her animal spirits. Let B be the positive utility gain that the entrepreneur obtains by starting his/her own business, in addition to the monetary gain. In that case, the entrant's incentive is expressed by $\pi^e = \alpha d_1 + B$. As a consequence, even if there is no reorganization cost, π^e can be greater than π^i.

2.4.2 Synergy by Entry

Suppose that the entrant is a firm already having operated in one or more lines of business and diversifying towards other markets may help the firm to realize its potential scope economy or synergy. Such economy can be associated with brand name and/or retailing channels that the firm is already endowed. Hence, diversifying through adopting the innovation creates an extra benefit to the firm and then π^e consists not only the pure profit, αd_1 but also of the gain from realizing synergy.

2.5 Job Creation and Destruction

To summarize the results of the model above, the scale innovation, and the competitiveness and the smallness of the product market are positively associated with *entry*. The second part of this paper tests these implications of the model using data on *job creation rate of new plants*. To do so, I assume that the number of job that each new plant create is constant and independent of the variables that affect decisions of plant startup. One justification for this assumption is adjustment costs for new plants to start operation and to grow. At startup stage, a plant primarily needs administrative personnel to handle legal registrations and recruiting. This kind of personnel has nature of fixed costs and the number of required personnel is presumably constant over plants. Furthermore, at startup stage, it requires substantial time to recruit workers and it may be difficult to achieve the desirable number of factory workers in a short interval. Thus, the number of workers that a new plant can hire may have an exogenous upper limit.

Nonetheless, entry and job creation are different concepts: more entries do not necessarily mean more job creation in the long run that is long enough to achieve the desired number of production workers. The purpose of this subsection is to clarify this distinction and to derive the long-run implication on job creation of new plants. For this sake, I assume that the ratio of labor input in the total cost is independent of technology and thereby the job creation rate is equal to the growth rate of the total cost. Initially, the incumbent supplies d_0/mc units of goods spending the cost equal to d_0/m. When the entrant adopts the innovation, the equilibrium supply is d_1/c and the total cost is $d_1(1-\alpha)$. Hence, the gross job creation rate is equal to:

$$\frac{d_1(1-\alpha)}{d_0/m} = mg(1-\alpha),$$

where g is rate of industry growth, d_1/d_0. This expression is increasing in m and g, and decreasing in α. Intuitions are straightforward. First, a high m means that the incumbent is initially setting a high price and producing little because the incumbent has a big cost advantage over the fringe firms. The situation becomes substantially different and the competition becomes tougher relative to the initial market when the entrant adopts the innovation. Due to this large increase in competition, the supply amount substantially increases and so does employment. Second, a high g implies that more units of goods are supplied in the market and more labor input is required. Third, a high α means that a firm can produce goods with less inputs. Hence, job creation rate is negatively associated with α.

Combining these results on job creation by new plants with ones on entry, the model implies that:

1. The degree of innovation is positively associated with entry while negatively associated with job creation by new plants conditioned on that entry has taken place.

2. The initial market competitiveness is negatively associated with entry while positively associated with job creation by new plants conditioned on that entry has taken place.

3. The industry growth is unrelated to entry while positively associated with job creation by new plants conditioned on that entry has taken place.

3 The Test of the Model

In this section, I test the results of the model by a standard multivariate regressions. Dependent variables are job creation rate of new plants and job destruction rate of shutdown plants. In the model, job creation rate of new plants corresponds to entry and job destruction rate of shutdown, exit. Explanatory variables are TFP growth, lead markup rate, output, and shipment growth at industry level and GDP growth. I call shipment growth at industry level industry growth in order to distinguish from GDP growth. In the model, TFP growth, lead markup rate, and output correspond to α, m, and d_1. The model implies that neither industry growth nor GDP growth explains entry and exit. Nonetheless, by presenting the regressions including those variables, I want to confirm the motivational facts presented in Introduction of this paper. That is, GDP growth is positively related to entry on the one hand, industry growth is not, on the other.

3.1 Data Description

The data on job creation and destruction come from US job-flow data, the Center for Economic Studies, US Bureau of Census. This dataset focus on manufacturing industries and identify job creation rates of new and continuing plants, and job destruction rates of shutdown and continuing plants. The part of the data that I use is job creation rate of new plants and job destruction rate of shutdown plants at SIC 2-digit level. The data sample is of annual frequency and covers from 1973 through 1993. The rest of the data used for this section comes from NBER manufacturing productivity database. This database identifies many productivity related variables including various expenditures, shipment, and TFP growth at four digit SIC level.[7] To align the NBER data with the job flow data that is as coarse as at SIC 2-digit level, I aggregate the four-digit level variables, TFP growth, lead markup, and industry growth to the two-digit level taking average weighted by shipment. Appendix details the construction of the variables.

Legend	
JCN:	Two-year average of job creation rates by new plants (%).
JDS:	Two-year average of job destruction rates by shutdown plants (%).
XTFP:	Two-year average of TFP growth (%).
MP:	Lead markup rate (%).
SHIP:	Two-year average of shipment, 1992 billions of dollars.
XSHIP:	Two-year average of industry growth (%).
XGDP	Two-year average of GDP growth (%)

Table 2 presents the descriptive statistics of the variables in the regressions and Table 3 presents the correlations between the variables.

Table 2
Descriptive Statistics

	JCN	JDS	XTFP	MP	SHIP	XSHIP	XGDP
Mean	1.4283	2.7049	0.3861	33.2946	1.5170	1.8881	2.5910
Median	1.2367	2.4462	0.4536	32.7770	1.1979	1.4881	2.5447
Max.	7.1392	13.110	7.7133	74.0492	4.2595	35.2599	5.4862
Min.	0.2598	0.5847	-8.5425	3.5981	0.0953	-19.6340	-0.5428
S.D.	0.8172	1.4745	2.2019	12.9050	1.0867	6.2443	1.7966

Number of Observations: 380; Number of Cross Sections: 19

As the theory predicts, the correlation between job creation rate of new plants and job destruction rate of shutdown plants are substantially and positively correlated and suggests that entry and exit are both driven by the same factors.

[7] For more detail about this data, see Bartelsman and Gray (1996).

Table 3
Correlation Matrix

	JCN	JDS	XTFP	MP	SHIP	XSHIP	XGDP
JCN	1						
JDS	0.4410	1					
XTFP	0.1149	0.0768	1				
MP	0.2104	0.0707	-0.0305	1			
SHIP	-0.2753	-0.2732	0.0539	-0.0568	1		
XSHIP	0.0358	-0.1767	0.1524	0.0834	0.0952	1	
XGDP	0.2004	0.0339	0.3949	-0.0173	0.0096	0.3843	1

Number of Observations: 380; Number of Cross Sections: 19

3.2 Regression Results

Table 4 presents the results of multivariate regressions on job creation rate of new plants and Table 5 presents the results on job destruction rate of shutdown plants. For both dependent variables, six different regressions are conducted. The first three regressions assume that all coefficients are common to all industries (common effects). The latter three regressions allow that the intercept may differ across industries (fixed effects). For each intercept specification, there are three distinct regressions. The first regression tests the model as it is and the explanatory variables are TFP growth, lead markup rate, and shipment. The model predicts that the coefficients on TFP growth are positive, the ones on lead markup rate and shipment are negative. The second regression includes industry growth as an explanatory variable in addition to see if entry is procyclical at industry level as the competitive equilibrium model with decreasing returns to scale suggests. The model in this paper predicts that the coefficient on industry growth is zero. The third regression furthermore adds GDP growth as an explanatory variable. Although the model presented in the current paper does not have any implication on macroeconomic effects on exit and entry, GDP growth may be related to an increase in net worth of collateral and relaxation of liquidity constraints. Thus, the coefficient on GDP growth is expected to be positive.

Table 4
Job Creation Rate of New Plants

Explanatory Variables	Intercept					
	Common Effects			Fixed Effects		
TFP Growth	0.0477***	0.0487***	0.0178	0.0439***	0.0466***	0.0100
(XTFP)	(0.0179)	(0.0181)	(0.0192)	(0.0156)	(0.0159)	(0.0168)
Lead Markup	0.0127***	0.0125***	0.0131***	0.0249***	0.0245***	0.0266***
(MP)	(0.0031)	(0.0031)	(0.0031)	(0.0077)	(0.0077)	(0.0075)
Shipment	-0.2045***	-0.2063***	-0.1987***	-0.1721	-0.1687	-0.2149
(SHIP)	(0.0362)	(0.0365)	(0.0358)	(0.1500)	(0.1497)	(0.1461)
Industry Growth		0.0034	-0.0070		0.0054	-0.0060
(XSHIP)		(0.0064)	(0.0068)		(0.0055)	(0.0059)
GDP Growth			0.0983***			0.1011***
(XGDP)			(0.0255)			(0.0215)
Adjusted R^2	0.1244	0.1223	0.1540	0.3843	0.3844	0.4184
Number of Observation: 380						

- ***: significant at 1% level; **: significant at 5% level; *: significant at 10% level.
- Standard errors are in parenthesis.

Table 5
Job Destruction Rate of Shutdown Plants

Explanatory Variables	Intercept					
	Common Effect			Fixed Effect		
TFP Growth	0.0611*	0.0786**	0.0586	0.0739***	0.0854***	0.0740***
(XTFP)	(0.0330)	(0.0329)	(0.0356)	(0.0253)	(0.0253)	(0.0277)
Lead Markup	0.0076	0.0097*	0.0101*	0.0539***	0.0575***	0.0584***
(MP)	(0.0057)	(0.0057)	(0.0057)	(0.0124)	(0.0124)	(0.0124)
Shipment	-0.3727***	-0.3503***	-0.3451***	-0.5332**	-0.5406**	-0.5564**
(SHIP)	(0.0670)	(0.0663)	(0.0663)	(0.2429)	(0.2403)	(0.2408)
Industry Growth		-0.0420***	-0.0491***		-0.0263***	-0.0030***
(XSHIP)		(0.0117)	(0.0126)		(0.0089)	(0.0097)
GDP Growth			0.0689			0.0361
(XTFP)			(0.0472)			(0.0354)
Adjusted R^2	0.0800	0.1083	0.1110	0.5042	0.5147	0.5147
Number of Observation: 380						

- ***: significant at 1% level; **: significant at 5% level; *: significant at 10% level.
- Standard errors are in parenthesis.

As expected, the coefficients on TFP growth are positive for all regressions. The regressions without GDP growth as an explanatory variable suggest that one percent increase in TFP leads to .04-.05 percent increase in job creation rate of new plants and .06-.08 percent increase in job destruction rate of shutdown plants. When including

GDP growth as an explanatory variable, those effects become weak and not significant for job creation rate of new plants however. This may be due to a high correlation between TFP growth and GDP growth. As Table 3 shows, the correlation between these two variables is about 40 percent and suggests a problem of colinearity.

Contrary to the model, the coefficients on lead markup rate is positive for all regressions: data shows that competitiveness of the product market discourages entry and exit. One interpretation for this result is herding and shakeout. A high markup may manifest that the market is at its preliminary stage and only few firms are operating. At this stage, the competition is not yet tough and markup is still high. Thus, many firms enter the market to seek temporary profit attempting to exploit short-run disequilibrium. Furthermore, literature on entry with uncertain productivity such as Jovanovic (1982) suggests that many of those startup firms tend to exit soon because they enter the market without knowing their potential productivity until entry and after the entry some of them discover that they are not viable.

The results on shipment confirm the model. The coefficients on shipment are all negative, that is, the size of the market is negatively associated with entry and exit. Nonetheless, the coefficients with fixed effects are not significant for the regressions on job creation rate of new plants and this suggests that the industry variation of the market size negatively affects entry on the one hand, the time variation not, on the other hand. One interpretation of this result is the time variation of shipment may measure product variety and thereby the number of market. As time goes by, the product variety in industry and the number of market may increase while the size of each market may not. In this case, the time variation of shipment does not correctly measure the time variation of the size of individual market and therefore the coefficients on shipment may be not significant in the regressions with fixed effects.

In the regressions on job creation rate of new plants, the coefficients on industry growth are not significant and sometimes negative. This confirms the current model and contradicts the competitive equilibrium model with decreasing returns to scale. Those coefficients in the regressions on job destruction rate of shutdown plants are negative and all significant. This result contradicts the model in this paper. One interpretation for this result is the possibility that plants may be shut down due to shrinking business opportunity that is not taken account in the model. Maintaining one plant requires a substantial fixed cost such as administration, and tenant fees or mortgage payments for factory buildings. Thus, if demand for products shrink, some plants are no longer profitable enough to cover those fixed costs and thereby shutdown.

The coefficients on GDP growth are positive and significant in the regression on job creation rate of new plants. This makes a sharp contrast to the results on industry growth in the same regressions. As described in Introduction, Audretsch and Acs (1994) find a similar result using the data on firm startup. Although the current regression uses job-flows data, it confirms the result of Audretsch and Acs in identifying an aggregate rather than a sectoral growth explains a sectoral startup activity.

4 Concluding Remarks

This paper studies business entry and exit in presence of imperfect price competition and of constant returns to scale. The model implies that entry and exit are associated with technological innovation, and competition and smallness of the product markets while unrelated to industry growth. The model is tested by the data on job creation by new plants and destruction by shutdown plants. The results of the test support that technological innovation and smallness of the product market foster business entry and exit, and that industry growth is unrelated to entry. Furthermore, I find that growth in aggregate level rather than sectoral level accounts for overall entry. Nonetheless, evidence is against one of the hypotheses that the product market competition foster entry and exit. Rather, when the market is competitive, there is less business turnover.

There are essentially two limitations of the model presented here. One is its partial equilibrium nature due to that the model fails to derive an implication on effects of aggregate variables on entry. The data supports the positive effect of GDP growth on entry, however. To overcome this limitation, one needs to study a general equilibrium model that features entry and exit. The other limitation is the assumption of pure price competition. The consequences of this assumption are the perfect correlation of entry and exit, and pure monopoly. These implications clearly contradicts the reality and suggests that it is necessary to study a more general form of competition to improve the test of the model.

5 Appendix: Construction of Variables

In this appendix, I describe how I constructed the variables in the regressions in detail. To make the transition from the source data clear, the legends adopted in the source data are used here.

The two-year average of job creation rate of new plants (JCN) and of job destruction rate of shutdown plants (JDS) are:

$$\mathrm{JCN}_t^i = \frac{\mathrm{POSB}_t^i + \mathrm{POSB}_{t+1}^i}{2}$$

and

$$\mathrm{JDS}_t^i = \frac{\mathrm{NEGD}_t^i + \mathrm{NEGD}_{t+1}^i}{2},$$

where the superscript indicates industry at 2-digit SIC level, the subscript indicates year, POSB is annual job creation rate of plants ages of that is less than one year, and NEGD is annual job destruction rate of plants that shut down during the year.

The two-year average of TFP growth (XTFP) is:

$$\text{XTFP}_t^i = \frac{1}{2}\left(\frac{\sum_j \left(\text{XTFP1}_t^{j,i} \times \text{VSHIP}_t^{j,i}\right)}{\sum_j \text{VSHIP}_t^{j,i}} + \frac{\sum_j \left(\text{XTFP1}_{t+1}^{j,i} \times \text{VSHIP}_{t+1}^{j,i}\right)}{\sum_j \text{VSHIP}_{t+1}^{j,i}}\right) \times 100$$

where XTFP1 is total factor productivity growth based on 4 factors, production workers, non-production workers, capital, and energy+materials, VSHIP is dollar value of shipments, the superscript j, i stands for industry j at SIC 4-digit level that belongs to industry i at SIC 2-digit level.

The lead markup rate (MP) is:

$$\text{MP}_{t-1}^i = \frac{100}{\sum_j \text{VSHIP}_{t-1}^{j,i}} \sum_j \left(\left(\frac{\text{VSHIP}_{t-1}^{j,i}}{\text{PAY}_{t-1}^{j,i} + \text{MATCOST}_{t-1}^{j,i} + \text{INVEST}_{t-1}^{j,i}} - 1\right) \text{VSHIP}_{t-1}^{j,i}\right),$$

where PAY is total compensation of employment, MATCOST is cost of materials input, and INVEST is new capital spending.

The two-year average shipment (SHIP) is

$$D_t = \frac{1}{2}\left(\frac{\sum_j \text{VSHIP}_t^{j,i}}{\text{CPI}_t^i} + \frac{\sum_j \text{VSHIP}_{t+1}^{j,i}}{\text{CPI}_{t+1}}\right),$$

where CPI is implicit price deflator normalizing the price level in 1992 to one.

The two-year average industry growth (XSHIP) is:

$$\begin{aligned} &\text{XSHIP}_t^i \\ = \; &\frac{1}{2}\left(\frac{\text{CPI}_{t-1}^i}{\text{CPI}_t^i \sum_j \text{VSHIP}_t^{j,i}} \sum_j \frac{\left(\text{VSHIP}_t^{j,i}\right)^2}{\text{VSHIP}_{t-1}^{j,i}} + \frac{\text{CPI}_t^i}{\text{CPI}_{t+1}^i \sum_j \text{VSHIP}_{t+1}^{j,i}} \sum_j \frac{\left(\text{VSHIP}_{t+1}^{j,i}\right)^2}{\text{VSHIP}_t^{j,i}}\right) \times 100. \end{aligned}$$

References

[1] Audretsch, D.B. and A.J. Acs, 1994, "New-Firm Startups, Technology, and Macroeconomic Fluctuations," *Small Business Economics* 6, 439-449.

[2] Bartelsman, E.J., and W. Gray, 1996, "The NBER Manufacturing Productivity Database," NBER Technical Working Paper 205.

[3] Black, Jane, David de-Meza, and David Jeffreys, 1996, "House Price, the Supply of Collateral and the Enterprise Economy," *Economic-Journal* 106(434), 1996, 60-75.

[4] Boeri,Tito, and Ulrich Cramer. 1992. "Employment Growth, Incumbents and Entrants: Evidence from Germany." International Journal of Industrial Organization 10, no. 4: 545-65.

[5] Caballero, Ricardo J. and Mohamad L. Hammour. 1994. "The Cleansing Effect of Recessions," *American Economic Review,* 84(5), 1350-1368.

[6] Caballero, Ricardo J. and Mohamad L. Hammour. 1996. "On the Timing and Efficiency of Creative Destruction," *Quarterly Journal of Economics,* 111(3), 805-852.

[7] Campbell, Jeffrey R. 1998. "Entry, Exit, Embodied Technology, and Business Cycles," *Review of Economic Dynamics* 1, 371-408.

[8] Campbell, Jeffrey R. and Jonas D.M. Fisher. 1998. "Organizational Flexibility and Employment Dynamics at Young and Old Plants," University of Chicago.

[9] Davis, S.J. and J.C. Haltiwanger, 1990, "Gross job creation and destruction: Microeconomic Evidence and macroeconomic implications," *NBER Macroeconomics Annual,* 5, 123-168.

[10] Davis, S.J., J.C. Haltiwanger, and S. Schuh 1996, *Job Creation and Destruction,* MIT Press, Cambridge.

[11] Dunne, T., M.J. Roberts, and L. Samuelson, 1989, "Plant turnover and gross employment flows in the U.S. manufacturing sector," *Journal of Labor Economics* 7, 48-71.

[12] Foster, Lucia, John Haltiwanger, and C.J. Kirzen, 1998, "Aggregate Productivity Growth: Lesson from Microeconomic Evidence," NBER Working Paper: 6803.

[13] Ghemawat, P. 1991, "Market Incumbency and Technological Inertia," *Marketing Science* 10(2), 161-171.

[14] Gilbert, R.J. and D.M.G Newbury, "Preemptive Patenting and the Persistence of Monopoly," *American Economic Review*, June 1982, 72, 514-26.

[15] Horvath, Michael, 1999, "Business Cycles and the Failure of Marginal Firms," Stanford University.

[16] Jovanovic, Boyan, 1982, "Selection and the Evolution of Industry," *Econometrica,* 50(3), 649-70.

[17] Katz, Lawrence F., and Lawrence G. Summers, 1989,m "Industry Rents: Evidence and Implications." Brookings Papers on Economic Activity spec. iss., 209-75. Washington, D.C.: Brookings Institution.

[18] Kiyotaki, Nobuhiro, and John Moore, 1997, "Credit Cycles," *Journal of Political Economy* 105(2), 211-48.

[19] Olley, Steven G. and Ariel Pakes, "The Dynamics of Productivity in Telecommunications Equipment Industries," *Econometrica* 64, 1263–97.

[20] Reinganum, J. 1983, "Uncertain Innovation and the Persistence of Monopoly," *Bell Journal of Economics* 12, 618-624.