

# Market Size and Firm Turnover (Part 1: Theory)

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## Abstract

This paper is motivated by the empirical regularity that industries differ greatly in the level of firm turnover, and that entry and exit rates are positively correlated across industries. Our objective is to investigate the effect of market size on entry and exit rates.

In this paper, we analyse a stochastic dynamic model of a monopolistically competitive industry. Each firm's marginal cost (or, alternatively, perceived quality) is assumed to follow a Markov process. We show existence and uniqueness of a stationary equilibrium with simultaneous entry and exit: efficient firms survive while inefficient ones leave the market and are replaced by new entrants. We perform comparative statics with respect to the level of sunk costs: entry costs are positively and fixed production costs negatively related to entry and exit rates. The main prediction of the model is that the level of firm turnover is increasing in market size. The intuition is as follows. In larger markets, price-cost margins are smaller since the number of active firms is larger. This implies that the marginal surviving firm has to be more efficient than in smaller markets. Hence, in larger markets, the expected life span of firms is shorter.

In our companion paper, the predictions are tested on industries where firms compete in well-defined geographical markets of different sizes. Our measures of market turbulence are based on the identities of all hairdressers and driving schools in Sweden that were active in 1990 and/or 2000. Most importantly, we find support for the prediction that firm turnover is increasing in market size. In addition, the hazard rates for individual firms and the turnover of firms are affected by changes in market size. There is also evidence that exit (entry) is more common in markets where the actual number of firms is too high (low) given the market characteristics.

# 1 Introduction

In the last two decades, much empirical research in industrial economics has been conducted on firm entry and exit.<sup>1</sup> A related line of research in labour economics has been concerned with gross job creation and destruction.<sup>2</sup> A finding of virtually all studies is that the gross entry rates of an industry (e.g. measured as the number of new entrants) is a multiple of the net entry rate (e.g. measured as the net increase in the number of active firms). Similarly, the rate of gross job reallocation is much higher than the rate of net employment growth. This holds even when defining industries very narrowly. That is, there is much simultaneous entry and exit going on at the industry level. Entry and exit rates differ substantially across industries; even within a two-digit sector, there is considerable variation in firm turnover (“turbulence”) across more narrowly defined industries. Moreover, there is a strong positive correlation between entry and exit levels across industries. The correlation persists when rates are measured at intervals that are much shorter than a business cycle. For instance, Dunne, Roberts and Samuelson (1988) find a correlation of 0.92 between the average market share of entering firms and the average market share of exiting firms across two-digit U.S. manufacturing industries. Hence, industries with high entry rates are likely to exhibit high exit rates. Another empirical regularity is that rates of entry and exit are highly correlated over time. Finally, the ranking of industries by turnover rates appears to be similar from one country to another. In their study of gross job flows in the U.S. and Canadian manufacturing sectors, Baldwin, Dunne and Haltiwanger (1998) report a correlation coefficient of 0.834 between U.S. and Canadian job reallocation rates.

In short, empirical evidence suggests that there are “high turnover industries” and “low turnover industries”. To explain these cross-industry differences in firm turnover is one of the important research agendas in the field of industrial market structure. For example, Dunne, Roberts, and Samuelson (1988) conclude their study as follows.

The high correlation between entry and exit across industries indicates that industries differ substantially in their degree of firm turnover. One area for further study is then to identify the characteristics of industry technology and demand that give rise to across industry differences in turnover.

It is probably fair to say that little progress has been made so far. There appears to be a lack of theories which make empirically testable predictions regarding the determinants of firm turnover. An important exception is the paper by Hopenhayn (1992). Hopenhayn’s main empirical prediction is that industries with higher (sunk) entry costs should *ceteris paribus* exhibit lower rates of firm turnover. As pointed out by Sutton

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<sup>1</sup>Caves (1998) provides a recent survey of the empirical literature on turnover and mobility of firms. See also Sutton (1997) and Cabral (1997).

<sup>2</sup>See Davis and Haltiwanger (1999) for a survey of the literature on job flows.

(1997), a problem with testing this and other cross-industry predictions is the following. “Economically interesting” determinants of turbulence may be of second order relative to other factors, such as underlying fluctuations in demand, which are extremely difficult to control for empirically.

This paper is devoted to the theoretical investigation of the effect of market size on entry and exit rates. The main prediction of the paper is that the level of firm turnover is increasing in market size. In our companion paper, Asplund and Nocke (2000), we test the predictions of the model empirically, largely circumventing the above-mentioned problem of cross-industry studies of turbulence. Specifically, we study turnover rates across independent geographical markets within the same industry. The main difference between the local markets is their size. By construction, this test should, to a large extent, control for underlying changes in demand (or technology).

In this paper, we analyse a stochastic dynamic model of a monopolistically competitive industry. Upon entry, a new firm gets a random draw of its marginal cost (or, alternatively, perceived quality). An incumbent’s cost level follows a Markov process exhibiting persistency: expected future efficiency is increasing in the firm’s current efficiency level. We show existence and uniqueness of a stationary equilibrium with simultaneous entry and exit. In equilibrium, firms follow a threshold exit policy: efficient firms survive while inefficient ones leave the market and are replaced by new entrants. We perform comparative statics with respect to the level of sunk costs: entry costs are positively and fixed production costs negatively related to entry and exit rates. The central prediction of the model is that the level of firm turnover is increasing in market size. The reason is that, in larger markets, price-cost margins are smaller since the distribution of active firms is larger. This can be shown to imply that the marginal surviving firm has to be more efficient than in smaller markets. Hence, in larger markets, the expected life span of firms is shorter, and the rate of firm turnover larger. Another implication of the stronger “selection effect” in larger markets is that firms are on average more efficient and the distributions of profits and firm values more skewed than in smaller markets. In addition, we show that an increase in the persistency of incumbents’ costs causes the turnover rate to decline, even though the marginal surviving firm has to be more efficient. In an extension of the model, we investigate the time-series pattern of entry and exit rates when market size changes over time. Perhaps surprisingly, we show that both entry and exit rates will tend to increase over time in growing markets, and decrease in declining markets.

Our model is closely related to Hopenhayn (1992). In Hopenhayn’s model of a perfectly competitive industry, however, market size has no effect on the equilibrium exit policy, and hence none on the rate of turnover. In fact, the equilibrium price is independent of market size. This is in contrast to the predictions of standard oligopoly models. For instance, consider the following two-stage game. First, ex-ante identical firms decide whether or not to enter the market. If they decide to do so, they have to pay a sunk

entry fee. Then, at the output stage, the newly entered firms compete in prices or quantities. (At the output stage, firms may be identical or heterogenous.) For a wide class of oligopoly models describing competition at the output stage, the number of entrants increases with market size, which causes price(s) and price-cost margins to fall. This implies the following empirical prediction: the number of active firms should rise less than proportionally with market size. This prediction has been tested empirically by Bresnahan and Reiss (1991) in their seminal paper, and more recently by Campbell and Hopenhayn (1999). The available empirical evidence strongly supports the prediction.

The relationship between market size and the number of active firms in oligopolistic markets motivates our departure from Hopenhayn's (1992) assumption of perfect competition. Indeed, we believe that competition in most markets may be roughly described as being "oligopolistic". In our model, we make quite general assumptions on the reduced-form profit function, which are consistent with a large class of oligopoly models, including the Cournot model. However, we do depart from the assumption of oligopolistic competition in that we assume that there is a continuum of firms, i.e. each firm is atomistic, but faces a downward-sloping demand curve; this is the assumption of monopolistic competition. The reasons for this assumption are purely technical.

1. If firms are atomistic, we do not have to worry about integer constraints. In a free entry equilibrium, the value of a new entrant is exactly equal to its outside option.
2. With a continuum of firms, idiosyncratic uncertainty washes out at the aggregate level; hence, if uncertainty enters at the individual level only, all aggregate variables are deterministic.
3. The assumption of monopolistic competition greatly reduces the set of equilibria. With a finite number of firms and oligopolistic competition there would be two sources of multiplicity of equilibria. First, the identity or type of an exiting firm are not uniquely determined. There are often equilibria in which an efficient firm exits even though (or, rather, precisely because) a less efficient firm decides to stay in the market. Second, if players are sufficiently patient, the Folk theorem applies and more or less "collusive" equilibria are sustainable.

Clearly, it would be desirable to study the case of oligopolistic competition as well. But, at the very least, our dynamic stochastic model of monopolistic competition should provide us with a useful benchmark.

There are a few other papers that build on Hopenhayn's (1992) model. Hopenhayn and Rogerson (1993) apply a general equilibrium version of the model to study the effect of changes in firing costs on total employment and welfare. Das and Das (1997) and Melitz (1999) both introduce monopolistic competition *à la* Dixit-Stiglitz into the model. Das and Das analyse the effect of entry adjustment costs on the convergence path to

the stationary state. They show that short-run dynamics may be non-monotonic under certain conditions. In work independent from ours, Melitz considers the impact of trade in a general equilibrium version of Hopenhayn's model. In his model, the efficiency of incumbents does not vary over time, and the death rate of incumbents is exogenously given. Entrants may decide to exit immediately after entry (and before production takes place). He shows that there is a non-monotonic relationship between the average efficiency of firms and the level of "export costs". There are no size effects. Indeed, it should be pointed out that the Dixit-Stiglitz model with a continuum of firms has properties that are quite different from those of standard oligopoly models. In particular, in a Dixit-Stiglitz model, firms use a simple markup pricing rule, where the markup is independent of the mass of competitors (and thus violates the main condition of our central prediction on market size). Consequently, price-cost margins are independent of market size and the mass of active firms rises proportionally with market size. Market size has no impact on firms' exit policies, and therefore none on the turnover rate. We believe this to be an unwarranted feature of the Dixit-Stiglitz model. As an *example* of our model of monopolistic competition with properties similar to oligopolistic models, we propose instead the linear demand model with a continuum of products. This example is potentially of great interest for trade and growth theorists as an alternative to the widely used Dixit-Stiglitz model.

The starting point of the recent literature on stochastic dynamic industry equilibria with heterogeneous firms is the seminal paper by Jovanovic (1982). Jovanovic considers a perfectly competitive industry where firms have different but time-invariant efficiency levels. Firms only gradually learn their types over time by observing their "noisy" cost realisations. Firms that learn that they are efficient grow and survive, while firms that obtain consistently negative information decline and eventually leave the market. The model produces an impressive array of empirical predictions on the relationship between firm growth and survival on the one hand and firm age and size on the other. However, all firms eventually learn their efficiency level; hence, there is no firm turnover in the long run. Lambson (1991) considers another model with atomistic price takers. In his paper, there are no idiosyncratic shocks but instead common shocks to input price (and demand), i.e. there is aggregate uncertainty. In equilibrium, firms may choose different technologies and, hence, be affected differently by the common shocks. The model predicts that variability of firm values is negatively related to the level of sunk costs. Some empirical evidence for this prediction is given in Lambson and Jensen (1998). Ericson and Pakes (1995) analyse a stochastic dynamic oligopoly model. There are two sources of uncertainty in the model: the outcomes of firms' investments in "quality" are stochastic and firms are subject to (negative) aggregate shocks. The equilibrium distribution of qualities at any time is itself stochastic (and ergodic): the industry is in a constant flux. Few analytic restrictions can be placed on equilibrium outcomes. Instead, the authors have developed a simulation package; see Pakes and McGuire (1994).

The plan of the paper is as follows. In section 2, we present the basic model. This is followed, in section 3, by the equilibrium analysis, including our existence and uniqueness results. In section 4, we investigate the comparative statics properties of the stationary equilibrium, which lie at the heart of the paper. This section contains the central prediction on the relationship between market size and firm turnover. We extend the model in section 5 by analysing the case of growing and declining markets. We provide results on the comovements of entry and exit rates and market size. Finally, we conclude in section 6. In our companion paper, Asplund and Nocke (2000), we test the predictions on industries where firms compete in well-defined geographical markets of different sizes. Specifically, our measures of turbulence are based on the identities of all hairdressers and driving schools in Sweden that were active in 1990, 1995, and/or 2000.

## 2 The Model

We consider a stochastic dynamic model of a monopolistically competitive industry. There are a continuum of consumers and a continuum of (potential) firms. The aggregate demand system is assumed to be symmetric regarding the different variants of the good produced in the industry. Moreover, each active firm produces a unique variant, and competition is non-localised. Although firms are atomistic, a firm does not take price as given since it faces a downward-sloping demand curve. Firms' marginal production costs are assumed to be constant. Firms differ in their "efficiency levels", which are subject to idiosyncratic shocks. Under our leading interpretation, the shocks directly affect firms' marginal costs. In this case, the marginal cost of a new entrant is drawn from the continuous distribution function  $G(\cdot)$  with support  $[0, 1]$ . An incumbent's marginal cost in period  $t$ ,  $c_t$ , is given by

$$\begin{aligned} c_t &= c_{t-1} \text{ with probability } \alpha, \\ c_t &\sim G(\cdot) \text{ otherwise,} \end{aligned}$$

where  $\alpha, \alpha \in [0, 1)$ , measures the persistency of an incumbent's costs. Under our alternative interpretation, all firms face the same constant level of marginal cost, but their products differ in the level of perceived quality. In this case, a firm's perceived quality is negatively related to the random variable  $c$ . In the remainder of the paper, we will refer to  $c$  as a firm's marginal cost, hoping that the reader keeps in mind the alternative interpretation. If a firm decides to enter the market, it has to pay a (sunk) entry fee  $\epsilon$ ,  $\epsilon > 0$ . Additionally, a firm faces a fixed production (or opportunity) cost of  $\phi$ ,  $\phi > 0$ , per period.

Time is discrete and indexed by  $t$ . Firms have an infinite horizon and maximise the discounted sum of profits. The common discount factor is denoted by  $\delta$ ,  $\delta \in [0, 1)$ . In each period, the timing is as follows.

1. Entry stage. The potential entrants decide whether to enter the market ( $e = 1$ ) or not ( $e = 0$ ).
2. Learning stage. The new entrants and incumbents observe the realisation of their current costs,  $c_t$ .
3. Exit stage. The new entrants and incumbents decide whether to leave the market forever ( $x = 1$ ) or not ( $x = 0$ ); if a firm decides to leave the market, it saves the fixed production cost  $\phi$ .
4. Output stage. The active firms set their prices so as to maximise their current profits.

Let  $\mathcal{M}$  denote the set of Borel measures on  $[0, 1]$ , and  $\mu, \mu \in \mathcal{M}$ , the measure of firms' cost levels at the output stage. That is, for any Borel set  $A, A \subset [0, 1]$ ,  $\mu(A)$  gives the mass of active firms with costs in  $A$ . Equilibrium profit (gross of fixed costs) of a type- $c$  firm is written as

$$S\pi(c; \mu),$$

where  $S, S > 0$ , is a measure of market size (e.g., the mass of consumers in the market), and  $\pi(\cdot; \cdot) : [0, 1] \times \mathcal{M} \rightarrow [0, \infty)$ . This implicitly assumes that an increase in market size means a replication of the population of consumers, leaving unchanged the distribution of preferences and income. Under our leading interpretation that  $c$  denotes marginal costs, we have

$$S\pi(c; \mu) \equiv [p(c; \mu) - c] \cdot S \cdot D(p(c; \mu); \mu),$$

where  $p(c; \mu)$  denotes the equilibrium price of a type- $c$  firm, and  $S \cdot D(\cdot; \mu)$  the demand function faced by an individual firm in equilibrium when the measure of active firms is given by  $\mu$ .

Throughout the paper, we make the following assumptions on  $\pi(\cdot; \cdot)$ .

**C.1** *The reduced-form profit function  $\pi(\cdot; \mu)$  is strictly decreasing in  $c$  on  $[0, \bar{c}(\mu)]$ , and  $\pi(c; \mu) = 0$  for all  $c \in (\bar{c}(\mu), 1]$ , where  $\bar{c}(\mu) \in [0, 1]$ .*

We define an ordering, denoted by  $\succeq$ , on the set  $\mathcal{M}$ . Formally, let

$$\mu' \succeq \mu \Leftrightarrow \forall c \in [0, 1], \pi(c; \mu') \leq \pi(c; \mu),$$

and

$$\mu' \succ \mu \Leftrightarrow \forall c \in [0, \bar{c}(\mu)), \pi(c; \mu') < \pi(c; \mu).$$

Note that the ordering implies  $\bar{c}(\mu') \leq \bar{c}(\mu)$  for  $\mu' \succeq \mu$ . Distribution  $\mu'$  is said to be (weakly) *larger* than  $\mu$  if  $\mu' \succeq \mu$ . Distributions  $\mu'$  and  $\mu$  are said to be equivalent if  $\mu' \sim \mu$ . We define the *equivalence class* of measure  $\mu$  as the set of Borel measures  $\mu'$  in  $\mathcal{M}$  such that  $\mu' \sim \mu$ .

**C.2** If  $\mu'([0, z]) \geq \mu([0, z])$  for any  $z \in (0, 1]$ , then  $\mu' \succeq \mu$ . If the inequality is strict and  $\pi(0; \mu) > 0$ , then  $\mu' \succ \mu$ .

The distribution of active firms is larger if the mass of active firms is larger and the population of firms more efficient. We remain completely agnostic about the effect of a more efficient but smaller population of firms on profits.

**C.3** The set  $(\mathcal{M}, \succeq)$  is completely ordered.

Complete ordering of  $(\mathcal{M}, \succeq)$  is a natural implication of symmetry and non-localised competition. (Actually, this assumption is stronger than necessary. It suffices to assume that  $(\mathcal{M}^*, \succeq)$  is completely ordered, where  $\mathcal{M}^* \equiv \mu \in \mathcal{M} \mid \mu([0, z]) = [kG(\min\{z, c^*\})]$ ,  $k > 0, c^* \in (0, 1]$ .)<sup>3</sup>

**C.4** Endowing  $\mathcal{M}$  with the topology of weak convergence, we assume that  $\pi(c; \mu)$  is continuous.

For two of our main comparative statics results, we have to impose further structure on the reduced-form profit function.

**A.1** For  $\mu' \succ \mu$ , the profit ratio  $\pi(c; \mu')/\pi(c; \mu)$  is strictly decreasing in  $c$  on  $[0, \bar{c}(\mu')]$ .

**A.2** For  $\mu' \succ \mu$ , the profit difference  $\pi(c; \mu') - \pi(c; \mu)$  is strictly increasing in  $c$  on  $[0, \bar{c}(\mu)]$ .

Consider an increase in the distribution of active firms. Clearly, this causes the gross profit of any firm to decrease, provided the firm makes a positive profit in the first place. Assumption A.1 is the condition for our central result on the relationship between market size and market turbulence. It says that the percentage decrease in gross profit is larger for inefficient firms than for efficient ones. Assumption A.2 says that efficient firms suffer more in terms of the absolute decrease in profit.

**Proposition 1** Suppose the random variable  $c$  denotes marginal costs, i.e.  $\pi(c; \mu) \equiv [p(c; \mu) - c] \cdot D(p(c; \mu); \mu)$ .

1. If  $D(\cdot; \mu)$  is differentiable, assumption A.1 holds if and only if the equilibrium price  $p(c; \mu)$  is decreasing in  $\mu$ ; that is, if and only if  $p(c; \mu') < p(c; \mu) \forall c \in [0, \bar{c}(\mu')]$ ,  $\mu' \succ \mu$ .
2. Assumption A.2 holds if and only if equilibrium demand  $D(p(c; \mu); \mu)$  is decreasing in  $\mu$ , i.e.

$$D(p(c; \mu'); \mu') < D(p(c; \mu); \mu) \quad \forall c \in [0, \bar{c}(\mu)], \mu' \succ \mu.$$

**Proof.** The first part of the result can be shown by taking the derivative of the profit ratio with respect to  $c$  and applying the envelope theorem. The second part can easily be checked by taking the derivative of the profit difference with respect to  $c$ . ■

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<sup>3</sup>Alternatively, we could assume the following. There exist functions  $h : \mathcal{M}^* \rightarrow \mathbb{R}$  and  $\hat{\pi} : [0, 1] \times \mathbb{R} \rightarrow \mathbb{R}_+$  such that  $\pi(c; \mu) \equiv \hat{\pi}(c; h(\mu))$  for all  $c \in [0, 1]$  and  $\mu \in \mathcal{M}^*$ , where  $\hat{\pi}$  is strictly decreasing in its second argument. Hence, by definition,  $h(\mu') \geq h(\mu)$  if and only if  $\mu' \succeq \mu$ .

Hence, if random variable  $c$  denotes marginal costs, assumptions A.1 and A.2 say the following. An increase in the distribution of active firms, which, by assumption, causes the profits of firms to fall, reduces the equilibrium price and quantity of any firm with positive sales. These assumptions (as well as the other conditions we impose on the reduced form profit function) are satisfied by a wide class of oligopoly models where firms differ in their marginal costs. Examples include the Cournot model (with homogenous products) and the linear demand model (with differentiated products and either price or quantity competition). As to models of monopolistic competition with a continuum of firms, the widely used Dixit-Stiglitz model satisfies most of our assumptions, including A.2, but not A.1. In fact, in the Dixit-Stiglitz model, firms use a simple markup pricing rule in which the markup is a function of some substitutability parameter in the utility function, but not of the mass of active firms. That is, the Dixit-Stiglitz model does not capture the empirically well-documented regularity that price-cost margins are falling with the number of firms in the market and hence with market size, which in turn implies that the number of active firms rises less than proportionally with market size; see Bresnahan and Reiss (1991), and Campbell and Hopenhayn (1999). In the following, we give two examples of models of monopolistic competition that satisfy our assumptions.

**Example 1 (The linear demand model with a continuum of firms.)** *There is a continuum of  $S$  identical consumers whose utility  $U$  is defined over a continuum of substitute goods and a Hicksian composite commodity. Specifically,*

$$U(\mathbf{x}; M) = \int_0^n \left( x(i) - x^2(i) - 2\sigma \int_0^n x(j)x(i)dj \right) di + M,$$

where  $x(i)$  is the consumption of variety  $i$ , and  $M$  the consumption of the Hicksian composite commodity. The parameter  $\sigma$ ,  $\sigma \in (0, 1)$ , measures the substitutability between different varieties. Suppose each active firm in the industry produces a unique variety. Denote by  $p(i)$  and  $c(i)$  the price and marginal cost of variety  $i$ , respectively, and by  $Y$  consumer income. Then,  $M = Y - \int_0^n p(i)x(i)di$ . Let us now re-label firms in increasing order of marginal costs, i.e.  $c(j) > c(i) \Rightarrow j > i$ . Let  $m$ ,  $m \in (0, n]$  denote the least efficient producer with positive sales in equilibrium. Then, if firms compete in prices, equilibrium profit of firm  $i$ ,  $i \in [0, m]$ , is given by

$$\frac{S}{8} \left( \frac{2 + \sigma \int_0^m c(j)dj}{2 + m\sigma} - c(i) \right)^2.$$

That is, profit is of the form  $S\pi(c; \mu) = S(h(\mu) - bc)^2$ , with  $h(\mu) > bc$ . It is straightforward to check that the equilibrium profit function satisfies our assumptions.  $\square$

**Example 2 (The linear demand model with perceived qualities.)** *This example is similar to the preceding one. All firms now have the same constant marginal cost, nor-*

malised to zero. The utility of the representative consumer is given by

$$U(\mathbf{x}; \mathbf{u}; M) = \int_0^n \left( x(i) - \frac{x^2(i)}{u^2(i)} - 2\sigma \int_0^n \frac{x(j) x(i)}{u(j) u(i)} dj \right) di + M,$$

where  $u(i)$ ,  $u(i) \geq 1$ , is the perceived quality of variety  $i$ . Utility is strictly increasing in quality  $u(i)$ , provided that  $x(i) > 0$ . Re-label firms in decreasing order of quality, i.e.  $u(i) > u(j) \Rightarrow i < j$ . Let  $m$  again denote the marginal producer. Firm  $i$ 's equilibrium profit under price competition can then be written as

$$\frac{S}{8} \left( u(i) - \frac{\sigma}{2 + m\sigma} \int_0^m u(j) dj \right)^2,$$

which is again of the form  $S\pi(c; \mu) = S(h(\mu) - bc)^2$ , using, for example, the transformation  $u = 2 - c$ .  $\square$

Formally, the model can be described as an *anonymous sequential game*; see Jovanovic and Rosenthal (1988). In period  $t$ , stage 1, a potential entrant, knowing the distribution of active firms in period  $t-1$ ,  $\mu_{t-1}$ , selects an action  $e_t(\mu_{t-1}) \in \{0, 1\}$ . Similarly, at stage 3 of the same period, a firm, knowing its own cost  $c_t$ , the distribution of last period's firms,  $\mu_{t-1}$ , and the mass of new entrants,  $M_t$ , takes its exit decision  $x_t(c_t, \mu_{t-1}, M_t)$ . It turns out that a firm's equilibrium exit strategy takes the form a simple threshold rule,  $c_t^*$ , according to which the firm exits ( $x_t = 1$ ) if and only if  $c_t > c_t^*$ . Thus, if  $c_t^* \in (0, 1)$ , inefficient firms leave the market and efficient firms survive. Although firms' efficiency levels follow a stochastic process, there is no aggregate uncertainty in our model. This follows from the law of large numbers (for a continuum of random variables)<sup>4</sup>. Hence, starting from an initial distribution  $\mu_0$ , the evolution of the industry is deterministic and can be characterised by the sequence  $\{\mu_t, M_t, c_t^*\}_{t=1}^\infty$ , where  $\mu_t$  gives the distribution of active firms in period  $t$ , stage 4,  $M_t$  is the mass of entering firms in period  $t$ , stage 1, and  $c_t^*$  is the exit policy at stage 3 of period  $t$ . In our equilibrium analysis, we will confine attention to a free entry stationary equilibrium. In equilibrium, the value of entrants is zero, and firms' strategies and the distribution of firms are stationary, i.e.  $\forall t$ ,  $c_t^* = c^*$ ,  $\mu_t = \mu$ , and  $M_t = M$ .

### 3 Stationary Equilibrium

The aim of this section is to show existence and uniqueness of a stationary equilibrium. We defer the analysis of the comparative statics properties, which lie at the heart of this paper, to the next section.

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<sup>4</sup>See Feldman and Gilles (1985).

The value of an incumbent of type  $c$  at the start of the exit stage,  $V(c)$ , can be written as

$$V(c) = \max \left\{ 0, [S\pi(c; \mu) - \phi] + \delta \left[ \alpha V(c) + (1 - \alpha) \int_0^1 V(z)G(dz) \right] \right\}. \quad (1)$$

If the firm exits the market, it gets a zero payoff. If, on the other hand, it stays in the market, it gets a current profit of  $S\pi(c; \mu) - \phi$ ; with probability  $\alpha$ , it will be of the same efficiency next period, otherwise it gets a new draw from  $G(\cdot)$ . The optimal exit policy  $c^*$  can then be expressed as

$$\begin{aligned} c^* &\equiv \sup \{c \in [0, 1] \mid V(c) > 0\}, \\ \text{or } c^* &\equiv 1 \text{ if } V(c) > 0 \text{ for all } c \in [0, 1]. \end{aligned}$$

If  $c^* \in (0, 1)$  and  $\pi(0; \mu) > 0$ , then standard arguments from dynamic programming imply that  $V(c)$  is strictly decreasing on  $[0, c^*]$ ; moreover, in this case,  $c^* < \bar{c}(\mu)$ . Let  $M$  denote the mass of entering firms in each period. In a stationary equilibrium,

$$\begin{aligned} V(c^*) &\geq 0, \\ \text{with } V(c^*) &= 0 \text{ if } M > 0. \end{aligned} \quad (2)$$

The value of an entrant at stage 1,  $V^e$ , is given by

$$V^e = \int_0^1 V(c)G(dc) - \epsilon. \quad (3)$$

Free entry implies that

$$\begin{aligned} V^e &\leq 0, \\ \text{with } V^e &= 0 \text{ if } M > 0. \end{aligned} \quad (4)$$

Suppose there is simultaneous entry and exit in the stationary equilibrium, i.e.  $M > 0$ . Using equations (1), (3), and (4), we can compute the reduced-form value functions as

$$V(c) = \frac{1}{1 - \alpha\delta} \{ [S\pi(c; \mu) - \phi] + \delta(1 - \alpha)\epsilon \}, \quad c \in [0, c^*], \quad (5)$$

and

$$\begin{aligned} V^e &= \frac{1}{1 - \alpha\delta} \left\{ \int_0^{c^*} [S\pi(c; \mu) - \phi + \delta(1 - \alpha)\epsilon] G(dc) - (1 - \alpha\delta)\epsilon \right\} \\ &= 0. \end{aligned}$$

If  $c^* \in (0, 1)$ , the entry and exit conditions can be re-written as

$$\psi(c^*; \mu) \equiv \int_0^{c^*} [S\pi(c; \mu) - \phi + \delta(1 - \alpha)\epsilon] G(dc) - (1 - \alpha\delta)\epsilon = 0, \quad (\text{E})$$

$$S\pi(c^*; \mu) - \phi + \delta(1 - \alpha)\epsilon = 0, \quad c^* \in (0, 1), \quad (\text{X})$$

or simply as

$$\psi(c^*; \mu) = 0, \quad (\text{E}')$$

and

$$\psi_1(c^*; \mu) = 0, \quad (\text{X}')$$

where  $\psi_1(\cdot; \cdot)$  denotes the derivative with respect to the first argument. That is, the exit condition is simply the derivative of the entry condition. This nice mathematical structure is a consequence of the assumed sequence of moves. Since any new entrant is treated as an incumbent at the exit stage, exit policy  $c^*$  must maximise the value of an entrant. Hence, both the value of a new entrant and the derivative of this value with respect to the exit policy have to be zero. From exit condition (X), it can be seen that the current net profit of the marginal incumbent firm,  $S\pi(c^*; \mu) - \phi$ , is negative. The last term in (X) captures the option value from staying in the market. Indeed, with probability  $1 - \alpha$ , the firm gets a new draw from  $G(\cdot)$ . In a stationary free entry equilibrium with simultaneous entry and exit, the value of such a new draw must be equal to the entry cost,  $\epsilon$ .

Let us consider the properties of the function  $\psi(\cdot; \cdot)$ , which are illustrated in figure 1. Notice first that  $\psi(\cdot; \mu)$  is single-peaked on  $[0, 1]$ . Either  $\psi(\cdot; \mu)$  is increasing in  $c^*$  on  $[0, 1]$ , decreasing on  $[0, 1]$ , or there exists a unique  $\hat{c}(\mu)$  such that  $\psi(\cdot; \mu)$  is increasing in  $c^*$  on  $[0, \hat{c}(\mu))$  and decreasing on  $(\hat{c}(\mu), 1]$ . Furthermore,  $\psi$  is continuous, and continuously differentiable with respect to its first argument. Observe also that  $\psi(0; \mu) = -(1 - \alpha\delta)\epsilon < 0$ . Hence, if  $\mu$  gives the cost distribution in the stationary equilibrium, and  $c^{**}$  the equilibrium exit policy, then  $\psi(\cdot; \mu)$  takes its unique maximum at  $\hat{c}(\mu) = c^{**}$ . This implies that if there exists a unique stationary distribution, there can be at most one stationary equilibrium with simultaneous entry and exit. Note finally that, for all  $c^* \in (0, 1]$ ,  $\psi(c^*; \cdot)$  is decreasing in  $\mu$ .

Let  $\mu[c^*, M]$  denote the measure of firms' efficiencies at stage 4 if all firms follow exit policy  $c^*$ ,  $c^* \in (0, 1)$ , and the mass of entrants in each period is  $M$ . This measure is uniquely defined by

$$\mu[c^*, M]([0, z]) = \frac{M}{(1 - \alpha)(1 - G(c^*))} G(\min\{z, c^*\}), \quad z \in [0, 1]. \quad (\text{D})$$

The stationary distribution is thus simply given by  $G(\cdot)$ , truncated at  $c^*$ , and scaled by factor  $M/[(1 - \alpha)(1 - G(c^*))]$ . In a stationary equilibrium without simultaneous entry

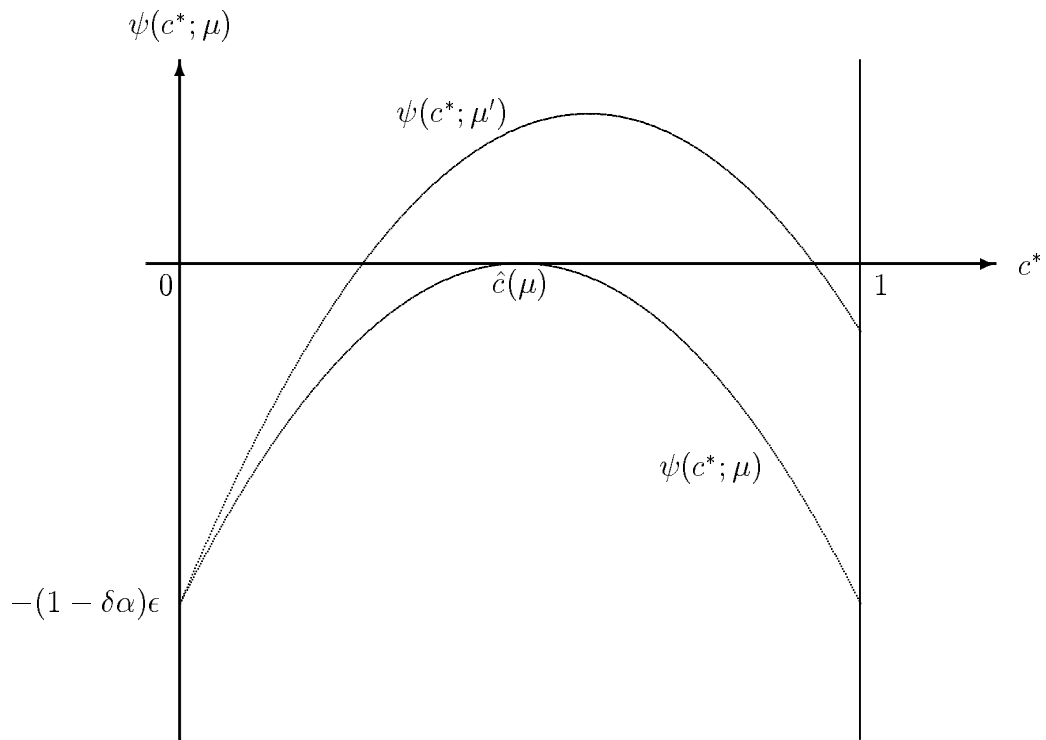


Figure 1: The function  $\psi$  with  $\mu' \succ \mu$ .

and exit, we have  $M = 0$ ,  $c^* = 1$ , and the stationary distribution is given by

$$\mu_\lambda([0, z]) = \lambda G(z), \lambda > 0, z \in [0, 1]. \quad (6)$$

The stationary equilibrium with simultaneous entry and exit can now be defined as the triple  $(\mu, M, c^*)$  satisfying equations (E), (X), and (D). The stationary equilibrium without entry and exit is given by  $(\mu_\lambda, 0, 1)$  satisfying (2), (4), and (6). Notice that any stationary equilibrium distribution must be an element of  $\mathcal{M}^*$ ,  $\mathcal{M}^* \equiv \{\mu \in \mathcal{M} \mid \mu([0, z]) = kG(\min\{z, c^*\}), k > 0, c^* \in (0, 1]\}$ .

The following lemmas will prove helpful in showing existence and uniqueness. Moreover, they may be of independent interest to the reader.

**Lemma 1** *Continuity of  $\pi(c; \cdot)$  in  $\mu$  and complete ordering of  $(\mathcal{M}, \succeq)$  imply that if  $\pi(0; \mu') = \pi(0; \mu'')$ , then  $\mu' \sim \mu''$ , i.e.  $\pi(c; \mu') = \pi(c; \mu'')$  for all  $c \in [0, 1]$ .*

**Proof.** Suppose the assertion is false. Then, there exist distributions  $\mu'$  and  $\mu''$  such that  $\pi(0; \mu') = \pi(0; \mu'')$ , and  $\pi(c'; \mu') > \pi(c'; \mu'')$  for some  $c' \in [0, 1]$ . By continuity of  $\pi(c; \cdot)$  in  $\mu$ , there exists a measure  $\mu'''$  (think of a slight perturbation of  $\mu''$ ),  $\mu''' \prec \mu''$ , such that  $\pi(0; \mu') < \pi(0; \mu''')$ , and  $\pi(c'; \mu') > \pi(c'; \mu''')$ . But this violates the assumption of complete ordering. ■

**Lemma 2** *Consider any two positive measures  $\mu$  and  $\mu'$  in  $\mathcal{M}^*$  such that  $\pi(0; \mu)$  and  $\pi(0; \mu')$  are positive. Then, there exists a unique  $h$ ,  $h > 0$ , such that measures  $h\mu$  and  $\mu'$  are equivalent, i.e.  $h\mu \sim \mu'$ .*

**Proof.** Since  $\mu$  and  $\mu'$  are elements of  $\mathcal{M}^*$ , we have

$$\mu'([0, z]) = k'G(\min\{z, l'\}), k' > 0, l' \in (0, 1]$$

and

$$\mu([0, z]) = kG(\min\{z, l\}), k > 0, l \in (0, 1]$$

for  $z \in [0, 1]$ . Assume w.l.o.g. that  $l \leq l'$ . Then, from condition C.2,  $h\mu \prec \mu'$  if  $hk < k'$ , and  $h\mu \succ \mu'$  if  $hkG(l) > k'G(l')$ . Continuity of  $\pi$  (C.4) and C.2 imply that there exists a unique  $h$  such that  $h\mu \sim \mu'$ . In particular, this means that  $\pi(0; h\mu) = \pi(0; \mu')$ . ■

**Corollary 1** *Consider any positive measure  $\mu'$  in  $\mathcal{M}^*$  such that  $\pi(0; \mu') > 0$ , and fix an arbitrary exit policy  $c^*$  in  $(0, 1)$ . Then, there exists a unique mass of entrants,  $M$ , such that the stationary distribution  $\mu[c^*, M]$ , generated by  $c^*$  and  $M$ , and defined by (D), is equivalent to  $\mu'$ , i.e.  $\mu[c^*, M] \sim \mu'$ .*

**Proof.** This is an immediate implication of lemma 2 and equation (D). ■

To simplify the proof of existence and uniqueness, we impose a technical condition on the reduced-form profit function  $\pi$ . We assume that the profit of a firm can be made arbitrarily small by making the distribution of efficient firms sufficiently large. Similarly, in the limit as the measure of active firms tends to zero, the expected profit of an entrant becomes positive. The condition may be formally expressed as follows.

**C.5** Fix any positive measure  $\mu$  in  $\mathcal{M}^*$ , and define  $\mu^k \equiv k\mu$ , where  $k > 0$  is some scaling parameter. Then,

$$\lim_{k \rightarrow \infty} \pi(c; \mu^k) = 0, \quad c \in (0, 1],$$

and

$$\lim_{k \rightarrow 0} \int_0^1 S\pi(c; \mu^k)G(dc) > \phi + (1 - \delta)\epsilon.$$

The second part of condition C.5 implies that any stationary equilibrium distribution must be positive. We are now in a position to state and prove our existence result.

**Proposition 2** *There always exists a stationary equilibrium. Moreover, if a stationary equilibrium with simultaneous entry and exit exists, it is unique.*

**Proof.** The proof proceeds in several steps.

Step one. Consider any positive measure  $\mu'$  in  $\mathcal{M}^*$  such that  $\psi(1; \mu') = 0$ . Conditions C.4 (continuity) and C.5 ensure that  $\mu'$  exists. Since  $\psi(\cdot; \mu')$  is single-peaked, there are two possibilities.

- (i)  $\psi(c^*; \mu') < 0$  for all  $c^* \in [0, 1)$ ,
- (ii)  $\psi(c^*; \mu') > 0$  for some  $c^* \in (0, 1)$ .

Step two. In case (i), there does not exist a stationary equilibrium with simultaneous entry and exit. To see this, suppose otherwise that there exists a stationary equilibrium with simultaneous entry and exit. Denote the associated stationary distribution by  $\mu''$ , and the exit policy by  $c''$ . Since  $\psi(c^*; \mu)$  is decreasing in  $\mu$ , condition (E) implies that  $\mu'' \prec \mu'$ . It follows that  $\psi(1; \mu'') > \psi(c''; \mu'') = 0$ . Since  $\psi(\cdot; \mu'')$  is single-peaked, we thus have  $\psi_1(c''; \mu'') > 0$ , which contradicts condition (X). Although there does not exist a stationary equilibrium with simultaneous entry and exit, there does exist at least one without entry and exit. Indeed, lemma 2 implies that there exists a positive number  $\lambda'$  such that  $\mu_{\lambda'} \sim \mu'$ , where  $\mu_{\lambda'}$  is the stationary distribution defined by (6). It is easy to check that  $(\mu_{\lambda'}, 0, 1)$  satisfies conditions (2), (4), and (6). Note that there may exist a multiplicity of stationary equilibria. More precisely, there exists a nonempty interval of  $\lambda$ -values,  $[\underline{\lambda}, \bar{\lambda}]$ , with  $\bar{\lambda} \geq \underline{\lambda}$ , such that  $(\mu_{\lambda}, 0, 1)$ ,  $\lambda \in [\underline{\lambda}, \bar{\lambda}]$ , forms a stationary equilibrium.

Step three. In case (ii), there exists a unique stationary equilibrium, which involves simultaneous entry and exit. We denote the stationary equilibrium by  $(\mu^*, M^*, c^{**})$ . Existence and uniqueness can be shown as follows. C.4 (continuity), C.5, and single-peakedness of  $\psi(\cdot; \mu)$  imply that we can increase  $\mu$  from  $\mu'$  to  $\mu''$  such that  $\psi(\cdot; \mu'')$  assumes a unique maximum at  $c^{**}$ , and  $\psi(c^{**}; \mu'') = 0$ . (It is easy to see that the exit policy  $c^{**}$  is unique.) Next, applying corollary 1, there exists a unique  $M^*$  such that  $\mu[c^{**}, M^*] \sim \mu''$ . The unique equilibrium distribution is then given by  $\mu^* \equiv \mu[c^{**}, M^*]$ . ■

In our proof, we do *not* simultaneously determine the equilibrium values of  $c^*$  and  $M$ , using some fixed-point argument. Instead, we construct the equilibrium sequentially. First, we neglect condition (D) and find the equilibrium exit policy  $c^*$  by varying  $\mu$  in  $\mathcal{M}^*$  until (E) and (X) are satisfied. (If such a  $c^*$  does not exist in  $(0, 1)$ , then the stationary equilibrium does not exhibit entry and exit.) Since  $\psi(c^*; \cdot)$  is strictly decreasing in  $\mu$  for  $c^* \in (0, 1]$ , conditions (E) and (X) also pin down the equivalence class of the stationary distribution. Only then do we consider the stationary distribution generated by  $c^*$  and  $M$ , as given by (D). From corollary 1, we know that there exists a unique mass  $M$  of entrants such that the stationary distribution generated by  $M$  and the exit policy is equivalent to the distribution determined in the first part. Our method of proof differs considerably from Hopenhayn's (1992). It should be of rather general interest, as it is applicable also to models of perfect competition, where firms are price takers.

It is straightforward to find conditions under which the unique stationary equilibrium involves simultaneous entry and exit.

**Proposition 3** *If the entry cost  $\epsilon$  is sufficiently small, there exists a unique stationary equilibrium with simultaneous entry and exit.*

**Proof.** Let

$$\xi(c^*; \mu) \equiv \int_0^{c^*} [S\pi(c; \mu) - \phi] G(dc).$$

Conditions C.4 (continuity) and C.5 ensure that there exist a positive measure  $\hat{\mu}$  in  $\mathcal{M}^*$  and an exit policy  $\hat{c}$ ,  $\hat{c} \in (0, 1)$ , such that

$$\xi(\hat{c}; \hat{\mu}) > 0 \geq \xi(1; \hat{\mu}).$$

Then, for  $\epsilon$  sufficiently small, we have

$$\psi(\hat{c}; \hat{\mu}) = \xi(\hat{c}; \hat{\mu}) - [(1 - \delta\alpha) - \delta(1 - \alpha)G(\hat{c})]\epsilon > 0,$$

and

$$\psi(1; \hat{\mu}) = \xi(1; \hat{\mu}) - (1 - \delta)\epsilon < 0.$$

Hence, if we define measure  $\mu'$ ,  $\mu' \in \mathcal{M}^*$ , again by  $\psi(1; \mu') = 0$ , we obtain  $\psi(\hat{c}; \mu') > 0$ . That is, we are in case (ii) of the proof of proposition 2. As we have already shown there,

this implies that there exists a unique stationary equilibrium which involves simultaneous entry and exit, i.e.  $c^* \in (0, 1)$ . ■

In the remainder of the paper, we will focus on the case of sufficiently small entry costs so that the stationary equilibrium exhibits firm turnover.

## 4 Comparative Statics: Market Size and Sunk Costs

The aim of this section is to analyse the comparative statics properties of the stationary equilibrium. We begin by defining a measure of firm turnover. Then, we analyse the effect of changes in the level of sunk costs (the entry cost  $\epsilon$  and the fixed cost  $\phi$ ) on the equilibrium level of firm turnover. Next, we turn to the main concern of the paper, namely the relationship between market size  $S$  and firm turnover. Finally, we look at changes in the level of persistency,  $\alpha$ .

The most natural measure of (relative) firm turnover is the ratio between the mass of new entrants and the total mass of active firms in each period. In our empirical application, we are not able to observe firms that enter and exit in the same period. This suggests to define the turnover rate  $\theta$  as

$$\theta \equiv \frac{G(c^*)M}{\mu([0, c^*])},$$

where the denominator is the mass of active firms at stage 4, and the numerator is the mass of active firms that have entered at stage 1 of the same period. (Alternatively, we could use the ratio  $M/\mu([0, c^*])$  as the turnover rate, with the caveat that we observe only the fraction  $G(c^*)$  of new entrants.) Using (D), the turnover rate in the stationary equilibrium can be written as

$$\theta = (1 - \alpha) [1 - G(c^*)]. \quad (7)$$

That is, given persistency  $\alpha$ , there is a monotonically decreasing relationship between the equilibrium exit policy  $c^*$  and the turnover rate  $\theta$ .

Having defined an appropriate measure of firm turnover, we can now analyse the effects of changes in the parameters of the model on the turnover rate. Let us begin by looking at the effect of an increase in the level of entry costs.

**Proposition 4** *An increase in the entry cost  $\epsilon$  leads to an increase in exit policy  $c^*$ , and hence to a lower turnover rate  $\theta$ . Furthermore, it causes the distribution of active firms,  $\mu$ , and the mass of entrants per period,  $M$ , to decrease.*

**Proof.** Starting from a stationary equilibrium with simultaneous entry and exit, denoted by  $(\mu_0, M_0, c_0^*)$ , we consider an increase in the entry cost from  $\epsilon_0$  to  $\epsilon_1$ ,  $\epsilon_1 > \epsilon_0$ . Let us

assume that there is still a positive turnover rate in the new stationary equilibrium  $(\mu_1, M_1, c_1^*)$ , i.e.  $\theta_1 > 0$ . From (E), it is easy to see that

$$\psi(c^*; \mu_0; \epsilon_1) < \psi(c^*; \mu_0; \epsilon_0) \text{ for all } c^* \in [0, 1],$$

abusing notation by inserting argument  $\epsilon$  into the function  $\psi$ , as defined by (E). Hence, for condition (E) to hold in the new stationary equilibrium, we must have  $\mu_1 \prec \mu_0$ . Since  $\mu_1 \prec \mu_0$  and  $\epsilon_1 > \epsilon_0$ , we must have  $c_1^* > c_0^*$  for condition (X) to hold:

$$\begin{aligned} S\pi(c_0^*; \mu_1) - \phi + \delta(1 - \alpha)\epsilon_1 &> S\pi(c_0^*; \mu_0) - \phi + \delta(1 - \alpha)\epsilon_0 \\ &= 0 \\ &= S\pi(c_1^*; \mu_1) - \phi + \delta(1 - \alpha)\epsilon_1. \end{aligned}$$

Thus, we obtain  $\theta_1 < \theta_0$ . (This would hold trivially if there is no turnover in the new stationary equilibrium.) To see that  $M_1 < M_0$ , notice that  $\mu_1 \prec \mu_0$  and  $c_1^* > c_0^*$  imply that  $\mu_1([0, c_0^*]) < \mu_0([0, c_0^*])$ . Using (D), the result follows. ■

The prediction of the proposition may be roughly explained as follows. Both the marginal incumbent (with cost level  $c^*$ ) and the new entrant have a value of zero in equilibrium. Now, since the marginal incumbent has already sunk its entry cost, the average entrant has to be more efficient than the marginal incumbent. Clearly, this wedge in efficiency is increasing in the level of entry costs. That is, exit policy  $c^*$  increases with  $\epsilon$ . This, in turn, implies, that the hazard rate of incumbents is negatively related to the level of entry costs. The same result has been obtained by Hopenhayn (1992) in a model of perfect competition.

Next, we analyse the effect of a change in  $\phi$ , which may be interpreted as a fixed production cost or as an opportunity cost. The following proposition summarises our results.

**Proposition 5** *Suppose assumption A.2 holds. Then, an increase in the fixed (or opportunity) cost  $\phi$  leads to a decrease in exit policy  $c^*$ , and hence to a higher turnover rate  $\theta$ . Furthermore, it causes the distribution of active firms,  $\mu$ , and the total mass of active firms,  $\mu([0, c^*])$ , to decrease.*

**Proof.** Starting from a stationary equilibrium with simultaneous entry and exit, denoted by  $(\mu_0, M_0, c_0^*)$ , we consider an increase in  $\phi$  from  $\phi_0$  to  $\phi_1$ ,  $\phi_1 > \phi_0$ . Assume that there is still a positive turnover rate in the new stationary equilibrium  $(\mu_1, M_1, c_1^*)$ , i.e.  $\theta_1 > 0$ . From entry condition (E), it follows that

$$\psi(c^*; \mu_0; \phi_1) < \psi(c^*; \mu_0; \phi_0) \text{ for all } c^* \in (0, 1],$$

and  $\psi(0; \mu_0; \phi_1) = \psi(0; \mu_0; \phi_0)$ . This implies that we must have  $\mu_1 \prec \mu_0$  for (E) to hold again in the new stationary equilibrium. We now claim that  $c_1^* < c_0^*$ . To see this, suppose otherwise that  $c_1^* \geq c_0^*$ . According to condition (X),

$$S\pi(c_1^*; \mu_1) - \phi_1 + \delta(1 - \alpha)\epsilon = 0 = S\pi(c_0^*; \mu_0) - \phi_0 + \delta(1 - \alpha)\epsilon.$$

Then, we obtain,

$$\begin{aligned}\psi(c_1^*; \mu_1; \phi_1) &\geq \psi(c_0^*; \mu_1; \phi_1) \\ &> \psi(c_0^*; \mu_0; \phi_0) \\ &= 0,\end{aligned}$$

where the second inequality follows from A.2. Now,  $\psi(c_1^*; \mu_1; \phi_1) > 0$  cannot hold as it is in contradiction with (E). That is, we must have  $c_1^* < c_0^*$ . Finally, notice that, from (7), the turnover rate decreases monotonically with  $c^*$ , holding  $\alpha$  fixed. Let us now show that we must indeed have  $\theta_1 > 0$  (as assumed above), given that  $\theta_0 > 0$ . Define  $\mu'_0$  and  $\mu'_1$  by  $\psi(1; \mu'_0; \phi_0) = 0$  and  $\psi(1; \mu'_1; \phi_1) = 0$ , respectively. (In the proof of proposition 2, we have already shown that such measures exist.) It is easy to see that  $\phi_1 > \phi_0$  implies  $\mu'_1 \prec \mu'_0$ . Since  $\theta_0 > 0$  by assumption, we have  $\psi(c^*; \mu'_0; \phi_0) = 0$  for some  $c^* \in (0, 1)$ . We are done if we can show that  $\psi(c^*; \mu'_1; \phi_1) > \psi(c^*; \mu'_0; \phi_0)$  for all  $c^* \in (0, 1)$ . But this follows immediately from assumption A.2,  $\mu'_1 \prec \mu'_0$ , and  $\phi_1 > \phi_0$ . This concludes the proof of the assertion on turnover. The result on the total mass of active firms follows immediately from  $\mu_1 \prec \mu_0$  and  $c_1^* > c_0^*$ . ■

Notice that we obtain this clear-cut prediction under a widely-satisfied assumption, A.2. In contrast, Hopenhayn (1992) needs to impose a much stronger assumption in his model of perfect competition.

We now turn to our major concern, namely the relationship between market size and firm turnover. The main prediction of this paper is summarised in the following proposition.

**Proposition 6** *Suppose assumption A.1 holds. Then, an increase in market size  $S$  leads to a decrease in exit policy  $c^*$ , and hence to a rise in the turnover rate  $\theta$ . That is, firm turnover is positively related to market size. Furthermore, an increase in market size causes the distribution of active firms,  $\mu$ , and the mass of entrants per period,  $M$ , to rise.*

**Proof.** Starting from a stationary equilibrium with simultaneous entry and exit, denoted by  $(\mu_0, M_0, c_0^*)$ , we consider an increase in the size of the market from  $S_0$  to  $S_1$ ,  $S_1 > S_0$ . Let us assume that there is still a positive turnover rate in the new stationary equilibrium  $(\mu_1, M_1, c_1^*)$ , i.e.  $\theta_1 > 0$ . (It is straightforward to show that turnover must indeed be positive in the new equilibrium, given that  $\theta_0 > 0$ . The argument is similar to that in the proof of proposition 5, replacing assumption A.2 by A.1.) The proof proceeds in several steps. First, notice that

$$\psi(c^*; \mu_0; S_1) > \psi(c^*; \mu_0; S_0) \text{ for all } c^* \in (0, 1],$$

and  $\psi(0; \mu_0; S_1) = \psi(0; \mu_0; S_0)$ . For entry condition (E) to hold in the new equilibrium, we thus need  $\mu_1 \succ \mu_0$ . Second, define  $y$  as follows:

$$\begin{aligned} y &\equiv \inf \{c \in [0, 1] \mid S_1\pi(c; \mu_1) = S_0\pi(c; \mu_0)\}, \\ y &\equiv 1 \text{ if } S_1\pi(c; \mu_1) > S_0\pi(c; \mu_0) \text{ for all } c \in [0, 1] \\ y &\equiv 0 \text{ if } S_1\pi(c; \mu_1) < S_0\pi(c; \mu_0) \text{ for all } c \in [0, 1]. \end{aligned}$$

Assumption A.1 implies that  $S_1\pi(c; \mu_1) > S_0\pi(c; \mu_0)$  for all  $c \in [0, y)$ , and the reverse inequality for all  $c \in (y, 1]$ . Third, suppose the assertion of the proposition does not hold, and  $c_1^* \geq c_0^*$ . Then,

$$\begin{aligned} S_1\pi(c_1^*; \mu_1) &= S_0\pi(c_0^*; \mu_0) \\ &\geq S_0\pi(c_1^*; \mu_0), \end{aligned}$$

where the equality follows from condition (X). Hence, we must have  $c_0^* \leq c_1^* \leq y$ . Consequently,

$$\begin{aligned} \psi(c_1^*; \mu_1; S_1) &\geq \psi(c_0^*; \mu_1; S_1) \\ &> \psi(c_0^*; \mu_0; S_0) \\ &= 0, \end{aligned}$$

where the second inequality follows from A.1. It follows that (E) does not hold in the new equilibrium: a contradiction. That is, we must indeed have  $c_1^* < c_0^*$ , and hence  $\theta_1 > \theta_0$ . It is worth mentioning that we must have  $y \in (0, c_0^*)$  since  $S_1\pi(c_1^*; \mu_1) = S_0\pi(c_0^*; \mu_0)$  and  $c_1^* < c_0^*$  imply that  $S_1\pi(c_0^*; \mu_1) > S_0\pi(c_0^*; \mu_0)$ . Finally, let us consider the effect of the increase in market size on the mass of firms that enter each per period. Since  $\mu_1 \succ \mu_0$  and  $c_1^* < c_0^*$ , we obtain  $\mu_1([0, c_1^*]) > \mu_0([0, c_1^*])$ , and hence, using (D),  $M_1 > M_0$ . ■

The idea behind the result may be described as follows. In a free entry equilibrium, the distribution of active firms,  $\mu$ , is positively related to market size. Indeed, holding the distribution of active firms fixed, an increase in market size raises the value of firms for any exit policy. Free entry then implies that the distribution of firms has to increase with market size. However, as the distribution of firms increases, prices and, hence, price-cost margins fall. This implies that the marginal surviving firm has to be more efficient in larger markets. That is, exit policy  $c^*$  is decreasing with market size. The hazard rate of the average incumbent firm is therefore higher in larger markets: firm turnover and market size are positively correlated.

Intuitively, as price-cost margins fall with an increase in the distribution of active firms, the mass of active firms increases less than proportionally with market size. This has been empirically well documented by Bresnahan and Reiss (1991), and Campbell and Hopenhayn (1999). However, in our model, without imposing further assumptions on the profit function, the relationship between market size and the total mass of active

firms may not be monotonic. To be clear, our model does imply that  $\mu$  increases with  $S$ . Nevertheless, since the “average efficiency” of firms increases with market size (as  $c^*$  is negatively related to  $S$ ), the total mass of active firms,  $\mu([0, c^*])$ , does not necessarily have to rise. This effect may be of independent theoretical interest.

It is important to point out that our main prediction (proposition 6) would not obtain in a model of perfect competition (as in Hopenhayn (1992)) or in a Dixit-Stiglitz-type model. The reason is that, in these models, price-cost margins are independent of market size; this is in contrast to many standard models of oligopolistic competition. Let us illustrate this in a model of a homogenous goods industry with perfect competition. In such a model, the gross profit of a type- $c$  firm may be written as  $\pi(c; p)$ , where  $p$  is the equilibrium price. Market size enters the profit function only indirectly through  $p$ . The value of a type- $c$  incumbent at stage 4 may then be denoted by  $V(c; p)$ . Under weak assumptions,  $V(c; p)$  is strictly increasing in  $p$  for all  $c \in [0, c^*(p)]$ , where  $c^*(p)$  is the optimal exit policy, given price  $p$ . Furthermore,  $V(c; p) > 0$  for all  $c \in [0, c^*(p))$ , and  $V(c; p) = 0$  for all  $c \in [c^*(p), 1]$ . The entry condition for a stationary equilibrium is given by

$$\int_0^1 V(c; p)G(dc) - \epsilon = 0.$$

Hence, the entry condition uniquely determines the equilibrium price  $p$ , which is independent of market size. Given  $p$ , the exit threshold is uniquely determined by the exit condition  $V(c^*(p); p) = 0$ . Consequently, in a model of perfect competition, exit policy and turnover rate do not vary with market size.

A straightforward implication of proposition 6 is the following empirical prediction.

**Corollary 2** *The range of profits and firm values across active firms in the same market is increasing with market size. Formally,  $\Delta\pi(S) \equiv S\pi(0; \mu) - S\pi(c^*; \mu)$  and  $\Delta V(S) \equiv V(0) - V(c^*)$  are increasing with  $S$ .*

**Proof.** Exit condition (X) implies that  $S\pi(c^*; \mu) = \phi - \delta(1 - \alpha)\epsilon$ , and hence  $\Delta\pi(S_1) - \Delta\pi(S_0) = S_1\pi(0; \mu_1) - S_0\pi(0; \mu_0)$ , using the same notation as in the proof of proposition 6. For  $S_1 > S_0$  (and, therefore,  $\mu_1 \succ \mu_0$ ), the last expression is strictly positive since  $y > 0$ . Similarly,  $V(c^*) = 0$ , and hence  $\Delta V(S) = V(0)$ . Using (5) and  $y > 0$ , one obtains the result. ■

How are lower price-cost margins and a stricter exit policy in larger markets consistent with the same (zero) value for entrants? The explanation is this: a firm’s equilibrium output is increasing with market size, holding fixed the firm’s type  $c$ ,  $c \in [0, c_1^*)$ . In fact, the corollary shows that efficient firms make higher profits in larger markets, and hence are more valuable; in contrast, less efficient firms are better off in smaller markets. That is, the distribution of profits and firm values is more skewed in larger markets. The effect on profits is graphically illustrated in figure 2.

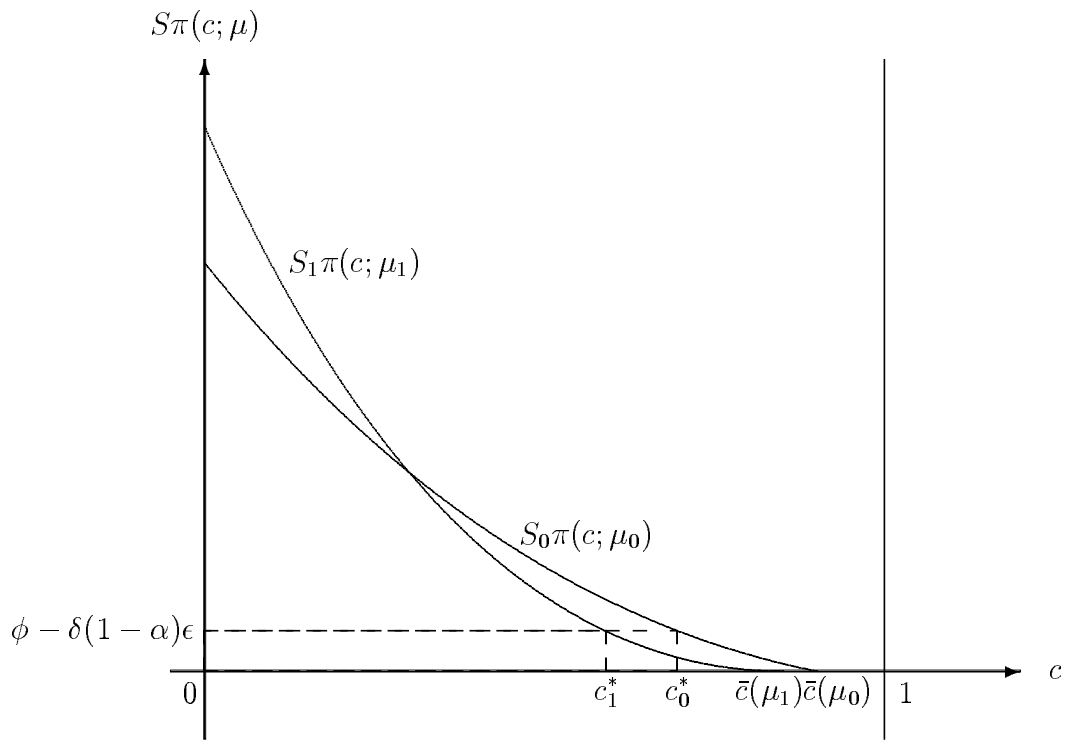


Figure 2: The effect of an increase of market size on gross profits:  $S_1 > S_0$ , and hence  $\mu_1 \succ \mu_0$ .

In empirical applications, the level of sunk costs may not be independent of the size of the market. In particular, one may expect fixed costs (e.g. rents) to be higher in larger markets. The following reassuring result is an immediate implication of propositions 5 and 6.

**Corollary 3** *Suppose entry and fixed costs are functions of market size. Specifically, let  $\epsilon(S) = h(S)\bar{\epsilon}$  and  $\phi(S) = f(S)\bar{\phi}$ . Assume that  $f(S)/h(S)$  and  $S/h(S)$  are increasing in market size. Then, turnover rate  $\theta$  is increasing with market size  $S$ .*

Let us now consider a change in the persistency of a firm's efficiency.

**Proposition 7** *An increase in the persistency parameter  $\alpha$  reduces the turnover rate  $\theta$ , even though it leads to a decrease in the exit policy  $c^*$ .*

**Proof.** Starting from a stationary equilibrium with simultaneous entry and exit, denoted by  $(\mu_0, M_0, c_0^*)$ , we consider an increase in the level of persistency from  $\alpha_0$  to  $\alpha_1$ ,  $\alpha_1 > \alpha_0$ . Let us assume that there is still a positive turnover rate in the new stationary equilibrium  $(\mu_1, M_1, c_1^*)$ , i.e.  $\theta_1 > 0$ ; otherwise, the result holds trivially. The first step in the proof consists in showing that  $\mu_1 \succ \mu_0$ . This follows immediately from condition (E) and the fact that

$$\psi(c^*; \mu_0; \alpha_1) > \psi(c^*; \mu_0; \alpha_0) \text{ for all } c^* \in [0, 1),$$

and  $\psi(1; \mu_0; \alpha_1) = \psi(1; \mu_0; \alpha_0)$ . The second step consists in proving that  $c_1^* < c_0^*$ . To see this, notice that

$$S\pi(c_0^*; \mu_1) - \phi + \delta(1 - \alpha_1)\epsilon < S\pi(c_0^*; \mu_0) - \phi + \delta(1 - \alpha_0)\epsilon = 0.$$

The claim then follows from condition (X), the assumption that  $\pi(\cdot; \mu)$  is strictly decreasing on  $[0, \bar{c}(\mu))$ , and the observation that in a stationary equilibrium with exit policy  $c^*$ ,  $c^* \in (0, 1)$ , we must have  $c^* < \bar{c}(\mu)$ . In the final step of the proof, we show that  $\theta_1 < \theta_0$ . From  $\mu_1 \succ \mu_0$  and  $c_1^* < c_0^*$ , we get

$$\eta_1 \equiv \int_0^{c_1^*} [S\pi(c; \mu_1) - \phi] G(dc) < \int_0^{c_0^*} [S\pi(c; \mu_0) - \phi] G(dc) \equiv \eta_0.$$

Condition (E) implies

$$\begin{aligned} \psi(c_1^*; \mu_1; \alpha_1) &\equiv \eta_1 - \theta_1\delta\epsilon - (1 - \delta)\epsilon \\ &= 0 \\ &= \eta_0 - \theta_0\delta\epsilon - (1 - \delta)\epsilon \equiv \psi(c_0^*; \mu_0; \alpha_0). \end{aligned}$$

Hence, the desired result obtains. ■

The result that more persistency implies less turnover seems to be obvious, but it is not. The reason is that the marginal incumbent, who is less efficient than the average entrant, is only in the market because of the prospect of lower costs in the future (“option value effect”); indeed, the marginal incumbent’s current net profit,  $S\pi(c^*; \mu) - \phi$ , is negative. An increase in the persistency of costs decreases the value of this option; that is, the marginal incumbent has to be more efficient. This implies that there are two opposing effects on the turnover rate  $\theta$ : the first term in (7),  $(1 - \alpha)$ , clearly decreases with  $\alpha$ , but the second term,  $[1 - G(c^*)]$ , is positively correlated with  $\alpha$ . Nevertheless, one can show that the overall effect is unambiguous. (This may no longer hold if one defines the turnover rate as  $M/\mu([0, c^*])$ , which keeps track of those (unobservable) entrants that exit immediately. In fact, the share of entrants that never produce is given by  $[1 - G(c^*)]$ , and increases with  $\alpha$ .)

In empirical applications, it may be feasible to control for cross-industry differences in sunk costs. But it is probably extremely difficult to control for differences in the stochastic process governing the evolution of firms’ efficiencies (or consumers’ tastes), such as differences in our persistency parameter  $\alpha$ . Our proposition shows that turnover rates are likely to be affected by such differences. This indicates that any cross-industry study involving industries with very different products and technologies is likely to face major problems. In contrast, in our empirical test, we analyse turnover rates across independent local markets within the same industry. This methodology should keep differences in the level of  $\alpha$  as small as possible.

## 5 Growing and Declining Markets

So far, we have assumed that market size is constant over time. In empirical applications, this assumption may be violated. Independently, it is of theoretical interest to investigate the time series properties of entry and exit rates in growing and declining markets. In nonstationary markets, entry and exit rates will, in general, be different. Hence, our previous analysis does not carry over. Intuitively, one may expect entry (exit) rates to be high (low) in periods of market growth and low (high) in periods of decline. This intuition is false. The aim of this section is to analyse entry and exit rates when market size changes over time. We show that both entry and exit rates tend to be positively correlated with market size.

The exogenous evolution of market size is summarised by the deterministic sequence  $\{S_t\}$ , which is common knowledge to all firms. All other exogenous variables remain constant over time. To make the analysis more tractable, we assume throughout in this section that changes in market size and entry costs are sufficiently small so that there is simultaneous entry and exit in each period along the equilibrium path. Moreover, let us simplify the analysis further by assuming  $\alpha = 0$ ; that is, in each period, all incumbents get a new draw from distribution  $G(\cdot)$ .

The value function of an incumbent in period  $t$ , stage 3, is denoted by  $V_t(\cdot)$ . It is given by

$$V_t(c) = \max \left\{ 0, S_t \pi(c; \mu_t) - \phi + \delta \int_0^{c_{t+1}^*} V_{t+1}(z) G(dz) \right\},$$

where  $\mu_t$  is the distribution of active firms in period  $t$ , stage 4, and  $c_{t+1}^*$  the exit policy in  $t + 1$ . The value of an entrant at the start of period  $t$ , which is denoted by  $V_{t+1}^e$ , can be written as

$$V_t^e = \int_0^{c_t^*} V_t(c) G(dc) - \epsilon.$$

Since we assume entry costs and the changes in market size to be small, there is simultaneous entry and exit in each period, i.e.  $c_t^* \in (0, 1)$  and  $M_t > 0$  for all  $t$ . This implies that the value of an entrant is always zero, as is the value of the marginal incumbent:  $V_t^e = 0$  and  $V_t(c_t^*) = 0$  for all  $t$ . The entry and exit conditions can then be expressed as

$$\int_0^{c_t^*} [S_t \pi(c; \mu_t) - \phi + \delta \epsilon] G(dc) - \epsilon = 0, \quad (\text{E}_t)$$

and

$$S_t \pi(c_t^*; \mu_t) - \phi + \delta \epsilon = 0, \quad (\text{X}_t)$$

respectively. Given that all firms follow exit policy  $\{c_t^*\}$  and the mass of new entrants is given by  $\{M_t\}$ , we obtain the following relationship between the distribution of active firms in period  $t$  and the total mass of active firms in  $t - 1$ :

$$\mu_t([0, z]) = [M_t + \mu_{t-1}([0, c_{t-1}^*])] G(\min\{z, c_t^*\}), \quad z \in [0, 1]. \quad (\text{D}_t)$$

As before, the equilibrium distribution is an element of  $\mathcal{M}^*$ . Given the mass of initially active firms, equilibrium is described by the sequence  $\{\mu_t, M_t, c_t^*\}$  satisfying equations (E<sub>t</sub>), (X<sub>t</sub>), and (D<sub>t</sub>) for all  $t$ .

Let us now define entry and exit rates. The period- $t$  entry rate,  $\eta_t$ , is the share of firms active in period  $t$ , which have entered at the beginning of the same period. Formally,

$$\eta_t \equiv \frac{G(c_t^*) M_t}{\mu_t([0, c_t^*])}.$$

The period- $t$  exit rate,  $\chi_t$ , is the share of firms active in period  $t - 1$ , which have left the market in period  $t$ . That is,

$$\begin{aligned} \chi_t &\equiv \frac{[1 - G(c_t^*)] \mu_{t-1}([0, c_{t-1}^*])}{\mu_{t-1}([0, c_{t-1}^*])} \\ &= 1 - G(c_t^*). \end{aligned}$$

We have decided to define the entry rate to be “forward looking”, and the exit rate to be “backward looking”. Of course, there may be other natural definitions. In any case, entry and exit rates will in general not be the same if market size changes over time.

Notice that the future enters conditions  $(E_t)$  and  $(X_t)$  only through the option value of staying in the market, which is constant over time and given by  $\delta\epsilon$ , provided (as assumed) that there is positive gross entry in all future periods. In contrast, the future does not directly enter condition  $(D_t)$ . The only way the past enters the equilibrium conditions is in  $(D_t)$  through the total mass of firms active in the previous period. As a result, the dynamic entry and exit conditions,  $(E_t)$  and  $(X_t)$ , are equal to the static ones,  $(E)$  and  $(X)$ , except for the fact that  $\alpha = 0$ , and  $S$  and  $\mu$  are indexed by  $t$ . Now, from our previous analysis (proof of proposition 2), we know that the entry and exit conditions uniquely determine the equilibrium exit policy and the “equivalence class” of the stationary distribution. That is,  $c_t^*$  and the equivalence class of  $\mu_t$  are uniquely defined by  $(E_t)$  and  $(X_t)$ . In particular, they are independent of future and past values of market size. Since the stationary distribution in period  $t$  is, according to  $(D_t)$ , given by distribution function  $G(\cdot)$ , truncated at  $c_t^*$ , and scaled by  $M_t + \mu_{t-1}([0, c_{t-1}^*])$ , conditions  $(E_t)$  and  $(X_t)$  also pin down the scaling factor, and hence the total mass of active firms,  $\mu_t([0, c_t^*])$ . Thus, condition  $(D_t)$  uniquely determines the mass of new entrants,  $M_t$ , as a function of  $\mu_{t-1}([0, c_{t-1}^*])$  and  $S_t$ . More specifically, since  $(E_t)$  and  $(X_t)$  pin down  $M_t + \mu_{t-1}([0, c_{t-1}^*])$ , any change in the mass of last period’s active firms will be exactly offset by a change in this period’s mass of entrants (again, provided there is some entry and exit in all periods).<sup>5</sup>

We are now in the position to state our two main results on firm turnover when market size changes over time. First, we consider a given sequence  $\{S_t\}$ , and analyse the effect of changing market size in a single period. Then, we analyse the co-movements between  $\{S_t\}$ ,  $\{\eta_t\}$ , and  $\{\chi_t\}$ .

**Proposition 8** *Consider two sequences of market size,  $\{S_t\}$  and  $\{\widehat{S}_t\}$ , where  $S_r < \widehat{S}_r$ , and  $S_t = \widehat{S}_t$  for all  $t \neq r$ . Then, the resulting equilibrium sequences of entry rates are such that  $\eta_t = \widehat{\eta}_t$  for all  $t < r$  and  $t > r + 1$ ,  $\eta_r < \widehat{\eta}_r$ , and  $\eta_{r+1} > \widehat{\eta}_{r+1}$  if and only if  $\mu_r([0, c_r^*]) < \widehat{\mu}_r([0, \widehat{c}_r^*])$ . Equilibrium exit rates are characterised by  $\chi_t = \widehat{\chi}_t$  for all  $t \neq r$ , and  $\chi_r < \widehat{\chi}_r$ .*

**Proof.** As pointed out above, the future enters the equilibrium conditions only through the constant option value  $\delta\epsilon$  in  $(E_t)$  and  $(X_t)$ . Consequently, the change in market size

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<sup>5</sup>This last observation provides some theoretical justification for the assumptions on entry in our econometric model. There, we assume that any deviation from the average number of last period’s active firms will be (approximately) offset by a change in this period’s number of entrants. In our empirical application, such a deviation may come about as there is a finite number of firms, and hence idiosyncratic uncertainty is not washed out at the aggregate level.

in period  $r$  has no effect on endogenous variables in periods before  $r$ . Moreover, again from the discussion above,  $c_t^*$  and the equivalence class of  $\mu_t$  are independent of future and past values of market size. The same applies to  $M_t + \mu_{t-1} ([0, c_{t-1}^*])$ . Using our comparative statics result on market size, proposition 6, we then obtain the following characterisation of endogenous variables:  $c_t^* = \widehat{c}_t^*$  for all  $t \neq r$ , and  $c_r^* < \widehat{c}_r^*$ ,  $\mu_t = \widehat{\mu}_t$  for all  $t \neq r$ , and  $\mu_r < \widehat{\mu}_r$ ,  $\eta_t = \widehat{\eta}_t$  for all  $t < r$  and  $t > r + 1$ ,  $M_r < \widehat{M}_r$ , and  $M_{r+1} > \widehat{M}_{r+1}$  if and only if  $\mu_r ([0, c_r^*]) < \widehat{\mu}_r ([0, \widehat{c}_r^*])$ . The prediction on the evolution of exit rates follows immediately. Let us now show that  $\eta_r < \widehat{\eta}_r$ . Condition (D<sub>t</sub>),  $\mu_{r-1} = \widehat{\mu}_{r-1}$ , and  $c_{r-1}^* = \widehat{c}_{r-1}^*$  imply

$$\frac{\left[ \widehat{M}_r + \mu_{r-1} ([0, c_{r-1}^*]) \right] G(\widehat{c}_r^*)}{\widehat{\mu}_r ([0, \widehat{c}_r^*])} = 1 = \frac{\left[ M_r + \mu_{r-1} ([0, c_{r-1}^*]) \right] G(c_r^*)}{\mu_r ([0, c_r^*])}.$$

Since  $M_r < \widehat{M}_r$ , one obtains

$$\frac{\widehat{M}_r G(\widehat{c}_r^*)}{\widehat{\mu}_r ([0, \widehat{c}_r^*])} > \frac{M_r G(c_r^*)}{\mu_r ([0, c_r^*])},$$

which is the desired result. The remaining characterisation of the evolution of entry rates follows from the discussion above. ■

**Corollary 4** *Consider an arbitrary sequence of market size,  $\{S_t\}$ . In equilibrium, exit rates are positively correlated with current market size. More precisely,  $\chi_t$  is increasing in  $S_t$ , and independent of  $S_r$ ,  $r \neq t$ . Equilibrium entry rates are positively related to current market size, too, but only if controlling for last period's market size: holding  $S_{t-1}$  fixed, entry rate  $\eta_t$  is increasing in  $S_t$ , and independent of  $S_r$ ,  $r \neq t, t - 1$ . Moreover, holding  $S_t$  fixed,  $\eta_t$  is negatively correlated with the mass of active firms in  $t - 1$ .*

Let us point out that the predictions of proposition 8 and corollary 4 would remain unchanged if we assumed that market size follows some stochastic process, and the realisation of current market size becomes common knowledge at the start of each period (prior to entry decisions). The results of this section provide us with a useful benchmark. But it should be kept in mind that they have been obtained under the assumption that incumbents' cost draws are i.i.d., i.e.  $\alpha = 0$ .

## 6 Conclusion

This paper has been devoted to the investigation of the determinants of market turbulence, in particular the relationship between market size and entry and exit rates. To this aim, we have analysed a stochastic dynamic model of a monopolistically competitive

industry. Firms are subject to idiosyncratic shocks to their efficiencies. The stationary equilibrium exhibits simultaneous entry and exit: currently efficient firms survive while firms with bad cost draws leave the market and are replaced by new entrants. The main prediction of the model is that the rate of firm turnover should be increasing with market size. In an extension of the model, we have shown that both entry and exit rates should tend to increase over time in growing markets, and decrease in declining markets.

In our companion paper, Asplund and Nocke (2000), we set out to test the predictions of the model. The idea of the empirical test is to study industries where firms compete in well-defined geographical markets of different sizes. This should avoid the usual problems with cross-industry studies since we compare turnover rates within the same industry. Specifically, our measures of market turbulence are based on the identities of all hairdressers and driving schools in Sweden that were active in 1990, 1995, and/or 2000. Most importantly, we find support for the prediction that firm turnover is increasing in market size. In addition, the hazard rates for individual firms and the turnover of firms are affected by changes in market size. There is also evidence that exit (entry) is more common in markets where the actual number of firms is too high (low) given the market characteristics.

The paper provides a number of results in addition to those on market turbulence. In particular, the model predicts that, in larger markets, firms are more efficient on average, and the distributions of profits and firm values are more skewed than in smaller markets. These results may have important implications not only for industrial market structure but also for international trade and other fields. For instance, an increase in market size may be interpreted as an opening to trade, e.g. as a move from two autarkic economies to a fully integrated economy. Such a move has no effect in Melitz' (1999) trade model as there are no size effects in his specification *à la* Dixit-Stiglitz. In contrast, our model predicts that average firm efficiency should rise as a result of economic integration (or opening to trade).

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