Firm Turnover in Imperfectly Competitive Markets[1]

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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 sunk costs and, in particular, market size on entry and exit rates, and hence on the age distribution of firms.

We analyze a stochastic dynamic model of a monopolistically competitive industry. Each firm's efficiency 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 negatively and fixed production costs positively related to entry and exit rates. A central empirical 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, and the age distribution of firms is first-order stochastically dominated by that in smaller markets. In an extension of the model with time-varying market size, we explore the comovements between market size and entry and exit rates. It is shown that both entry and exit rates tend to rise over time in growing markets.

In the empirical part, the prediction on market size and firm turnover is tested on industries where firms compete in well-defined geographical markets of different sizes. Using data on hair salons in Sweden, we show that an increase in market size or fixed costs shifts the age distribution of firms towards younger firms, as predicted by the model.

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1 Introduction

There is much simultaneous ¯rm entry and exit going on at the industry level, and there is considerable variation in ¯rm turnover across industries.[1] To explain these cross-industry di®erences in ¯rm turnover is one of the important research agendas in the ¯eld of industrial economics. For example, Dunne, Roberts, and Samuelson (1988) conclude their study as follows.

> The high correlation between entry and exit across industries indicates that industries di®er substantially in their degree of ¯rm turnover. One area for further study is then to identify the characteristics of industry technology and demand that give rise to across industry di®erences in turnover.

It is probably fair to say that the cross-industry di®erences in ¯rm turnover are not yet very well understood. Although there are some notable exceptions (discussed below), there appear to be only a few theories which make empirically testable predictions regarding the determinants of ¯rm turnover. This paper considers observable industry characteristics { sunk costs and, in particular, market size { and explores their e®ects on entry and exit rates in an imperfectly competitive industry. The same factors should also be expected to cause cross-industry variations in gross job reallocation.[2]

We analyze a stochastic dynamic model of an imperfectly competitive industry. Upon entry, a new ¯rm gets an initial draw of its productive e±ciency or the perceived quality of its product. Over time, a ¯rm's e±ciency is likely to change, as it is hit by idiosyncratic shocks. To illustrate, the perceived quality of a restaurant is partly given by the chef's skills. If the chef quits, the restaurant needs to hire a new chef, who may turn out to be better or worse than the previous one. In stationary equilibrium, ¯rms follow a threshold exit policy: ¯rms that are hit by a su±ciently bad shock optimally decide to leave the market and are replaced by new entrants. The focus of this paper is to relate the equilibrium rate of ¯rm turnover to entry costs, ¯xed production costs, and market size. Since the equilibrium distribution of ¯rm e±ciencies depends on industry characteristics, our model also provides testable predictions regarding the well-documented di®erences in productivity between and within industries.[3]

The central new prediction of the model is that the rate of ¯rm turnover is increasing in market size. The intuition is the following. In a free entry equilibrium, a rise in market size causes the population of active ¯rms to increase. This, in turn, leads to lower price-cost margins. Hence, there tend to be two opposing e®ects on ¯rms' pro¯ts: lower price-cost margins and larger sales. In equilibrium, the overall e®ect is positive for more e±cient ¯rms, and negative for less e±cient ¯rms, and so the marginal surviving ¯rm has to be more e±cient in larger markets. Hence, in larger markets, the expected life span of ¯rms is shorter, and the rate of ¯rm turnover larger. It follows that the age distribution of ¯rms in larger markets is shifted toward younger ¯rms. A direct implication of the stronger \selection e®ect" in larger markets is that ¯rms are on average more e±cient.

Our result on market size and ¯rm turnover is closely related to the price competition e®ect (Sutton (1997a)) in standard models of oligopolistic competition: equilibrium prices (and hence price-cost margins) fall with an increase in the number of ¯rms. An implication of the price competition e®ect is that, in a free entry equilibrium, the number of active ¯rms rises less than proportionally with market size. This is, in fact, what Bresnahan and Reiss (1991) ¯nd in their seminal paper. More recent papers by Asplund and Sandin (1999) and Campbell and Hopenhayn (2002) provide further empirical support. Existing studies on the price competition e®ect commonly assume that ¯rms are symmetric or, more generally, that the distribution of ¯rms' e±ciencies within a market is independent of market size. In

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[1]Caves (1998) provides a recent survey of the empirical literature on turnover and mobility of ¯rms. See also Sutton (1997b) and Cabral (1997).

[2]See Davis and Haltiwanger (1999) for a survey of the literature on gross job creation and destruction.

[3]See Bartelsman and Doms (2000) for a review of the evidence.

our dynamic model, however, the existence of the selection effect implies that firms are on average more efficient in larger markets. How does this affect the conclusion on the size-structure relationship? We show that the selection effect reinforces the price competition effect, which implies that the number of firms will increase at a decreasing rate as the market size increases.

Another prediction of our model is that firm turnover is lower in markets with higher entry costs. As entry costs increase, fewer firms find it profitable to enter the market. This reduces the competitive pressure and allows less efficient firms to survive. The effect of fixed costs is more subtle. An increase in fixed costs also makes entry less attractive, which corresponds to fewer firms in the market and less intense competition with higher equilibrium prices. There is, however, the opposing effect that each firm has to spend more on fixed costs which reduces net profits. In equilibrium, the overall effect is positive for more efficient firms as they gain more from higher prices, and negative for less efficient firms. Consequently, the marginal surviving firm has to be more efficient in markets with higher fixed costs, and the expected life span of firms is shorter.

How can our predictions be tested empirically? The magnitude of the underlying fluctuations in the pattern of demand or technology is likely to vary greatly across industries. As pointed out by Sutton (1997b), this factor may be of primary importance, but it is very difficult to measure it or to control for its impact empirically. This causes a serious problem for any empirical test of cross-industry predictions on firm turnover. Fortunately, an attractive feature of the explanatory variable \market size" is that this problem can be largely circumvented. The idea is to study turnover rates in geographically independent (\local") markets of different sizes but within the same industry. This should control for most of those factors that would differ across industries. This is the route taken in the empirical part of the paper, where we set out to test two predictions of our theory, using data on the age distribution of hair salons in Sweden: firms tend to be younger in (i) larger markets, and (ii) markets with higher fixed costs. Using non-parametric tests of first-order stochastic dominance (Anderson (1996); Davidson and Duclos (2000)), we find empirical support for both predictions.

The starting point of the recent literature on stochastic dynamic industry equilibria with heterogenous firms is the seminal paper by Jovanovic (1982).[4] 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 realizations. Firms which learn that they are efficient grow and survive, while firms that obtain consistently negative information decline and eventually leave the market. The model produces a rich 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, and so 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). In equilibrium, firms may choose different technologies and hence be affected differently by the common shocks. The model predicts that the 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) and Gschwandtner and Lambson (2002). Ericson and Pakes (1995) analyze a stochastic dynamic oligopoly model. There are two sources of uncertainty in their 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. Few analytic restrictions can be placed on equilibrium outcomes. Instead, the authors have developed a simulation package; see Pakes and McGuire (1994).[5]

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[4]Note that we study the properties of a stationary industry equilibrium; we do not analyze the life-cycle of an industry as in Klepper (1996). For more evidence on how entry and exit rates are related to the evolution of an industry, see also Carroll and Hannan (1999).

[5]The passive learning model by Jovanovic (1982) differs from a number of other models (such as Ericson and Pakes (1995), Hopenhayn (1992), and our model) in that the stochastic process generating the size of a firm is non-ergodic. This is used by Pakes and Ericson (1998) to empirically distinguish between the two classes of models.

Hopenhayn (1992) is closely related to our model. The key di®erence between his model and ours is the assumed form of competition: Hopenhayn considers a perfectly competitive industry. The main prediction of his model is that ¯rm turnover is negatively related to entry costs. Due to the absence of the price competition e®ect, however, market size has no e®ect on entry and exit rates. There are a few other papers that build on Hopenhayn's framework. Hopenhayn and Rogerson (1993) apply a general equilibrium version of the model to study the e®ect of changes in ¯ring costs on total employment and welfare. Bergin and Bernhardt (1999) consider business cycle e®ects in a model of perfect competition. Das and Das (1997) and Melitz (1999) both introduce monopolistic competition but assume a particular demand structure. Das and Das analyze the e®ect of entry adjustment costs on the convergence path to the stationary state. Melitz considers the impact of trade costs in a two-country version of Hopenhayn's model. In his model, the e±ciency of incumbents does not vary over time, and the death rate of incumbents is exogenously given. There are no market size e®ects on ¯rm turnover.

The plan of the paper is as follows. In Section 2, we present the basic model. Then, in Section 3, we characterize (stationary) equilibrium, and show existence and uniqueness. In Section 4, we investigate the comparative statics properties of the stationary equilibrium, which lie at the heart of the paper. We extend the model in Section 5 by analyzing the case of growing and declining markets, and providing results on the co-movements of entry and exit rates and market size. The robustness of the main results is discussed in Section 6. In the empirical part of the paper, Section 7, we investigate our prediction on market size and ¯rm turnover, using Swedish data on hair salons. Finally, we conclude in Section 8.

2   The Model

We consider a stochastic dynamic model of an imperfectly competitive industry. There are a continuum of consumers and a continuum of (potential) ¯rms. Each ¯rm produces a unique di®erentiated product, and hence faces a downward-sloping demand curve. In a stochastic dynamic model, it is more convenient to work with a continuum of monopolistically competitive ¯rms rather than with a ¯nite number of oligopolistic players. First, if ¯rms 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. Second, with a continuum of ¯rms, idiosyncratic uncertainty washes out at the aggregate level. Hence, if uncertainty enters at the individual level only, all aggregate variables are deterministic. Third, the assumption of monopolistic competition greatly reduces the set of equilibria.

Firms di®er in their \e±ciency levels", or types, which are subject to idiosyncratic shocks. Under our leading interpretation, the shocks directly a®ect ¯rms' marginal costs. In this case, the marginal cost of each new entrant is independently drawn from the continuous cumulative distribution function $F(c)$ with support $[0, 1]$. An incumbent's marginal cost in period t, c_t, is given by

$$
\begin{aligned}
c_t &= c_{t-1} \text{ with probability } \gamma \\
c_t &\sim F(c) \text{ otherwise,}
\end{aligned}
\tag{1}
$$

where $\gamma \in [0, 1)$, measures the persistence of an incumbent's costs. The \shocks" to incumbents' e±ciencies are assumed to be ¯rm speci¯c. There is, however, an alternative interpretation where ¯rms di®er in the perceived quality of their product; see Example 2 below. In this case, a ¯rm's perceived quality (relative to marginal cost) is negatively related to ¯rm type c. For brevity, we will refer to c as a ¯rm's marginal cost in the remainder of the paper. The simple stochastic process (1) allows us to obtain closed-form solutions. Moreover, this particular Markov process can be motivated by a simple economic model: the e±ciency of a ¯rm depends on the quality of its match with a manager. In each period, the manager leaves the ¯rm with (exogenous) probability $1 - \gamma$. If the manager stays, the quality

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of the firm-manager match (and thus the firm's efficiency) remains unchanged. If the manager leaves, however, the firm has to get a new manager from the pool of (potential) managers. The quality of the firm-manager match is distributed according to $\Phi(\cdot)$. Importantly, in Section 6 we show that the main predictions of the paper remain unchanged if we replace (1) by a more general class of Markov processes with the property that a currently efficient firm is more likely to be efficient next period than a less efficient firm.

Regarding sunk costs, we assume that a firm has to pay an irrecoverable entry fee $\varepsilon \geq 0$ when it enters the market. Additionally, a firm faces a fixed production (or opportunity) cost of $f \geq 0$ per period.[6]

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

1. Entry stage. The potential entrants decide whether to enter the market or, instead, take up the outside option (the value of which is normalized to zero).

2. Learning stage. The entrants and the incumbents observe the realization of their current costs, c_t.

3. Exit stage. The new entrants and incumbents decide whether to leave the market forever (and take up the outside option) or not.

4. Output stage. The active firms play some "market game", pay a fixed production cost f, and receive profits.

Let us make two remarks on the sequence of moves. First, potential entrants decide whether or not to enter the market before knowing their current efficiency. This assumption is common to most dynamic industry models. It allows us to avoid assumptions about the size of the pool of potential entrants (other than that it is sufficiently large to ensure there is always a positive mass of firms which do not enter in equilibrium). This is of particular importance in our model as we are interested in the effects of market size. It seems plausible that the number of potential entrants is not independent of market size. Fortunately, with the assumed sequence of moves, we can remain agnostic about this relationship.[7] Second, new entrants are treated as incumbents at the exit stage, which takes place after firms have learnt their current types. This sequence of moves gives rise to a convenient and novel mathematical structure. In Section 6, we show that the assumption is not essential for the results.

Formally, the model can be described as an anonymous sequential game; see Jovanovic and Rosenthal (1988). Let M denote the set of Borel measures on $[0,1]$, and $\mu \in M$, the measure of firms' cost levels at the output stage. That is, for any Borel set (or interval) $c \subseteq [0,1]$, $\mu(c)$ gives the mass of active firms with costs in c. The payoff relevant state of the industry in period t, stage 4, can then be summarized by μ_t, the measure of active firms' types at the output stage. We confine attention to Markov strategies.[8] Appealing to the law of large numbers (for a continuum of random variables), we

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[6]We could easily introduce a scrap value for exiting firms. However, any such scrap value would affect equilibrium in the same way as the fixed cost f.

[7]In Nocke (2000), a different route is taken which also avoids making arbitrary assumptions about the relationship between the size of the pool of potential entrants and market size. There, it is assumed that potential entrants, knowing their current type, self-select into markets of different size. Reassuringly, it is found that the central prediction of the present paper is insensitive to the assumptions on the entry process.

[8]To focus on pure entry strategies, each potential entrant in period t is assigned a unique (and payoff irrelevant) label $\omega \in R$. Entry decisions only depend on the firm's label ω and last period's industry state μ_{t-1}. An entry strategy is thus a mapping $\xi : R \times M \to \{0,1\}$. An incumbents' exit decision only depends on its own current costs c_t, last period's state μ_{t-1}, and the mass of new entrants, e_t. An exit strategy is thus a mapping $\chi : [0,1] \times M \times R_+ \to \{0,1\}$. Since there is no aggregate uncertainty and each firm is atomistic, the requirements on firms' information could be weakened substantially. For instance, incumbents may or may not condition their exit decisions on the current mass of entrants.

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assume that all idiosyncratic uncertainty washes out at the aggregate level.[9] Hence, the evolution of the industry (from an arbitrary initial state $\star_0$) is deterministic.

To allow for a large class of models describing competition at the output stage, we do not model the \market game" explicitly. In particular, we do not specify ¯rms' strategic variables (prices or quantities) nor the details of the demand system. Instead, each ¯rm's equilibrium pro¯t is summarized by a reduced-form pro¯t function. A ¯rm's equilibrium pro¯t depends on its own type, on market size, and on the endogenous distribution of active ¯rms. The equilibrium pro¯t (gross of ¯xed costs) of a type-$\star$ ¯rm when the measure of ¯rms is $\star$ is denoted by

$$\star\star(\star;\star) \quad 0\star \tag{2}$$

where $\star$ is a measure of market size (e.g., the mass of consumers in the market). By writing a ¯rm's pro¯t as in (2), we make a number of implicit assumptions. First, ¯rms di®er only in their types; they are symmetric in all other respects. Hence, if $\star$ denotes marginal costs, then the aggregate demand system is symmetric and competition non-localized. Second, an increase in market size means a replication of the population of consumers, leaving unchanged the distribution of preferences and income. Moreover, ¯rms' marginal production costs are independent of output levels. This implies that market size enters (2) in a multiplicative way.[10] Of course, in equilibrium, the measure $\star$ will depend on market size, but it is taken as given at the output stage.

To be more speci¯c, let us consider the case where $\star$ denotes marginal costs. Denote by $\star\star$ ($\mathbb{C};\star$) and $\star$ ($\mathbb{C}\star\star;\star$) the demand and inverse demand functions, respectively, faced by an individual ¯rm in equilibrium when the measure of active ¯rms is given by $\star$. In this case, equilibrium gross pro¯t can be written as

$$\star\star(\star;\star) \quad ´ \quad [\star(\star;\star)\ ¡\ \star]\star\star\ (\star(\star;\star);\star)$$
$$= \quad [\star\ (\star(\star;\star\star)\star\star\ ;\star)\ ¡\ \star]\star(\star;\star\star)\star \tag{3}$$

where $\star(\star;\star)$ and $\star(\star;\star\star)$ are equilibrium price and output.

Throughout the paper, we make the following assumptions on the reduced-form pro¯t function.

(MON) The reduced-form pro¯t function $\star$ ($\mathbb{C};\star$) is strictly decreasing in $\star$ on $[0\star\bar{\star}(\star))$, and $\star$ $(\star;\star) = 0$ for all $\star\ 2\ [\bar{\star}(\star)\star 1]$, where $\bar{\star}(\star)\ 2\ [0\star 1]\star$

That is, ¯rms with lower marginal costs have higher pro¯ts. We allow for the possibility that some ine±cient ¯rms (the types above $\bar{\star}(\star)$) may not sell their products even when o®ered at marginal cost and hence make zero gross pro¯t.

Since the distribution of active ¯rms is endogenous, we have to compare di®erent distributions. For this purpose, we de¯ne a partial ordering, denoted by $^{\circ}$, on the set M. Formally, let

$$\star^0\ \%\ \star\ ,\quad 8\star\ 2\ [0\star 1]\star\ \star(\star;\star^0)\ ·\ \star(\star;\star)\star$$

and

$$\star^0\ \hat{A}\ \star\ ,\quad 8\star\ 2\ [0\star\bar{\star}(\star))\star\ \star(\star;\star^0)\ \star\ \star(\star;\star)\star$$

Note that the ordering implies $\bar{\star}(\star^0)\ ·\ \bar{\star}(\star)$ for $\star^0\ \%\ \star$. Distribution $\star^0$ is said to be (weakly) larger than $\star$ if $\star^0\ ^{\circ}\ \star$. Distributions $\star^0$ and $\star$ are said to be equivalent if $\star^0\ \gg\ \star$. We de¯ne the equivalence class of measure $\star$ as the set of Borel measures $\star^0$ in M such that $\star^0\ \gg\ \star$.

(DOM) If $\star^0([0\star\star])\ \ \star([0\star\star])$ for all $\star\ 2\ (0\star 1]$, then $\star^0\ \%\ \star$. If, in addition, the inequality is strict for some $\mathbf{e}\ 2\ (0\star\bar{\star}(\star))$, then $\star^0\ \hat{A}\ \star$.

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[9]See Feldman and Gilles (1985) and Uhlig (1996) for a precise statement of the conditions under which a law of large numbers can be justi¯ed for a continuum of random variables.

[10]The assumption that market size enters multiplicatively into the gross pro¯t function can easily be relaxed; see Nocke (2000).

In words, the distribution of active ¯rms is larger if the mass of active ¯rms is larger and the population of ¯rms more e±cient. We can remain completely agnostic about the e®ect on pro¯ts of increasing \average e±ciency" of ¯rms while reducing the mass of active ¯rms. Assumption (DOM) implies that a rise in the mass of ¯rms reduces the pro¯t of any active ¯rm and thus the value of an entrant.

(ORD) The set (M⋆°) is completely ordered.

Complete ordering of (M⋆°) is a common property of models of symmetric and non-localized competition. The assumption rules out that some ¯rm makes larger pro¯ts when the distribution of active ¯rms is given by ⋆ rather than ⋆⁰, while some other ¯rm is better o® under ⋆⁰. If ¯rms di®er only in their types and are symmetric otherwise, then all types should have the same ranking of distributions.[11]

(CON) The reduced-form pro¯t function ⋆ (⋆; ⋆) is continuous.[12]

For two of our main comparative statics results, we have to impose further structure on the reduced-form pro¯t function. The following two conditions summarize properties of a large class of oligopoly models with heterogeneous ¯rms.

A.1 For ⋆⁰ Â ⋆, the pro¯t di®erence j⋆(⋆; ⋆) ¡ ⋆(⋆; ⋆⁰)j is strictly decreasing in ⋆ on [0⋆̄⋆(⋆)).

A.2 For ⋆⁰ Â ⋆, the pro¯t ratio ⋆(⋆; ⋆⁰)⋆⋆(⋆; ⋆) is strictly decreasing in ⋆ on [0⋆̄⋆(⋆⁰)).

Consider an increase in the distribution of active ¯rms. By de¯nition, this causes the gross pro¯t of any ¯rm to decrease, provided the ¯rm makes a positive pro¯t in the ¯rst place. Assumption A.1 says that e±cient ¯rms su®er more than ine±cient ¯rms in terms of the absolute decrease in pro¯t. Assumption A.2 is the condition for our central result on the relationship between market size and market turbulence. It says that the percentage decrease in gross pro¯t is larger for ine±cient ¯rms than for e±cient ones. While both general and intuitive, these properties appear to have remained widely unnoticed in the literature.[13]

To improve our understanding of assumptions A.1 and A.2, the following proposition shows that they are equivalent to properties of equilibrium prices and quantities.

Proposition 1 Suppose ¯rm type ⋆ denotes marginal costs, and ¯rms compete either in prices or in quantities. That is, equilibrium pro¯t is given by (3). Assume also that the demand and inverse demand functions faced by an individual ¯rm in equilibrium, ⋆⋆ (¢; ⋆) and ⋆ (¢⋆⋆ ; ⋆), are di®erentiable.

1. Assumption A.1 holds if and only if equilibrium output ⋆(⋆; ⋆) = ⋆⋆ (⋆(⋆; ⋆); ⋆) is decreasing in ⋆; that is, if and only if ⋆(⋆; ⋆⁰) ⋆ ⋆(⋆; ⋆) 8⋆ 2 [0⋆̄⋆(⋆)) ⋆⋆⁰ Â ⋆.

2. Assumption A.2 holds if and only if the equilibrium price ⋆(⋆; ⋆) = ⋆ (⋆(⋆; ⋆)⋆⋆ ; ⋆) is decreasing in ⋆; that is, if and only if ⋆(⋆; ⋆⁰) ⋆ ⋆(⋆; ⋆) 8⋆ 2 [0⋆̄⋆(⋆⁰)) ⋆⋆⁰ Â ⋆.

Proof. The assertions can be shown by taking the derivative of the pro¯t di®erence and pro¯t ratio with respect to ⋆ and applying the envelope theorem. ∎

By de¯nition, an increase in the distribution of active ¯rms causes the pro¯ts of ¯rms to fall. For this to hold, the equilibrium price or quantity of any given ¯rm must fall. If ¯rm type ⋆ denotes marginal costs, assumptions A.1 and A.2 say that both quantities and prices must fall in equilibrium. Proposition 1 is of independent interest. Since its proof does not make use of the fact that ⋆ summarizes the distribution of active ¯rms, it can be applied to any shift in consumers' tastes or incomes which reduces ¯rms' pro¯ts.

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[11]Alternatively, we could assume the following. There exist functions ⋆ : M¤ ! R and b : [0⋆1] £ R ! R₊ such that ⋆(⋆; ⋆) ´ b(⋆; ⋆(⋆)) for all ⋆ 2 [0⋆1] and ⋆ 2 M¤, where b is strictly decreasing in its second argument. Hence, by de¯nition, ⋆(⋆⁰) ¸ ⋆(⋆) if and only if ⋆⁰ ° ⋆.

[12]Formally, we endow M with the topology of weak* convergence.

[13]However, Boone (2000) { in independent work { provides a few parametric examples to show that an increase in the toughness of competition results in an increase in the pro¯t ratio between a more and a less e±cient ¯rm. This corresponds to A.2.

Assumptions A.1 and A.2 (as well as the other conditions we impose on the reduced form pro¯t function) are satis¯ed by a wide class of oligopoly models. Examples include the standard Cournot model with homogenous products, and the linear demand model with a ¯nite number of di®erentiated products and either price or quantity competition; in Appendix A this is shown for the Cournot model. As to models of monopolistic competition with a continuum of ¯rms, the widely used Dixit-Stiglitz model satis¯es most of our assumptions, including A.1, but not A.2. In fact, in the Dixit-Stiglitz model, ¯rms 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 ¯rms. 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 ¯rms.) There is a continuum of ★ identical consumers whose utility ★ is de¯ned over a continuum of substitute goods and a Hicsian composite commodity. Speci¯cally,

$$\star(x;\star) = \int_0^{\star} \star(\star) \text{¡} \star^2(\star) \text{¡} 2\star \int_0^{\star} \star(\star)\star(\star)\star \star\star + \star\star$$

where ★(★) is the consumption of variety ★, and ★ the consumption of the Hicsian composite commodity.[14] The parameter ★ 2 (0★1), measures the substitutability between di®erent varieties. Suppose each active ¯rm in the industry produces a unique variety. Denote by ★(★) and ★(★) the price and marginal cost of variety ★, respectively, and by ★ consumer income. Normalizing the price of the Hicsian composite commodity to 1, ★ = ★ ¡ $\int_0^{\star}$ ★(★)★(★)★★. Re-label ¯rms in increasing order of marginal costs, i.e., ★(★) ★ ★(★)) ★★ ★. Let ★ 2 (0★★] denote the least e±cient producer with positive sales in equilibrium. Then, if ¯rms compete in prices (or quantities), equilibrium pro¯t of ¯rm ★ 2 [0★★], is given by

$$\frac{\star}{8} \left(\frac{2 + \star \int_0^{\star} \star(\star)\star\star}{2 + \star\star} \text{¡} \star(\star) \right)^2 \star$$

That is, pro¯t is of the form ★★(★;★) = ★★(★̄(★) ¡ ★)² if ★★ ★̄(★), and ★★(★;★) = 0 otherwise. It is straightforward to check that the equilibrium pro¯t function satis¯es our assumptions.¤

Example 2 (The linear demand model with perceived qualities.) This example is similar to the preceding one. All ¯rms now have the same constant marginal cost, normalized to zero. The utility of the representative consumer is given by

$$\star(x;u;\star) = \int_0^{\star} \star(\star) \text{¡} \frac{\star^2(\star)}{\star^2(\star)} \text{¡} 2\star \int_0^{\star} \frac{\star(\star)}{\star(\star)}\frac{\star(\star)}{\star(\star)}\star\star \star\star + \star\star$$

where ★(★) ¸ 1 , is the perceived quality of variety ★.[15] Utility is strictly increasing in quality ★(★), provided that ★(★) ★ 0. Re-label ¯rms in decreasing order of quality, i.e., ★(★) ★ ★(★)) ★★ ★. Let ★ again denote the marginal producer. Firm ★'s equilibrium pro¯t under price (or quantity) competition can then be written as

$$\frac{\star}{8} \left(\star(\star) \text{¡} \frac{\star}{2 + \star\star} \int_0^{\star} \star(\star)\star\star \right)^2 \star$$

which is again of the form ★★(★;★) = ★★(★̄(★) ¡ ★)², using, for example, the transformation ★ = 2 ¡ ★.¤

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[14]This is the continuum version of the quadratic utility function which goes back to Bowley (1924). The associated demand system is widely used in oligopoly models; see Vives (1999).

[15]This is the continuum version of the utility function in Sutton (1997c).

3 Stationary Equilibrium

We now turn to the equilibrium analysis, where we con¯ne attention to a free entry stationary equilibrium, in which ¯rms' strategies and the distribution of ¯rms are stationary. We characterize the stationary equilibrium, and show existence and uniqueness. We defer the analysis of the comparative statics properties, which lie at the heart of this paper, to the next section.

In a stationary equilibrium, the value of a type-$\star$ incumbent at the start of the exit stage, $\star(\star)$, can be written as

$$\star(\star) = \max\left\{0, \overline{\star\star}(\star)\right\}^a \star \tag{4}$$

where

$$\overline{\star}(\star) = [\star\star(\star;\star) ¡ \star] + \star \left[\star\star(\star) + (1 ¡ \star) \int_0^1 \star(\star)\star(\star\star)\right] \tag{}$$

is the value conditional on staying in the market for one period and behaving optimally thereafter. (In other words, $\overline{\star}(\star)$ is the value of a type-$\star$ ¯rm at the output stage.) The expression for the conditional value consists of two terms: the ¯rst term is the ¯rm's current net pro¯t $\star\star(\star;\star) ¡ \star$, the second captures the expected continuation value { with probability $\star$ the ¯rm will be of the same e±ciency in the next period, while with the remaining probability it obtains a new draw from the distribution function $\star(\textcent)$.

Let $\star^\square$ be de¯ned by

$$\star^\square \, \raisebox{0.5ex}{,} \, \begin{cases} \sup\{\star 2 [0,1] j \star(\star) \star 0\} & \text{if } \star(1) = 0\star \\ 1 & \text{if } \star(1) \star 0\star \end{cases}$$

Our assumptions ensure that the value function $\star(\star)$ is continuous on $[0,1]$, and constant on $[\overline{\star}(\star),1]$. If $\star(0;\star) \star 0$, then standard arguments from dynamic programming imply that $\star(\star)$ is strictly decreasing on $[0, \min\{\star^\square, \overline{\star}(\star)\}]$. Hence, a ¯rm's equilibrium exit strategy takes the form of a simple threshold rule, $\star^\square$, according to which the ¯rm exits if and only if $\star\star \star^\square$. Let $\star$ denote the mass of entering ¯rms in each period. In a stationary equilibrium,

$$\star(\star^\square) \, \raisebox{0.5ex}{,} \, 0\star$$
$$\text{with } \star(\star^\square) = 0 \text{ if } \star \star 0\star \tag{5}$$

The value of an entrant at stage 1, $\star^\star$, is given by

$$\star^\star = \int_0^1 \star(\star)\star(\star\star) ¡ \star\star \tag{6}$$

Free entry implies that

$$\star^\star \, \cdot \, 0\star$$
$$\text{with } \star^\star = 0 \text{ if } \star \star 0\star \tag{7}$$

Suppose the stationary equilibrium exhibits simultaneous entry and exit, i.e., $\star \star 0$ and $\star^\square \star 1$. In this case, $\star^\star = 0$, and so $\int_0^1 \star(\star)\star(\star\star) = \star$. This allows us to compute the conditional value function in closed form as

$$\overline{\star}(\star) = \begin{cases} \dfrac{\star\star(\star;\star) ¡ \star + \star(1 ¡ \star)\star}{1 ¡ \star\star} & \text{if } \star \cdot \star^\square\star \\ \star\star(\star;\star) ¡ \star + \star(1 ¡ \star)\star & \text{if } \star \, \raisebox{0.5ex}{,} \, \star^\square\star \end{cases} \tag{8}$$

In stationary equilibrium with simultaneous entry and exit, the free entry condition $\star^\star = 0$ becomes

$$\int_0^{\star^\square} [\star\star(\star;\star) ¡ \star + \star(1 ¡ \star)\star]\star(\star\star) ¡ (1 ¡ \star\star)\star = 0\star \tag{E}$$

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Similarly, the condition for optimal exit, $\star(\star^{\scriptscriptstyle\square}) = 0$, becomes

$$\star\star(\star^{\scriptscriptstyle\square};\star) \; ¡ \; \star + \star(1 \; ¡ \; \star)\star = 0\star \tag{X}$$

>From exit condition (X), the current net pro¯t of the marginal incumbent ¯rm, $\star\star(\star^{\scriptscriptstyle\square};\star) \; ¡ \; \star$, is negative. This ¯rm stays in the market only because there is a probability $1 \; ¡ \; \star$ that it will get a new draw from $\star(\textcent)$, and the value of this option is $\star(1 \; ¡ \; \star)\star$. In a stationary free entry equilibrium with simultaneous entry and exit, the value of a new draw must be equal to the entry cost $\star$. To simplify the exposition, we henceforth assume that $\star \; \boldsymbol{6} \; \star(1 \; ¡ \; \star)\star$. Then, a necessary condition for a stationary equilibrium with entry and exit is $\star \; \star \; \star(1 \; ¡ \; \star)\star$, which implies that the current gross pro¯t of the marginal incumbent ¯rm must be strictly positive, i.e., $\star^{\scriptscriptstyle\square} \; \star \; \bar{\star}(\star)$.

Let $\overline{\star}^{*}(\star;\star)$ denote the value of a new entrant who uses exit policy $\star$ in the period of entry and behaves optimally thereafter,

$$\overline{\star}^{*}(\star;\star) = \int_{0}^{\star} \overline{\star}(\star)\star\,(\star\star) \; ¡ \; \star\star \tag{9}$$

In stationary equilibrium with simultaneous entry and exit, the free entry condition (E) can then be rewritten as

$$\overline{\star}^{*}(\star^{\scriptscriptstyle\square};\star) = 0\star \tag{E'}$$

and the condition for optimal exit as

$$\frac{\star}{\star\star}\overline{\star}^{*}(\star^{\scriptscriptstyle\square};\star) = 0\star \tag{X'}$$

The entry condition (E') says that the value of an entrant who uses the equilibrium policy $\star^{\scriptscriptstyle\square}$ in the ¯rst period, and behaves optimally thereafter, is equal to zero. The exit condition (X') says that the derivative of this value function of an entrant with respect to the exit policy (and evaluated at the equilibrium exit policy $\star^{\scriptscriptstyle\square}$) is equal to zero. This close link between the entry and exit conditions is a consequence of the assumed sequence of moves. Since incumbents and new entrants face the same decision problem at the exit stage, the equilibrium exit policy of an incumbent, $\star^{\scriptscriptstyle\square}$, must maximize the value of an entrant. Hence, at the equilibrium exit policy, both the value of a new entrant and the derivative of the value function with respect to the exit policy have to be zero.

These properties of the value function $\overline{\star}^{*}(\star;\star)$ are straightforward to illustrate in Figure 1. Note ¯rst that $\overline{\star}^{*}(\textcent;\star)$ is (for $\star \; \boldsymbol{6} \; \star(1 \; ¡ \; \star)\star$) single-peaked on $[0\star1]$.[16] Furthermore, $\overline{\star}^{*}$ is continuous, and continuously di®erentiable with respect to its ¯rst argument. Observe also that $\overline{\star}^{*}(0;\star) = \; ¡ \; \star \; \star \; 0$. Hence, if $\star$ gives the cost distribution in the stationary equilibrium, and $\star^{\scriptscriptstyle\square}$ the equilibrium exit policy, then $\overline{\star}^{*}(\textcent;\star)$ takes its unique maximum at $\boldsymbol{b}(\star) = \star^{\scriptscriptstyle\square}\star$ This implies that there can be at most one stationary equilibrium with simultaneous entry and exit. Note ¯nally that, for all $\star \; \star \; 0$, $\overline{\star}^{*}(\star;\textcent)$ is decreasing in $\star$ (provided $\bar{\star}(\star) \; \star \; 0$).

The distribution of active ¯rms is determined by ¯rms' entry and exit decisions. Let $\star[\star^{\scriptscriptstyle\square}\star\star \;]$ denote the invariant measure of ¯rms' e±ciencies at stage 4 if all ¯rms follow exit policy $\star^{\scriptscriptstyle\square} \; 2 \; (0\star1)$, and the mass of entrants in each period is $\star$. This measure is uniquely de¯ned by

$$\star[\star^{\scriptscriptstyle\square}\star\star \;] \; ([0\star\star]) = \frac{\star}{(1 \; ¡ \; \star) \; (1 \; ¡ \; \star \; (\star^{\scriptscriptstyle\square}))} \; \star \; (\min f\star\star\star^{\scriptscriptstyle\square}g)\star \; 8\star \; 2 \; [0\star1]\star \tag{D}$$

The stationary distribution has thus the shape of $\star(\textcent)$, is truncated at $\star^{\scriptscriptstyle\square}$, and scaled by the factor $\star \; \star [(1 \; ¡ \; \star) \; (1 \; ¡ \; \star \; (\star^{\scriptscriptstyle\square}))]$. The stationary equilibrium with simultaneous entry and exit can now be de¯ned as the triplet $(\star\star\star \; \star\star^{\scriptscriptstyle\square})$ satisfying equations (E), (X), and (D).

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[16]Either $\overline{\star}^{*}(\textcent;\star)$ is increasing in $\star$ on $[0\star1]$, decreasing on $[0\star1]$, or there exists a unique $\boldsymbol{b}(\star)$ such that $\overline{\star}^{*}(\textcent;\star)$ is increasing in $\star$ on $[0\star\boldsymbol{b}(\star)]$ and decreasing on $[\boldsymbol{b}(\star)\star1]$. In the non-generic case $\star = \star(1 \; ¡ \; \star)\star$, $\overline{\star}^{*}(\textcent;\star)$ is increasing in $\star$ on $[0\star\bar{\star}(\star)]$ and constant on $[\bar{\star}(\star)\star1]$.

In a stationary equilibrium without entry and exit, we have $\star = 0$ and $\star^\pi = 1$, and the stationary distribution is given by

$$\star_\star([0\star\star]) = \star\star(\star), \ 8\star \ 2 \ [0\star1]\star \tag{10}$$

where $\star \star 0$ is a scaling parameter. The stationary equilibrium without entry and exit is summarized by the triplet $(\star_\star\star0\star1)$, satisfying (5), (7), and (10). Note that any stationary equilibrium distribution must be an element of $M^\pi \ \acute{} \ f\star \ 2 \ M \ j \ 8\star \ 2 \ [0\star1]\star\star([0\star\star]) = \star\star(minf\star\star\star^\pi g)\star \ \star \ 0\star\star^\pi \ 2 \ (0\star1]g.$

Before we turn to the issues of existence and uniqueness of equilibrium, let us consider some features of the equilibrium which are consistent with stylized facts on industry dynamics. The probability of immediate exit of a new entrant is $1 \ \mathbf{i} \ \star(\star^\pi)$, whereas an incumbent leaves the market with a smaller probability, namely $(1 \ \mathbf{i} \ \star)(1 \ \mathbf{i} \ \star(\star^\pi))$. Empirical studies have indeed shown that new ¯rms are the ones most likely to exit the market. Moreover, the model implies that new entrants are on average more e±cient than exiting ¯rms, but less e±cient than surviving incumbents. This is again consistent with the empirical evidence. Finally, if ¯rm size (e.g., measured by output) decreases with marginal cost $\star$, the simple stochastic process given by (1) implies that ¯rm growth is negatively related to ¯rm size, as found by Evans (1987) and others. In Section 6, we re-consider the model and allow for a broader class of Markov processes. This permits the model to be consistent with a number of other empirical ¯ndings.

To simplify the proof of existence and uniqueness, we impose a technical condition on the reduced-form pro¯t function $\star$.

(FREE) Let $\star^0$ denote the null measure, i.e., $\star^0(\star) \ \acute{} \ 0$ for any Borel set $\star$. Then,

(i) $\star(\star;\star^0) = 0$ for all $\star\star \ 0\star$ and

(ii) $\displaystyle\int_0^1 \star\star(\star;\star^0)\star(\star\star) \ \star \ \star \ + \ (1 \ \mathbf{i} \ \star)\star\star$

The ¯rst part of the free entry assumption (FREE) ensures that unlimited entry drives pro¯ts down to zero, and the second part implies that any stationary equilibrium distribution must be positive. We are now in a position to state 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. See Appendix. ∎

There are two kinds of stationary equilibria: (i) with simultaneous entry and exit, and (ii) without simultaneous entry and exit. If the ¯rst kind exists, it is the unique equilibrium. If it does not, there exists an equilibrium in which a (positive) mass of ¯rms is active, and no entry and exit take place. Since in this case, the entry and exit conditions become inequalities ($\star \ \star \ 0$ and $\star(1) \ _{\mathbf{,}} \ 0$, respectively), the mass of active ¯rms in this equilibrium is not uniquely determined. In our proof of existence, we proceed in two steps. First, we neglect condition (D) and ¯nd the equilibrium exit policy $\star^\pi$ by varying the distribution of ¯rms in M^π until (E) and (X) are satis¯ed. (If such a $\star^\pi$ does not exist in $(0\star1)$, then the stationary equilibrium does not exhibit entry and exit.) Since $\overline{\star}^\star(\star;¢)$ is strictly decreasing in $\star$ for $\star \ 2 \ (0\star1]$, conditions (E) and (X) also pin down the equivalence class of the stationary distribution. Only then do we consider the stationary distribution generated by $\star^\pi$ and $\star$, as given by (D). From assumptions (DOM) and (CON), and condition (D), it then follows there exists a unique mass $\star$ of entrants such that the stationary distribution generated by $\star$ and the exit policy $\star^\pi$ is equivalent to the distribution determined in the ¯rst part of the proof. Note that our novel method of proof is applicable also to models of perfect competition where ¯rms are price-takers.

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

Proposition 3 If the entry cost $\star$ is su±ciently small, there exists a unique stationary equilibrium with simultaneous entry and exit.

Proof. See Appendix. ∎

For a stationary equilibrium to exhibit no entry and exit, the value of the least e±cient incumbent (of type $\star = 1$), conditional on staying in the market for another period, has to be larger than or equal to the value of an entrant: $\overline{\star}(1) \, {}_{\,} 0 \, {}_{\,} \star^{*}$. An incumbent of type $\star = 1$ is less e±cient than a potential entrant (whose e±ciency is drawn from $\star(\text{¢})$) { but (in contrast to the potential entrant) has already sunk the entry cost $\star$. Clearly, for small entry costs, the e±ciency di®erence will outweigh the incumbent's sunk cost advantage, and we must have $\overline{\star}(1) \star \star^{*}$.

In the remainder of the paper, we will focus on the case of su±ciently small entry costs so that the stationary equilibrium exhibits ¯rm turnover.

4   Comparative Statics: Market Size and Sunk Costs

In this section, we analyze the comparative statics properties of the stationary equilibrium. We begin by de¯ning a measure of ¯rm turnover and showing the close connection between ¯rm turnover and the age distribution of ¯rms. Then, we analyze the e®ect of changes in the level of the entry cost $\star$ and the ¯xed cost $\star$ on the equilibrium level of ¯rm turnover. Next, we turn to the main concern of the paper, namely the relationship between market size $\star$ on the one hand, and ¯rm turnover and the age distribution of ¯rms on the other. We also consider the relationship between market size and the number of active ¯rms.

Measuring ¯rm turnover. A natural measure of (relative) ¯rm turnover is the ratio between the mass of new entrants and the total mass of active ¯rms in each period. This suggests de¯ning the turnover rate $\star$ as

$$\star \, \acute{} \, \frac{\star}{\star([0\star1])}\star$$

where the denominator is the mass of active ¯rms at stage 4, and the numerator is the mass of ¯rms that have entered at stage 1 of the same period.

Using (D), the turnover rate in the stationary equilibrium can be written as

$$\star = (1 \, {}_{\text{¡}} \, \star)\frac{1 \, {}_{\text{¡}} \, \star(\star^{\text{¤}})}{\star(\star^{\text{¤}})}\star \tag{11}$$

That is, given persistence $\star$, there is a monotonically decreasing relationship between the equilibrium exit policy $\star^{\text{¤}}$ and the turnover rate $\star$. The monotonicity of the relationship between $\star^{\text{¤}}$ and $\star$ not only holds for the simple Markov process (1) considered here, but for a large class of Markov processes, as we will show in Section 6.

Age distribution of ¯rms. In a stationary equilibrium, ¯rms' exit policy shapes the age distribution of ¯rms in a market. Let $\flat$ denote the (average) probability of exit of incumbents. In stationary equilibrium, $\flat = (1 \, {}_{\text{¡}} \, \star)[1 \, {}_{\text{¡}} \, \star(\star^{\text{¤}})] = \star(\star^{\text{¤}})\star$.[17] We introduce the convention that the age of a newly entered ¯rm (which is still active at the output stage) is one. Conditional on not leaving the market in the period of entry, the probability that a ¯rm will survive until it reaches age $\star$ is then equal to $(1 \, {}_{\text{¡}} \, \flat)^{\star_{\text{¡}} 1}$. Consequently, the share of active ¯rms whose age is less than or equal to $\star$ is given by

$$\star(\star j\star^{\text{¤}}) \, \acute{} \, \frac{\mathbf{P}_{\star_{\text{¡}} 1}^{}{}_{\star=0}(1 \, {}_{\text{¡}} \, \flat)^{\star}}{\mathbf{P}_{\star=0}^{1}(1 \, {}_{\text{¡}} \, \flat)^{\star}} = 1 \, {}_{\text{¡}} \, (1 \, {}_{\text{¡}} \, \flat)^{\star}\star$$

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[17] The exit probability $\flat$ is another natural measure of ¯rm turnover. The main results of the paper are not sensitive to the particular choice of turnover measure.

which is strictly decreasing in $\star^{\pi}$. Hence, a decrease in exit policy $\star^{\pi}$ shifts the age distribution towards younger ¯rms in the sense of ¯rst-order stochastic dominance. In Section 6, we show that this stochastic dominance result holds much more generally for a large class of Markov processes.

Entry costs and ¯rm turnover. Having de¯ned a measure of ¯rm turnover, we can now analyze the e®ects of changes in the parameters of the model on the turnover rate. Let us begin by looking at the e®ect of an increase in the level of entry costs.

Proposition 4 An increase in the entry cost $\star$ leads to an increase in exit policy $\star^{\pi}$, and hence to a lower turnover rate $\star$ and a shift in the age distribution of ¯rms towards older ¯rms. Furthermore, it causes the distribution of active ¯rms, $\star$, and the mass of entrants per period, $\star$, to decrease.

Proof. Starting from a stationary equilibrium with simultaneous entry and exit, denoted by $(\star_0 \star \star_0 \star \star_0^{\pi})$, we consider an increase in the entry cost from $\star_0$ to $\star_1 \star \star_0$. Let us assume that there is still a positive turnover rate in the new stationary equilibrium $(\star_1 \star \star_1 \star \star_1^{\pi})$, i.e., $\star_1 \star 0$. (The proposition holds trivially if $\star_1 = 0$.) From (8) and (9), it is easy to see that

$$\overline{\star}^* (\star; \star_0; \star_1) \star \overline{\star}^* (\star; \star_0; \star_0) \text{ for all } \star \ 2 \ [0 \star 1] \star$$

abusing notation by inserting argument $\star$ into the value function $\overline{\star}^*$, as de¯ned by (9). Hence, for condition (E) to hold in the new stationary equilibrium, we must have $\star_1 \ \acute{A} \ \star_0$. Since $\star_1 \ \acute{A} \ \star_0$ and $\star_1 \star \star_0$, we must have $\star_1^{\pi} \star \star_0^{\pi}$ for condition (X) to hold:

$$\star \star (\star_0^{\pi}; \star_1) \ \dot{\imath} \ \star + \star (1 \ \dot{\imath} \ \star) \star_1 \quad \star \quad \star \star (\star_0^{\pi}; \star_0) \ \dot{\imath} \ \star + \star (1 \ \dot{\imath} \ \star) \star_0$$
$$= \quad 0$$
$$= \quad \star \star (\star_1^{\pi}; \star_1) \ \dot{\imath} \ \star + \star (1 \ \dot{\imath} \ \star) \star_1 \star$$

$\star$ From (11), we thus obtain $\star_1 \star \star_0$. To see that $\star_{1} \star \star_{0}$, notice that $\star_1 \ \acute{A} \ \star_0$ and $\star_1^{\pi} \star \star_0^{\pi}$, in conjunction with (DOM), imply that $\star_1 ([0 \star \star_0^{\pi}]) \star \star_0 ([0 \star \star_0^{\pi}])$. Using (D), the result follows. ∎

The assertion of the proposition may be roughly explained as follows. Both the marginal incumbent (with cost level $\star^{\pi}$) and the new entrant have a value of zero in equilibrium. However, since incumbents have already sunk the entry cost, the average entrant has to be more e±cient than the marginal incumbent. Clearly, this wedge in e±ciency is increasing in the level of entry costs. That is, exit policy $\star^{\pi}$ increases with $\star$. This, in turn, implies, that the hazard rate of incumbents is negatively related to the level of entry costs. A more formal explanation is the following. For any exit policy $\star^{\pi}$ and distribution $\star$, an increase in entry cost $\star$ reduces the value of an entrant; that is, the curve $\overline{\star}^*$ in Figure 1 shifts downwards. For the entry condition (E) to hold in the new equilibrium, the distribution of active ¯rms must be smaller. This implies that the net pro¯t $\star \star (\star; \star) \ \dot{\imath} \ \star$ of any type $\star$ goes up. This e®ect is reinforced by the fact that the option value of staying in the market rises with the level of entry cost. Hence, the value of the marginal incumbent in the initial equilibrium is now positive. This imply that the marginal incumbent is less e±cient in the new equilibrium. Hopenhayn (1992) derived the same prediction in a model with perfect competition. A corollary of this result is that, in markets with higher entry costs, ¯rms are on average less e±cient, while the induced intensity of price competition is lower (in that the induced measure $\star$ is smaller in the sense of our ordering on measures).

Fixed costs and ¯rm turnover. Next, we analyze the e®ect of a change in $\star$, which may be interpreted as a ¯xed production cost or as an opportunity cost. The following proposition summarizes our results.

Proposition 5 Suppose assumption A.1 holds. Then, an increase in the ¯xed (or opportunity) cost $\star$ leads to a decrease in exit policy $\star^{\pi}$, and hence to a higher turnover rate $\star$ and a shift in the age distribution towards younger ¯rms. Furthermore, it causes the distribution of active ¯rms, $\star$, and the total mass of active ¯rms, $\star ([0 \star 1])$, to decrease.

Proof. Starting from a stationary equilibrium with simultaneous entry and exit, denoted by $(\star_0 \star\star_0 \star\star_0^{\mathrm{n}})$, we consider an increase in $\star$ from $\star_0$ to $\star_1$, $\star_1 \star \star_0$. Assume that there is still a positive turnover rate in the new stationary equilibrium $(\star_1 \star\star_1 \star\star_1^{\mathrm{n}})$, i.e. $\star_1 \star 0$. From entry condition (E), it follows that

$$\overline{\star}^{*}(\star^{\mathrm{n}}; \star_0; \star_1) \star \overline{\star}^{*}(\star^{\mathrm{n}}; \star_0; \star_0) \text{ for all } \star^{\mathrm{n}} 2 (0 \star 1] \star$$

and $\overline{\star}^{*}(0; \star_0; \star_1) = \overline{\star}^{*}(0; \star_0; \star_0)$. This implies that we must have $\star_1 \mathrm{\acute{A}} \star_0$ for (E) to hold again in the new stationary equilibrium. We now claim that $\star_1^{\mathrm{n}} \star \star_0^{\mathrm{n}}$. To see this, suppose otherwise that $\star_1^{\mathrm{n}} \, \star_0^{\mathrm{n}}$. According to condition (X),

$$\star\star(\star_1^{\mathrm{n}}; \star_1) \, \mathrm{i} \, \star_1 + \star(1 \, \mathrm{i} \, \star)\star = 0 = \star\star(\star_0^{\mathrm{n}}; \star_0) \, \mathrm{i} \, \star_0 + \star(1 \, \mathrm{i} \, \star)\star\star$$

which implies that $\star\star(\star_0^{\mathrm{n}}; \star_1) \, \mathrm{i} \, \star_1 \, \, \star\star(\star_0^{\mathrm{n}}; \star_0) \, \mathrm{i} \, \star_0$. Assumption A.1 then ensures that

$$\star\star(\star; \star_1) \, \mathrm{i} \, \star_1 \star \star\star(\star; \star_0) \, \mathrm{i} \, \star_0 \text{ for all } \star 2 [0 \star \star_0^{\mathrm{n}}). \tag{12}$$

Thus, we obtain

$$\overline{\star}^{*}(\star_1^{\mathrm{n}}; \star_1; \star_1) \quad \, \quad \overline{\star}^{*}(\star_0^{\mathrm{n}}; \star_1; \star_1)$$
$$\star \quad \overline{\star}^{*}(\star_0^{\mathrm{n}}; \star_0; \star_0)$$
$$= \quad 0 \star$$

where the ﬁrst inequality follows from the fact that $\overline{\star}^{*}(\mathrm{\cent}; \star_1; \star_1)$ assumes a maximum at $\star_1^{\mathrm{n}}$, and the second inequality from (12). Now, $\overline{\star}^{*}(\star_1^{\mathrm{n}}; \star_1; \star_1) \star 0$ cannot hold as it is in contradiction with (E). That is, we must have $\star_1^{\mathrm{n}} \star \star_0^{\mathrm{n}}$. Finally, notice that, from (11), the turnover rate decreases monotonically with $\star^{\mathrm{n}}$, holding $\star$ ﬁxed. Let us now show that we must indeed have $\star_1 \star 0$ (as assumed above), given that $\star_0 \star 0$. Deﬁne $\star_0^0$ and $\star_1^0$ by $\overline{\star}^{*}(1; \star_0^0; \star_0) = 0$ and $\overline{\star}^{*}(1; \star_1^0; \star_1) = 0$, respectively. (In the proof of Proposition 2, we have already shown that such measures exist.) It is easy to see that $\star_1 \star \star_0$ implies $\star_1^0 \mathrm{\acute{A}} \star_0^0$. Since $\star_0 \star 0$ by assumption, we have $\overline{\star}^{*}(\star^{\mathrm{n}}; \star_0^0; \star_0) = 0$ for some $\star^{\mathrm{n}} 2 (0 \star 1)$. From assumption A.1, $\star_1^0 \mathrm{\acute{A}} \star_0^0$, and $\star_1 \star \star_0$, we get $\overline{\star}^{*}(\star^{\mathrm{n}}; \star_1^0; \star_1) \star \overline{\star}^{*}(\star^{\mathrm{n}}; \star_0^0; \star_0)$ for all $\star^{\mathrm{n}} 2 (0 \star 1)$. This concludes the proof of the assertion on turnover. The result on the total mass of active ﬁrms follows immediately from $\star_1 \mathrm{\acute{A}} \star_0$ and $\star_1^{\mathrm{n}} \star \star_0^{\mathrm{n}}$ (and (DOM)). ∎

Holding ﬁxed the distribution of active ﬁrms, an increase in the ﬁxed cost $\star$ shifts the curve $\overline{\star}^{*}$ downwards (see Figure 1): for any exit policy, the value of an entrant decreases. Since the equilibrium value of an entrant is zero, this implies that, in the new equilibrium, the measure of active ﬁrms $\star$ is smaller (in terms of our ordering on measures). Hence, there are two opposing eﬀects on an incumbent's net proﬁt $\star\star(\star; \star) \, \mathrm{i} \, \star$. On the one hand, the increase in ﬁxed cost $\star$ reduces the net proﬁt of all types by the same amount. On the other hand, the endogenous decrease in $\star$ reduces the intensity of price competition. All ﬁrms beneﬁt from the higher equilibrium prices, but (A.1 ensures that) less eﬃcient ﬁrms gain less in absolute terms. For the entry condition (E) to continue to hold, the overall eﬀect on proﬁt must be positive for the most eﬃcient ﬁrms, and negative for the least eﬃcient active ﬁrms. In particular, the increase in ﬁxed cost must decrease the proﬁt of the marginal incumbent in the initial equilibrium. Hence, the exit policy $\star^{\mathrm{n}}$ decreases with $\star$, which implies the predicted negative relationship between the ﬁxed cost $\star$ and turnover rate $\star$. Note that, in markets with higher ﬁxed costs, the distribution of ﬁrm types is shifted towards more eﬃcient ﬁrms, while the induced intensity of price competition is lower (in that $\star$ is smaller in the sense of our ordering on measures). That is, if one were to correlate observable price-cost margins with the average eﬃciency level, one would ﬁnd a positive cross-sectional correlation (assuming markets only diﬀered in their level of ﬁxed costs).

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

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Proposition 6 Suppose assumption A.2 holds. Then, an increase in market size $\star$ leads to a decrease in exit policy $\star^{\scriptscriptstyle\square}$, and hence to a rise in the turnover rate $\star$ and a shift in the age distribution of ¯rms towards younger ¯rms. Furthermore, an increase in market size causes the distribution of active ¯rms, $\star$, and the mass of entrants per period, $\star$, to rise.

Proof. Starting from a stationary equilibrium with simultaneous entry and exit, denoted by $(\star_0\star\star_0\star\star_0^{\scriptscriptstyle\square})$, we consider an increase in the size of the market from $\star_0$ to $\star_1 \star \star_0$. Let us assume that there is still a positive turnover rate in the new stationary equilibrium $(\star_1\star\star_1\star\star_1^{\scriptscriptstyle\square})$, i.e., $\star_1 \star$ 0. (It is straightforward to show that turnover must indeed be positive in the new equilibrium, given that $\star_0 \star$ 0. The argument is similar to that in the proof of Proposition 5, replacing assumption A.1 by A.2.) The proof proceeds in several steps. First, notice that

$$\overline{\star}^{*}(\star;\star_0;\star_1) \star \overline{\star}^{*}(\star;\star_0;\star_0) \text{ for all } \star \text{ 2 } (0\star1]\star$$

and $\overline{\star}^{*}(0;\star_0;\star_1) = \overline{\star}^{*}(0;\star_0;\star_0)$. For entry condition (E) to hold in the new equilibrium, we thus need $\star_1 \,\hat{A}\, \star_0$. Second, suppose there exists a $\star$, $\star$ 2 $(0\star\overline{\star}(\star_1))$ such that $\star_1\star(\star;\star_1) = \star_0\star(\star;\star_0)$. Assumption A.2 then implies that $\star_1\star(\star;\star_1) \star \star_0\star(\star;\star_0)$ for all $\star$ 2 $[0\star\star)$, and the reverse inequality for all $\star$ 2 $(\star\star\overline{\star}(\star_1))$. Third, assume the assertion of the proposition does not hold, and so $\star_1^{\scriptscriptstyle\square} \,{}_{\raisebox{-2pt}{\tiny\text{,}}}\, \star_0^{\scriptscriptstyle\square}$. Then,

$$\star_1\star(\star_1^{\scriptscriptstyle\square};\star_1) \;=\; \star_0\star(\star_0^{\scriptscriptstyle\square};\star_0)$$
$$\phantom{\star_1\star(\star_1^{\scriptscriptstyle\square};\star_1) \;=\;}{}_{\raisebox{-2pt}{\tiny\text{,}}}\; \star_0\star(\star_1^{\scriptscriptstyle\square};\star_0)\star$$

where the equality follows from condition (X). From A.2 we then obtain

$$\star_1\star(\star;\star_1) \star \star_0\star(\star;\star_0) \text{ for all } \star \text{ 2 } [0\star\star_1^{\scriptscriptstyle\square}) \tag{13}$$

Consequently,

$$\overline{\star}^{*}(\star_1^{\scriptscriptstyle\square};\star_1;\star_1) \;\;{}_{\raisebox{-2pt}{\tiny\text{,}}}\;\; \overline{\star}^{*}(\star_0^{\scriptscriptstyle\square};\star_1;\star_1)$$
$$\star \;\; \overline{\star}^{*}(\star_0^{\scriptscriptstyle\square};\star_0;\star_0)$$
$$=\;\; 0\star$$

where the ¯rst inequality follows from the fact that $\overline{\star}^{*}(\mathbb{C};\star_1;\star_1)$ is maximized at $\star_1^{\scriptscriptstyle\square}$, and the second inequality from (13). Thus, entry condition (E) cannot hold in the new equilibrium: a contradiction. Consequently, we must have $\star_1^{\scriptscriptstyle\square} \star \star_0^{\scriptscriptstyle\square}$, and hence $\star_1 \star \star_0$. It is worth mentioning that $\star$ exists and is in $(0\star\star_0^{\scriptscriptstyle\square})$; otherwise (E) would be violated. Finally, let us consider the e®ect of the increase in market size on the mass of ¯rms that enter each period. Since $\star_1 \,\hat{A}\, \star_0$ and $\star_1^{\scriptscriptstyle\square} \star \star_0^{\scriptscriptstyle\square}$, we obtain (using (DOM)) $\star_1 ([0\star\star_1^{\scriptscriptstyle\square}]) \star \star_0 ([0\star\star_0^{\scriptscriptstyle\square}])$, and hence, using (D), $\star_1 \star \star_0$. ∎

    The result may be explained as follows. In a free entry equilibrium, the measure of active ¯rms, $\star$, is positively related to market size. Holding the distribution of active ¯rms ¯xed, an increase in market size raises the value of ¯rms for any exit policy. Graphically, this means that the curve $\overline{\star}^{*}$ in Figure 1 shifts upwards. Free entry then implies that the measure of ¯rms has to increase with market size. This shifts the curve $\overline{\star}^{*}$ downwards. Hence, there are two opposing e®ects on a ¯rm's gross pro¯t $\star\star(\star;\star)$. On the one hand, the rise in market size $\star$ increases the pro¯ts of all ¯rms proportionally. This can be thought of as an increase in output levels, holding prices ¯xed. On the other hand, as the distribution of ¯rms increases, prices (and, hence, price-cost margins) fall. A.2 implies that the percentage decrease in pro¯t from an increase in $\star$ is greater the less e±cient is the ¯rm. Hence, if there is some type for which the value remains unchanged, then the value of all better types increases, and that of all worse types decreases. Since the equilibrium value of an entrant is zero, independently of

market size, there must be some types in [0★★$^{¤}$], which are worse o® in the larger market. In particular, the marginal incumbent in the smaller market would have a negative value in the larger market if it decided to use the same exit policy as before. This implies that the marginal surviving ¯rm has to be more e±cient in larger markets. That is, exit policy ★$^{¤}$ is decreasing with market size. The hazard rate of the average incumbent ¯rm is therefore higher in larger markets: ¯rm turnover and market size are positively correlated. An immediate consequence is that the age distribution of ¯rms in a smaller market ¯rst-order stochastically dominates that in a larger market. Moreover, in larger markets, the distribution of ¯rm types is shifted towards more e±cient ¯rms, while the induced intensity of price competition is higher (in that ★ is greater in the sense of our ordering on measures). That is, if one were to correlate observable price-cost margins with the average e±ciency level of active ¯rms, one would ¯nd a negative cross-sectional correlation (assuming markets only di®ered in their size).

It is important to point out that our prediction on market size and ¯rm turnover (Proposition 6) would not obtain in a model of perfect competition (as in Hopenhayn (1992)) or in a Dixit-Stiglitz type model of monopolistic competition (as in Melitz (1999)). The reason is that, in these models, the price competition e®ect is absent, which implies that equilibrium price-cost margins are independent of market size.

Let us illustrate this in a model of a homogenous goods industry with perfect competition. In such a model, the gross pro¯t of a type-★ ¯rm may be written as ★ (★; ★), where ★ is the equilibrium price. Market size enters the pro¯t function only indirectly through ★. The value of a type-★ incumbent at stage 4 may then be denoted by ★ (★; ★). Under weak assumptions, ★ (★; ★) is strictly increasing in ★ for all ★ 2 [0★★$^{¤}$], where ★$^{¤}$ is the optimal exit policy, given price ★. Furthermore, ★ (★; ★) ★ 0 for all ★ 2 [0★★$^{¤}$), and ★ (★; ★) = 0 for all ★ 2 [★$^{¤}$★1]. The entry condition for a stationary equilibrium is given by

$$\int_0^1 ★ (★; ★)★ (★★) \text{¡} ★ = 0★$$

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

The reasoning in the proof of Proposition 6 shows that e±cient ¯rms make higher pro¯ts in larger markets, and hence are more valuable. In contrast, less e±cient ¯rms are better o® in smaller markets. That is, the distribution of pro¯ts and ¯rm values is more \dispersed" in larger markets, while the distribution of e±ciency levels is less \dispersed". The e®ect on pro¯ts is illustrated graphically in Figure 2.

Corollary 1 The range of pro¯ts and ¯rm values across active ¯rms in the same market is increasing with market size. Formally, ¢★(★) ´ ★★(0; ★) ¡ ★★(★$^{¤}$; ★) and ¢★ (★) ´ ★ (0) ¡ ★ (★$^{¤}$) are increasing with ★.

Proof. Exit condition (X) implies that ★★(★$^{¤}$; ★) = ★ ¡ ★(1 ¡ ★)★, and hence ¢★($★_1$) ¡ ¢★($★_0$) = $★_1$★(0; $★_1$) ¡ $★_0$★(0; $★_0$), using the same notation as in the proof of Proposition 6. For $★_1$ ★ $★_0$ (and, therefore, $★_1$ Â $★_0$), the last expression is strictly positive since ★ ★ 0. Similarly, ★ (★$^{¤}$) = 0, and hence ¢★ (★) = ★ (0). Using (8) and ★★ 0, one obtains the result. ■

Market size and the number of active ¯rms: price competition and selection e®ects. Under the assumption that ¯rms within a market are identical (or, more generally, that the distribution of ¯rm e±ciencies is independent of market characteristics), Bresnahan and Reiss (1991) use the relation between the number of ¯rms and market size to back out parameters in a reduced form pro¯t function. Examining the extent to which the market size per ¯rm increases in the number of ¯rms, they are able to infer how competition changes with the number of ¯rms. Later studies (e.g., Asplund and Sandin (1999) and Campbell and Hopenhayn (2002)) have con¯rmed Bresnahan and Reiss' initial ¯nding that

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an increase in market size leads to a less-than-proportionate increase in the number of active firms. In our model, however, firms are heterogeneous, and the endogenous distribution of efficiencies depends on characteristics such as market size. Let us therefore reconsider the size-structure relationship in our model.

Consider the following thought experiment: increase market size (through replication of the population of consumers) by a factor $\lambda > 1$, and scale up the population of firms by the same factor (in that the measure of firm types changes from μ to $\lambda\mu$). Standard models of imperfect competition (such as the Cournot model, the linear demand model, or Hotelling type models of localized competition) have the property that this simultaneous change in market size and the population of firms decreases the profit of any given firm type. This property has sometimes been called the price competition effect (Sutton (1997a)) as it is a consequence of the negative impact of an increase in the population of firms on equilibrium prices (and hence price-cost margins) in standard models.

A.3 For any $\lambda > 1$, $\lambda\pi(c; \lambda\mu) < \pi(c; \mu)$ for all $c \in [0, \bar{c}(\mu))$.

That is, scaling up market size and the population of firms by the same factor reduces the profit of all types. In our model, an increase in market size causes an endogenous increase in the population of firms, which in turn makes competition more intense in the sense that it reduces price-cost margins. As a result, firms use a tougher exit policy in the larger market, and hence are on average more efficient. That is, the competition effect induces a selection effect. What is then the prediction of our model on the relationship between market size and the total mass of active firms? Does the selection effect reinforce or counteract the price competition effect?

Proposition 7 Suppose assumptions A.2 and A.3 hold. Then, an increase in market size from μ_0 to $\mu_1 > \mu_0$ induces a less-than-proportionate increase in the mass of active firms: $\mu_1([0,1])/\mu_0([0,1]) < \mu_1/\mu_0$.

Proof. Suppose the assertion does not hold. Then, $\mu_{10} \geq \mu_1/\mu_0$, where $\mu_{10} \equiv \mu_1([0,1])/\mu_0([0,1])$. In the stationary equilibrium, firms are endogenously more efficient in larger markets (in the sense of first-order stochastic dominance), as shown in our previous analysis. Assumption (DOM) then implies that $\mu_1 \tilde{A} \mu_{10}\mu_0$; that is, competition is more intense in the larger market than in the smaller market even if we scale the distribution of types in the smaller market such that the total mass of active firms is the same in both markets. Similarly, since we assume $\mu_{10} \geq \mu_1/\mu_0$, (DOM) further implies that $\mu_{10}\mu_0 \geq (\mu_1/\mu_0)\mu_0$. For all $c \in [0, \bar{c}(\mu_0))$, we obtain

$$\mu_1\pi(c; \mu_1) < \mu_1\pi(c; \mu_{10}\mu_0) \cdot \mu_1\pi(c; (\mu_1/\mu_0)\mu_0) < \mu_0\pi(c; \mu_0),$$

where the last inequality follows from assumption A.3 (the price competition effect). That is, all firms make lower profits in the larger and endogenously more competitive market. This is inconsistent with equilibrium, however, since the value of an entrant must be the same in both markets. Indeed, as we have seen in our previous analysis, while more efficient firms do indeed earn higher profits in the larger market, some less efficient firms earn higher profits in the smaller market. ∎

The mass of active firms per unit of market size, $\mu([0,1])/\mu$, is decreasing with market size. This proposition shows that the well-known relationship between market size and the number of firms when firms are identical carries over to our model, where firms are heterogeneous and the distribution of efficiencies changes endogenously with market size. In fact, the selection effect reinforces the price competition effect: an increase in average efficiency (holding the mass of firms constant) reduces the profit of any given type and hence the expected profit of a new entrant; as a result, fewer firms find it profitable to enter the market. This insight suggests that the existing empirical studies (which implicitly assume that the distribution of firms efficiencies is independent of market size) overestimate the pure price-competition effect. However, the selection effect is induced by the price-competition effect: if price-cost margins were independent of the population of firms, the distribution of firm efficiencies would be

independent of market size. Note that this implies that this selection e®ect of market size is absent in models of perfect competition and Dixit-Stiglitz type models.[18]

Cost persistence and ¯rm turnover. What is the e®ect of changes in the persistence of costs, as measured by parameter $\star$, on the turnover rate? In the ¯rst discussion paper version of this paper (Asplund and Nocke (2000)), we show that an increase in $\star$ has two opposing e®ects on the turnover rate $\star$: the ¯rst term in (11), $(1 \mathbin{\text{¡}} \star)$, clearly decreases with $\star$, but the second term, $[1 \mathbin{\text{¡}} \star(\star^{\scriptscriptstyle\square})] \star\star(\star^{\scriptscriptstyle\square})$, is positively correlated with $\star$. (The intuition for the latter observation is the following. The marginal incumbent makes a negative net pro¯t, $\star\star(\star^{\scriptscriptstyle\square};\star) \mathbin{\text{¡}} \star\star 0$, and is only in the market because of the prospect of lower costs in the future (\option value"). An increase in the persistence of costs decreases the value of this option, and so the marginal incumbent has to be more e±cient.) The overall e®ect on $\star$ is ambiguous.[19]

For empirical work, this has important implications. In a cross-industry study of ¯rm turnover, it is likely to be di±cult to control for di®erences in the stochastic process governing the evolution of ¯rms' e±ciencies or consumers' tastes (such as the persistence parameter $\star$). To minimize measurement problems in this dimension, in Section 7, we analyze turnover rates across independent local markets within the same industry.

5   Growing and Declining Markets

Intuitively, one may expect entry rates to be high in periods of market growth and low in periods of decline. Conversely, exit rates would be low when markets are growing and high when markets are shrinking. This intuition is not correct. The aim of this section is to analyze entry and exit rates when market size changes over time. In nonstationary markets, entry and exit rates will, in general, be di®erent. Hence, our previous analysis of stationary markets does not carry over. We now show that, even in nonstationary markets, both entry and exit rates tend to be positively correlated with the level of market size. Holding (current) market size ¯xed, however, entry rates will tend to be higher in growing than in declining markets.

The exogenous evolution of market size is summarized by the deterministic sequence $f\star_\star g$, which is common knowledge to all ¯rms. 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 su±ciently small so that there is simultaneous entry and exit in each period along the equilibrium path. Moreover, we simplify the analysis further by assuming $\star = 0$; that is, in each period, all incumbents get a new draw from distribution $\star$ (¢).

The value function of an incumbent at the period-$\star$ exit stage is given by

$$\star_\star(\star) = \max \left(0 \star\star_\star \star(\star;\star_\star) \mathbin{\text{¡}} \star + \star \int_0^{\star^{\scriptscriptstyle\square}_{\star+1}} \star_{\star+1}(\star)\star(\star\star) \right) \star$$

where $\star_\star$ is the distribution of active ¯rms at the period-$\star$ output stage, and $\star^{\scriptscriptstyle\square}_{\star+1}$ the exit policy in $\star+1$. The value of an entrant at the beginning of period $\star$ can be written as

$$\star_\star^\star = \int_0^1 \star_\star(\star)\star(\star\star) \mathbin{\text{¡}} \star.$$

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[18]Our model implies that the measure of active ¯rms $\star$ increases with market size $\star$ in terms of our ordering on measures. Without imposing further assumptions, it does not, however, imply that the mass of active ¯rms, $\star([0\star1])$, increases with market size. Since the average e±ciency of ¯rms increases with market size (as $\star^{\scriptscriptstyle\square}$ is negatively related to $\star$), the total mass of active ¯rms may actually decrease with an increase in market size.

[19]However, an increase in $\star$ has an unambiguously negative e®ect on the exit probability $\flat$ (which does not keep track of those entrants that leave immediately after learning their current type).

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., $\chi_t^\pi < 1$ and $\mu_t > 0$ for all t. Consequently, the value of an entrant and the value of the marginal incumbent are always zero: $\nu_t^e = 0$ and $\nu_t(\chi_t^\pi) = 0$ for all t. The entry and exit conditions can then be expressed as

$$\int_0^{\chi_t^\pi} [\pi_t (\epsilon; y_t) \; \lrcorner \; c + \beta \Omega] \, d\Phi(\epsilon) \; \lrcorner \; \kappa = 0 \qquad (E_t)$$

and

$$\pi_t (\chi_t^\pi; y_t) \; \lrcorner \; c + \beta \Omega = 0 \qquad (X_t)$$

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

$$\mu_t([0, x]) = [\mu_t + \nu_{t-1}([0, 1])] \, \Phi (\min \{x, \chi_t^\pi\}) , \; 8x 2 [0, 1] \qquad (D_t)$$

The term in brackets gives the total mass of firms at the beginning of the period-t exit stage: the sum of the mass of new entrants, μ_t, and the mass of incumbents, $\nu_{t-1}([0, 1])$. Each of these firms gets a draw from distribution function $\Phi (\epsilon)$, and thus stays in the market with probability $\Phi (\chi_t^\pi)$. As before, the equilibrium measure ν_t is an element of M^π. Given the mass of initially active firms, equilibrium is described by the sequence $\{\nu_t, \chi_t^\pi\}$ satisfying equations (E_t), (X_t), and (D_t) for all t.

We define the entry rate to be "forward looking", and the exit rate to be "backward looking". The period-t entry rate, η_t, is the ratio between period-t entrants and the mass of active firms at the period-t output stage. Formally,[20]

$$\eta_t \; \acute{} \; \frac{\mu_t}{\nu_t([0, 1])} \star$$

The period-t exit rate, ξ_t, is the share of firms active in period $t - 1$, which leave the market in period t. That is,

$$\xi_t \; \acute{} \; \frac{[1 \; \lrcorner \; \Phi (\chi_t^\pi)] \nu_{t-1} ([0, 1])}{\nu_{t-1} ([0, 1])}$$
$$= 1 \; \lrcorner \; \Phi (\chi_t^\pi) \star$$

Note 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 Ω, 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 $\kappa = 0$, and c and π 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, χ_t^π and the equivalence class of ν_t are uniquely defined by (E_t) and (X_t). In particular, they are independent of future and past values of market size. Applying Proposition 6, we obtain that the exit policy χ_t^π is decreasing in current market size y_t. According to (D_t), the stationary distribution in period t is given by the distribution function $\Phi (\epsilon)$, truncated at χ_t^π, and scaled by $\mu_t + \nu_{t-1}([0, 1])$. Consequently, conditions (E_t) and (X_t) also pin down the scaling factor, and hence the total mass of active firms, $\nu_t([0, 1])$. Thus, condition (D_t) uniquely determines the mass of new entrants, μ_t, as a

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[20]Again, we could use $\tilde{\eta}_t \; \acute{} \; \Phi (\chi^\pi) \eta_t$ as an alternative measure, which does not keep track of those entrants that exit immediately after learning their current efficiency.

function of $\star_{\star_i}$ 1 ([0*1]) and $\star_\star$. More speci¯cally, since $(E_\star)$ and $(X_\star)$ pin down $\star_{\ \star} + \star_{\star_i}$ 1 ([0*1]), any change in the mass of last period's active ¯rms will be exactly o®set by a change in this period's mass of entrants (again, provided there is some entry and exit in all periods).

We are now in the position to state our two main results on ¯rm turnover when market size changes over time. First, we consider a given sequence f$\star$g, and analyze the e®ect of changing market size in a single period. Then, we analyze the co-movements between f$\star_\star$g, f$\star_\star$g, and f$\star_\star$g.

Proposition 8 Consider two sequences of market size, f$\star_\star$g and f$\star_\star^0$g, where $\star_\star \star \star_\star^0$, and $\star_\star = \star_\star^0$ for all $\star \mathbf{6} \star$. Then, the resulting equilibrium sequences of entry rates are such that $\star_\star = \star_\star^0$ for all $\star\star \star$ and $\star\star \star + 1$, $\star_\star \star \star_\star^0$, and $\star_{\star+1} \star \star_{\star+1}^0$ if and only if $\star_\star$ ([0*1]) $\star \star_\star^0$ ([0*1]). Equilibrium exit rates are characterized by $\star_\star = \star_\star^0$ for all $\star \mathbf{6} \star$, and $\star_\star \star \star_\star^0$.

Proof. See Appendix. ∎

Corollary 2 Consider an arbitrary sequence of market size, f$\star_\star$g. In equilibrium, exit rates are positively correlated with current market size. More precisely, $\star_\star$ is increasing in $\star_\star$, and independent of $\star_\star$, $\star \mathbf{6} \star$. Equilibrium entry rates are positively related to current market size, too, but only if controlling for last period's market size: holding $\star_{\star_i}$ 1 ¯xed, entry rate $\star_\star$ is increasing in $\star_\star$, and independent of $\star_\star$, $\star \mathbf{6} \star\star_i$ 1. Moreover, holding $\star_\star$ ¯xed, $\star_\star$ is negatively correlated with the mass of active ¯rms in $\star_i$ 1.

>From the dynamic entry and exit conditions, $(E_\star)$ and $(X_\star)$, the exit policy $\star_\star^\pi$ and the mass of active ¯rms, $\star_\star$([0*1]), is a function of current market size $\star_\star$, and independent of past and future market size. From our analysis of stationary markets, we then know that $\star_\star^\pi$ is decreasing in $\star_\star$. Consequently, the exit rate $\star_\star$ is increasing in $\star_\star$. From our previous analysis, we also know that the measure of currently active types $\star_\star$ is increasing in $\star_\star$ (in terms of our ordering on measures). Given that the mass of incumbents, $\star_{\star_i}$ 1([0*1]), is independent of $\star_\star$, it follows that the mass of new entrants, $\star_{\ \star}$, must be positively related with $\star_\star$. Furthermore, since ¯rms use a tougher exit policy in larger markets, an increase in current market size must cause $\star_{\ \star}$ to raise by a larger fraction that the total mass of active ¯rms, $\star_\star$([0*1]) = [$\star_{\ \star} + \star_{\star_i}$ 1([0*1])] $\star$ ($\star_\star^\pi$). That is, the entry rate $\star_\star$ must increase with $\star_\star$, holding $\star_{\star_i}$ 1 (and hence $\star_{\star_i}$ 1([0*1])) ¯xed.

Note the asymmetry between entry rates in growing and declining markets. If market size and the mass of active ¯rms (i.e., $\star_\star$ and $\star_\star$([0*1])) are positively correlated, as one would intuitively expect, then entry rates will be higher in growing than in declining markets, holding ¯xed the level of market size: given $\star_\star$, $\star_\star$ is then negatively correlated with $\star_{\star_i}$ 1.

Let us point out that the predictions of Proposition 8 and Corollary 2 would remain unchanged if we assumed that market size followed some stochastic process, and the realization of current market size became common knowledge at the start of each period (prior to entry decisions). The results of this section provide us with a useful benchmark. The caveat to be kept in mind, however, is that they have been obtained under the rather strong assumption that incumbents' cost draws are i.i.d., i.e., $\star = 0$. A more general treatment of growing and declining markets is left for future research.

6 Robustness of Results

In this section, we explore the robustness of our results along two dimensions, namely the sequence of moves and the evolution of ¯rms' e±ciencies. So far, we have assumed that exit decisions take place after incumbents and entrants learn their current type. This gave rise to a simple mathematical structure. Moreover, it captured the observation that, in many markets, a subset of new entrants make initial investments but never reach the production stage and, hence, exit again. The obvious question is

whether our results are sensitive to the sequence of moves. The timing we want to analyze here is as in Hopenhayn's (1992) model. At the ¯rst stage, entry and exit decisions take place. At the second stage, the new entrants and surviving incumbents learn their current type. Finally, the active ¯rms play a market game and receive pro¯ts.

In the main part of this paper, we assumed that the evolution of an incumbent's e±ciency is governed by equation (1). This stochastic process allowed us to obtain simple closed-form solutions for ¯rms' value functions and the stationary distribution, expressed only in terms of the exit policy $\star^\pi$ and the mass of entrants $\star$. We now want to show that the main results of this paper hold more generally for a larger class of Markov processes. This is of particular interest since the simple stochastic process considered so far cannot account for some of the stylized facts regarding the relationship between ¯rm size and ¯rm age on the one hand, and ¯rm growth and survival on the other. For instance, assuming that a ¯rm's output $\star(\star; \star\star)$ is decreasing in marginal cost $\star$, equation (1) implies that the probability of exit, $(1 \text{¡} \star)(1 \text{¡} \star (\star^\pi))$, is independent of an incumbent's size. This is inconsistent with the empirical ¯nding that ¯rm size and failure are negatively correlated (e.g., Evans (1987), Hall (1987), and Dunne, Roberts and Samuelson (1989)). With the class of Markov processes considered here, this and other stylized facts are implied by or consistent with our model.

For brevity of exposition, we change both the timing and the stochastic process in our model, rather than discussing each modi¯cation in turn. Incorporating the new Markov process into the model of Section 2 proceeds in a very similar fashion.

Consider an incumbent of type $\star$. The probability that, in the next period, his marginal cost is less than or equal to $\star^0$ is given by $\star (\star^0 j\star)$. For any $\star^0 2 (0\star1)$, we assume that $\star (\star^0 j\star)$ is strictly decreasing in $\star$. This means that a currently e±cient ¯rm is more likely to be e±cient tomorrow than a currently less e±cient ¯rm; this is formally expressed in terms of ¯rst-order stochastic dominance. Suppose that ¯rm size is measured by output $\star(\star; \star\star)$, which is decreasing in $\star$, and suppose that su±ciently ine±cient ¯rms exit the market, $\star^\pi \star 1$. Then, the probability of survival is increasing with ¯rm size, which is consistent with the empirical evidence. For convenience, we assume that $\star (\cent j\star)$ is strictly increasing on $[0\star1]$, and $\star (\star^0 j\star)$ is continuous in $\star^0$ and $\star$. Moreover, we posit that the distribution of entrants' e±ciencies is given by the distribution of a particular type of incumbent. That is, there exists a cost level $\mathbf{b} 2 (0\star1)$ such that $\star (\cent) \acute \star (\cent j\mathbf{b})$. For some results, we impose a further technical condition, which will be discussed below.

At the entry and exit stage (the new stage 1), the value of an incumbent with previous cost level $\star$ can be written as

$$\star (\star; \star\star) \acute \max \overset{\copyright}{} 0\star\star \overline{} (\star; \star\star) \overset{\mathbf{a}}{} \star$$

where $\overline{\star} (\star; \star\star)$ is the value of the incumbent conditional on staying in the market and behaving optimally thereafter. This conditional value is given by

$$\overline{\star} (\star; \star\star) \acute \overset{Z}{}_{0}^{1} \star (\star^0; \star\star)\star (\star\star^0 j\star)$$

where $\star (\star^0; \star\star) \acute \star\star(\star^0; \star) \text{¡} \star + \star\star (\star^0; \star\star)$ is the value of a ¯rm after learning that its new type is $\star^0$. Similarly, prior to learning his current type, the value of a new entrant is given by

$$\star^\star(\star\star) \acute \overset{Z}{}_{0}^{1} \star (\star; \star\star)\star (\star\star) \text{¡} \star$$
$$= \overline{\star} (\mathbf{b}; \star\star) \text{¡} \star\star$$

Standard arguments in dynamic programming imply that the conditional value $\overline{\star} (\star; \star\star)$ is strictly decreasing in marginal cost $\star$, provided the conditional value of the most e±cient ¯rm is positive,

$\bar{\star}(0;\star\star\star) \star 0$. Furthermore, under the same condition, $\bar{\star}(\star;\star\star\star)$ is strictly decreasing in the measure $\star$ and strictly increasing in market size $\star$.

In a stationary equilibrium with simultaneous entry and exit, where $\star^\alpha \star 1$,

$$\star^{\star}(\star\star\star) = 0 \qquad\qquad (E_\star)$$

and

$$\bar{\star}(\star^\alpha;\star\star\star) = 0\star \qquad\qquad (X_\star)$$

Consequently, if $\star^\alpha \star 1$, the \average entrant" is more e±cient than the marginal incumbent $\star^\alpha$: $\star \star^\alpha$.

Exit policy $\star^\alpha$ and the mass of entrants per period, $\star$, induce a unique stationary distribution. The mass of active ¯rms with costs in $[0\star\star]$ is given by

$$\star([0\star\star]) = \star \star (\star) + \int_0^{\star^\alpha} \star (\star j\star)\star(\star\star)\star 8\star 2 [0\star 1]\star \qquad (D_\star)$$

A stationary equilibrium is a triplet $f\star\star\star \star\star^\alpha g$ satisfying equations $(E_\star)$, $(X_\star)$, and $(D_\star)$. Proving existence and uniqueness of a stationary equilibrium is beyond the scope of this section. Instead, we focus on the main comparative statics results.

The turnover rate is de¯ned by $\star \; \acute{}\; \star \star\star([0\star 1])$. In a stationary equilibrium, we can interpret the total mass of ¯rms active at the output stage in period $\star$ as being the survivors amongst the ¯rms that entered in periods $\star$, $\star$ ¡ 1, $\star$ ¡ 2, $\star$ ¡ 3, and so on. Decomposing the mass of active ¯rms into di®erent cohorts of surviving ¯rms, we obtain

$$\star([0\star 1]) = \star \left[1 + \sum_{\star=1}^{X} \star_\star(\star^\alpha) \right] \star$$

where $\star_\star(\star^\alpha)$ is the probability of surviving $\star$ periods. For $\star \; , \; 1$, this probability is given by

$$\star_\star(\star^\alpha) \; \acute{}\; \int_0^{\star^\alpha}\int_0^{\star^\alpha} \star\star \int_0^{\star^\alpha}\int_0^{\star^\alpha} \star (\star\star_\star j\star\star_\star ¡ 1)\star (\star\star_\star ¡ 1 j\star\star_\star ¡ 2)\star\star\star (\star\star 2 j\star\star 1)\star (\star\star 1)$$

Since $\star\star_\star(\star^\alpha)\star\star\star^\alpha \star 0$, the equilibrium turnover rate $\star = 1\star[1 + \sum_{\star=1}^{1}\star_\star(\star^\alpha)]$ is strictly decreasing with exit policy $\star^\alpha$. Very generally, there is a close relationship between the exit policy $\star^\alpha$ (which acts as an absorbing barrier for the Markov process governing a ¯rm's e±ciency) and the probability distribution of a ¯rm's age at the time of exit: the probability that a ¯rm exits less than or equal to $\star$ periods after entry is given by 1 ¡ $\star_\star(\star^\alpha)$. Hence, an increase in $\star^\alpha$ shifts the probability distribution of a ¯rm's age at exit towards later exit (in terms of ¯rst-order stochastic dominance) and raises the expected life time of a new entrant, $1\star\star = 1 + \sum_{\star=1}^{1}\star_\star(\star^\alpha)$.

What is the e®ect of a change in the exit policy $\star^\alpha$ on the (stationary) age distribution of ¯rms at a given point in time? Let $\star (\cent j\star^\alpha)$ denote the cumulative age distribution function, given that all ¯rms use exit policy $\star^\alpha$. The share of active ¯rms whose age is less than or equal to $\star$ is given by

$$\star (\star j\star^\alpha) = \frac{1 + \sum_{\star=1}^{\star ¡ 1}\star_\star(\star^\alpha)}{1 + \sum_{\star=1}^{1}\star_\star(\star^\alpha)}\star$$

For $\star (\star j\star^\alpha)$ to be decreasing in $\star^\alpha$ for all $\star$, we need to impose a regularity condition on the Markov process.

Proposition 9 Suppose $\star$ and $\star$ are such that the probability that a ¯rm exits $\star \; , \; 1$ periods after entry, conditional on having survived for $\star$ ¡ 1 periods, is decreasing in the exit policy $\star^\alpha$. That is, let the hazard rate $(\star\star_\star ¡ 1(\star^\alpha) ¡ \star_\star(\star^\alpha))\star\star_\star ¡ 1(\star^\alpha)$ be decreasing in $\star^\alpha$. Then, an increase in exit policy $\star^\alpha$ shifts the (stationary) age distribution of ¯rms towards older ¯rms in terms of ¯rst-order stochastic dominance. Formally, $\star (\star j\star^\alpha)$ is decreasing in $\star^\alpha$ for all $\star \; , \; 1$.

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Proof. See Appendix. ∎

We are now in the position to analyze the e®ects of sunk costs and market size on market turbulence. Throughout, we assume that there is simultaneous entry and exit in the initial stationary equilibrium. First, we consider an increase in entry costs from $\star_0$ to $\star_1$. Holding the distribution of active ¯rms ¯xed at $\star_0$, this reduces the value of a new entrant:

$$\overline{\star}(\mathbf{b}; \star_0 \star\star) \; ; \; \star_1 \star \overline{\star}(\mathbf{b}; \star_0 \star\star) \; ; \; \star_0 = 0 \star$$

For the entry condition $(E_\star)$ to hold in the new equilibrium, the distribution of active ¯rms must decrease, i.e. $\star_1 \, \text{Á} \, \star_0$. This raises the conditional value of any ¯rm. In particular, the conditional value of the marginal incumbent in the initial equilibrium is now positive:

$$\overline{\star}(\star_0^{\mathtt{\pi}}; \star_1 \star\star) \star \overline{\star}(\star_0^{\mathtt{\pi}}; \star_0 \star\star) = 0 \star$$

The exit condition $(X_\star)$ then implies that the marginal incumbent is less e±cient in the new equilibrium: $\star_1^{\mathtt{\pi}} \star \star_0^{\mathtt{\pi}}$. Hence, the rise in entry costs causes the equilibrium turnover rate $\star$ to decrease, as predicted by Proposition 4.

Next, we consider the e®ect of an increase in market size from $\star_0$ to $\star_1 \star \star_0$. As before, we assume A.2. In addition, we impose a technical condition on the Markov process. Speci¯cally, the conditional (cumulative) distribution function $\star(\star^0 j \star)$ can be decomposed as a weighted average of two distribution functions:

$$\star(\star^0 j \star) = \star(\star) \underline{\star}(\star^0) + [1 \; ; \; \star(\star)] \overline{\star}(\star^0) \star \tag{14}$$

where the weight $\star(\star) \, 2 \, (0 \star 1)$, is continuous and strictly decreasing in $\star$. The (continuous) distribution functions $\underline{\star}(\mathbb{¢})$ and $\overline{\star}(\mathbb{¢})$ have support $[0 \star\star]$ and $[\star\star 1]$, respectively, where $\star \, 2 \, (0 \star 1)$. That is, $\underline{\star}(\mathbb{¢})$ gives the distribution of \good types", and $\overline{\star}(\mathbb{¢})$ the distribution of \bad types". The more e±cient the ¯rm is currently, the more \likely" it is to get a draw from the good distribution in the future: $\star(\star^0 j \star)$ is decreasing in $\star$. We assume that $\star$ is not too large so that $\star \star \overline{\star}(\star_0)$.

For a given distribution of active ¯rms, the increase in market size raises the value of a new entrant:

$$\star^*(\star_0 \star\star_1) \star \star^*(\star_0 \star\star_0) = 0 \star$$

Hence, the distribution of active ¯rms is increasing with market size; that is, $\star_1 \, \text{Á} \, \star_0$. Assumption A.2 implies that there exists a type $\star \, 2 \, (0 \star\star_0^{\mathtt{\pi}})$ such that all better types have higher current pro¯ts in the larger market, while all worse types have lower pro¯ts (provided they make pro¯ts at all in the smaller market). Moreover, our assumption on the stochastic process ensure that

$$\int_0^{\star} \star_1 \star(\star; \star_1) \underline{\star}(\star\star) \star \int_0^{\star} \star_0 \star(\star; \star_0) \underline{\star}(\star\star) \star$$

and

$$\int_{\star}^{1} \star_1 \star(\star; \star_1) \overline{\star}(\star\star) \star \int_{\star}^{1} \star_0 \star(\star; \star_0) \overline{\star}(\star\star) \star$$

It should be clear that the two inequalities cannot point the same way: if they did, the conditional value of all types would rise (fall) with market size, which is inconsistent with the entry condition $(E_\star)$. Since the value of an entrant can be written as

$$\star^*(\star\star\star) = \star(\mathbf{b}) \int_0^{\star} \star(\star; \star\star\star) \underline{\star}(\star\star) \star + [1 \; ; \; \star(\mathbf{b})] \int_{\star}^{1} \star(\star; \star\star\star) \overline{\star}(\star\star) \star$$

we obtain

$$\int_0^{\star} \star(\star; \star_1 \star\star_1) \underline{\star}(\star\star) \star \int_0^{\star} \star(\star; \star_0 \star\star_0) \underline{\star}(\star\star)$$

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and

$$\star \quad \int_\star^1 (\star; \star_1 \star \star_1) \overline{\star} (\star \star) \star \quad \star \quad \int_\star^1 (\star; \star_0 \star \star_0) \overline{\star} (\star \star) \star$$

That is, conditional on obtaining a draw from the good distribution, the conditional value of a ¯rm is larger in the larger market, while the opposite relationship holds conditional on getting a draw from the bad distribution. For an entrant, these two e®ects cancel each other out in expectation. Now, the marginal incumbent ¯rm in the smaller market, $\star_0^\pi$, is less e±cient than the average entrant b, and hence obtains a bad draw with a larger probability. This implies that the conditional value of type $\star_0^\pi$ is negative in the larger market, i.e., $\overline{\star} (\star_0^\pi; \star_1 \star \star_1) \star 0$. It follows that $\star_1^\pi \star \star_0^\pi$. The e±ciency of the marginal incumbent rises with market size. This implies the positive relationship between market size and ¯rm turnover predicted by Proposition 6.

It is important to point out that we can dispense with condition (14) and still obtain our result on market size and ¯rm turnover (and the age distribution), provided we assume that the discount factor is not too large. If $\star$ is small, then single-crossing of the pro¯t function implies single-crossing of the value function. Hence, in a larger and endogenously more competitive market, the value function will cross the value function in the smaller market only once, and ¯rms will use a tougher exit policy.

The analysis of the e®ect of a change in the ¯xed cost $\star$ proceeds analogously to that of a change in market size. It is omitted for brevity. The results of this section should be reassuring. The main predictions of this paper are quite robust to changes in the sequence of moves and the stochastic process governing the evolution of incumbents' e±ciencies.

7 Empirical Application: Hair Salons in Sweden

We now turn to the empirical application of our theory. As stressed in the Introduction, we have focused on the comparative dynamics properties of our model with respect to \observables" such as entry costs, ¯xed costs, and market size. However, one important variable in our model, namely the magnitude of the underlying idiosyncratic shocks (as captured by the persistence parameter $\star$ in our benchmark formulation) is hard to measure or to control for, and is likely to vary across industries. In addition, there are likely to be other factors that contribute to cross-industry di®erences in entry and exit patterns (e.g., ¯nancial constraints, regulations, industry life-cycles) and that are left out of our model. Our empirical application is therefore based on data from a single sector where competition takes place in many geographical markets: hair salons in Sweden. Thus, we use variations in local market conditions, in particular market size and ¯xed costs, to explain di®erences in entry and exit rates. An identifying assumption of this approach, discussed further below, is that other factors remain constant across geographical markets. In the context of studying di®erences in turnover rates, we believe this assumption to be much more reasonable within an industry rather than across industries.

Competition among hair salons corresponds closely to the assumptions of our model. Even in small towns, there is typically a large number of hair salons to choose from.[21] Products are clearly di®eren-tiated in terms of location and quality of service (which is closely tied to the skills and personalities of employees). The assumption of monopolistic competition seems therefore to hold good in this industry. Moreover, casual observation suggests that there is a great deal of entry and exit of hair salons. An important source of idiosyncratic shocks is likely to be the turnover of employees.

The central prediction of our theory is that an increase in market size causes a rise in the turnover rate of ¯rms, and hence a shift in the age distribution towards younger ¯rms. We test this prediction as

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[21] In Asplund and Nocke (2000) we tested our predictions by relating hazard rates of Swedish driving schools to market size. This data set gave some support for the theory, but had two weaknesses. First, very few markets had more than ¯ve ¯rms such that the assumption of monopolisticc competition is untenable. Second, a demographic shift in the population aged 16 to 24 years lead to a distinct decrease in market size.

follows: we split our sample into small and large markets and then test if the age distribution of firms in the subsample of small markets first-order stochastically dominates that of firms in the subsample of large markets. Furthermore, we use information on land values to test our prediction that higher fixed costs result in higher rates of firm turnover, as evidenced by a shift in the age distribution towards younger firms. We begin by describing the data, and then turn to non-parametric tests of first-order stochastic dominance (FOSD).

7.1   Data

The 2001 edition of the Swedish Yellow Pages lists 7,243 hair salons, out of which we contacted 1,100 by phone.[22] The sample contains information from interviews with 1,030 of these; the remaining were either unwilling to participate or not possible to reach. The majority of hair salons in Sweden are small, single establishment operations. Chains play only a minor role in the sector (our impression from studying the Yellow Pages and discussions with a number of hairdressers is that less than five percent of the salons are part of a chain) and we identify each establishment with a firm.

The measure of firm age is the number of years the salon has been established at the current location, $***$. The median age in the sample is nine years (see Table 1) but the data show, as expected, a wide range of ages { with the 10th and 90th percentile at 2 and 25 years, respectively.[23]

Our theory is concerned with the effects of market size on firm turnover. Finding an appropriate measure of market size requires careful consideration. Since haircuts are not very costly and purchased frequently, and most consumers have many nearby salons to choose from, consumers are unlikely to travel significant distances to purchase the service. This suggests to measure market size by the population living in an area, and to assume that the population is solely served by the salons located within the same area.[24] The smallest areas that the Yellow Pages allow us to identify, and for which population figures are available, are the 8,977 five-digit postal codes. At this level of market definition, however, we are unlikely to measure market size correctly since many consumers frequent salons outside the postal code where they reside. On the other hand, defining markets very broadly, e.g., by municipalities (of which there are 289 in Sweden), runs into the opposite problem: a municipality is likely to contain several submarkets with little or no overlap. We have therefore decided to use an intermediate level of aggregation, namely postal areas, to define market boundaries. Our measure of market size, $* ****$, is then the population living within a postal area. In Sweden, there are 1,534 postal areas, ranging in size from small villages with less than 200 inhabitants up to the three largest postal areas Stockholm, Gothenburg, and Malmo with more than 200,000 inhabitants each. In our sample, 368 postal areas are represented, with a median population of 7,096 inhabitants. To measure the number of firms in a market, we use the number of hair salons listed in the Yellow Pages for a given postal area, $* *** *$. The median is 11 hair salons in a postal area.

Are postal areas a reasonable market definition for hair salons? To a first approximation, the number of consumers needed to make a hair salon viable should be roughly the same across markets, which would translate into a strong correlation between population and number of firms.[25] The raw correlation (for

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[22]The selection was conducted as follows. Each hair salon was assigned a number, and in a first step we randomly selected 1,000 of these. With such a non-stratified sample, most observations are from medium to large towns. To obtain greater representation from small markets, we randomly selected an additional 100 hair salons from the subsample of markets (postal areas) with less than 10 hair salons. Some hair salons may have chosen not to pay to appear in the Yellow Pages, but we believe that given the small cost ($*$ SEK900¼ USD100) these make up only a tiny fraction of all hair salons.

[23]We also have information on whether the present owner had been previously established in the same area but at a different adress; approximately 40 percent of the observations fall into this category. There is no significant correlation between having moved location on the one hand, and firm age, market size, and land values on the other.

[24]The number of inhabitants in a market may not be a perfect measure of market size. Unfortunately, official income statistics are only broken down to the far more aggregated municipality level. The same applies to demographic information on gender and age composition. Preferences, and thereby per capita demand, could potentially also vary across markets.

[25]Note, however, that our theory predicts that an increase in market size should induce a less-than-proportionate

1,534 postal areas) between $\star$ $\star\star\star$ and $\star$ $\star\star$ $\star$ is 0.92. In contrast, the corresponding correlation for postal codes is only 0.16. A simple example can explain this. Consider a typical medium sized town, which is a single postal area with 20,000 inhabitants and 20 postal codes. The centre of the town has three postal codes, and the 17 other postal codes comprise residential suburbs. Although relatively few people live in the centre, many of the hair salons are located there and, as a consequence, the majority of the other postal codes do not have a single hair salon. This explains the low correlation between between population and the number of ¯rms in a postal code. Aggregating to the postal area level re°ects our lack of information on exactly how market demand is geographically distributed. In larger towns (say, with population above 100,000), there are often several centres, and so the postal area is a too broad market de¯nition. To sum up, the population in a postal area is an imperfect measure of market size, but should be su±ciently powerful a measure to allow us to distinguish between small and large markets. Since measurement problems are likely to be most pronounced in large towns, we focus our analysis on smaller markets.

Our paper is also concerned with the e®ects of ¯xed costs on ¯rm turnover. For hair salons, the cost of °oor space is an important source of ¯xed costs that varies considerably between, and even within, towns. The closest proxy for which public information exists is the average assessed value per square meter for commercial properties, $\star$ $\star$ $\star$ $\star$ (collected to provide a basis for property taxation). These data are broken down by postal code. We base our tests of FOSD on this low level of aggregation so as to be able to measure as exactly as possible the ¯xed costs a particular ¯rm faces. With reference to the example above, rents vary not only between residential suburbs and the centre, but certainly also between the three postal codes in the centre. For the 890 postal codes represented in the sample, the median is SEK 2,720/m^2 and the 10th and 90th percentiles are 1,240 and 6,190, respectively. For comparison, we also calculate a measure of the average ¯xed costs in a postal area, $\star$ $\star$ $\star$ $\star\star$ $\star\star\star$, by using the total value of commercial properties in the constituent postal codes as weights of $\star$ $\star$ $\star$ $\star$.

A potential problem of identi¯cation is that rents tend to be increasing with town size. In the sample, the raw correlation between $\star$ $\star\star\star\star$ and $\star$ $\star\star\star$ is 0.62. Also, the cost of °oor space is usually higher in the centre, partly since demand is greatest there. However, since rents are not only determined by the number of potential customers for hair salons, but by many other factors, it should in principle be possible to separate the e®ects of market size and ¯xed costs. In Section 4, there are two results of our model, which allow a simple check of this. Proposition 7 states that the the number of ¯rms rises less-than-proportionally with market size. In other words, as market size increases, there are fewer ¯rms per unit of market size. Proposition 5 asserts that, for a given market size, the number of ¯rms is decreasing with ¯xed costs. In Table 2, we report the results from a parsimonious Tobit speci¯cation, with $\star$ $\star\star$ $\star$ $\star$ as the dependent variable.[26] In the ¯rst column, where the largest markets are excluded, the coe±cient of $\star$ $\star\star\star\star$ is positive and that of $\star$ $\star\star\star\star$ ^{2} negative. The coe±cient of the interaction term $\star$ $\star\star\star\star$ $\pounds$ $\star\star$ $\star\star$ $\star\star\star$ is negative and signi¯cant, which implies that, conditional on market size, there are fewer ¯rms where rents are high. These results are in line with our predictions. In the second column, where we include all but the 11 largest markets, the coe±cient of $\star$ $\star\star\star\star$ $\pounds$ $\star\star$ $\star\star$ $\star\star\star$ remains negative, but the one of $\star$ $\star\star\star\star$ ^{2} becomes insigni¯cant. Using the full sample produces markedly di®erent coe±cients. As noted above, problems of measuring market size in the large towns, and using a market average of rents, are the most likely explanations as to why including the largest markets may distort the estimates. It is also conceivable that we underestimate the size of

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increase in the number of ¯rms (due to price competition and selection e®ects), which will result in a correlation of less than one. The correlation could also be weakened by di®erences in, e.g., ¯xed costs and per capita demand. Below we report regressions where FIRMS is related to MSIZE and our measure of ¯xed costs.

[26]The speci¯cation follows from assuming that $\star$ $\star\star\star$ $\star\star\star$ $\star\star\star$ decreases linearly in both $\star$ $\star\star\star\star$ and $\star\star$ $\star\star$ $\star\star\star$. The regression equation is obtained by multiplying both sides of $\frac{\star\star\star\star\;\star}{\star\;\star\star\star\star}$ $=$ $\star_1 + \star_2\star$ $\star\star\star\star$ $+$ $\star_3\star\star$ $\star\star$ $\star\star\star$ $+\star$ with $\star$ $\star\star\star\star$ and adding a constant. A Tobit model is used since many (mostly small) markets lack a hair salon.

the largest markets by ignoring the possibility that per capita demand is higher there (e.g., people in big towns go more often to the hairdresser). Overall, the results suggests that it is reasonable to focus on the smaller markets so as to reduce measurement problems.

Finally, we use regressions to check the robustness of our results and examine some competing explanations. The control variables we use are discussed in conjunction with the results in Table 5.

7.2   Statistical Tests of FOSD

Let X and Y be two random variables with cumulative distribution functions $F_X(x)$ and $F_Y(y)$. Random variable X first-order stochastically dominates Y, denoted $X \succeq_1 Y$, if

$$F_X(x_i) \leq F_Y(x_i) \text{ for all } x_i, \text{ and}$$
$$F_X(x_i) < F_Y(x_i) \text{ for some } x_i.$$

Suppose the data consist of n_X and n_Y independent observations from $F_X(x)$ and $F_Y(y)$, which form the empirical distributions, $\hat{F}_X(x)$ and $\hat{F}_Y(y)$.[27] In the present context, $\hat{F}_X(x)$ and $\hat{F}_Y(y)$ correspond to the proportions of firms that are less than or equal to x_i years old, in two different subsets of markets (small vs. large, and low rent vs. high rent markets). To test for first-order stochastic dominance (FOSD), we use the non-parametric procedure proposed by Davidson and Duclos (2000), which compares the two distributions at a finite number of grid points x_i, $i = 1 \dots N$. Anderson (1996) provides an alternative test.

Davidson and Duclos show that, under the null hypothesis of equal distributions, $\hat{F}_X(x_i) - \hat{F}_Y(x_i)$ is asymptotically normally distributed, $N(0, \sigma^2_{\hat{F}}(x_i))$, with variance

$$
\begin{aligned}
\sigma^2_{\hat{F}}(x_i) &= \frac{\hat{F}_X(x_i) + \hat{F}_Y(x_i)}{3} \\
&= \frac{1}{n_X}\left[\hat{F}_X(x_i) - \hat{F}_X(x_i)^2\right] + \frac{1}{n_Y}\left[\hat{F}_Y(x_i) - \hat{F}_Y(x_i)^2\right].
\end{aligned}
$$

The standardized test statistic is then given by

$$
t^{**}(x_i) = \frac{\hat{F}_X(x_i) - \hat{F}_Y(x_i)}{\sqrt{\sigma^2_{\hat{F}}(x_i)}}.
$$

As the test for FOSD involves multiple comparisons (i.e., one for each grid point x_i), the critical values from the standard Student's t-statistics are not applicable. Instead, let $\alpha_{N,\infty,1}$ denote the critical value at the α percent level of significance of the studentized maximum modulus test with N and infinite degrees of freedom, tabulated in Stoline and Ury (1979). We accept the hypothesis of $X \succeq_1 Y$ if

$$-t^{**}(x_i) > \alpha_{N,\infty,1} \text{ for some } i, \text{ and}$$
$$t^{**}(x_i) > \alpha_{N,\infty,1} \text{ for all } i.$$

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[27]There is a subtle issue whether the observations in our data are completely independently drawn. While we have randomly sampled about one in eight hair salons in Sweden, we drew each observation without returning it into the \urne". Hence, sampling an observation from one market reduces the probability of drawing again from the same market. Moreover, the fact that one has drawn a firm of a certain age may change the expected age distribution of the firms from the same market that remain in the urne. We believe that this does not significantly reduce the power of our tests. First, we have sampled only a small fraction of firms, and (due to the large number of markets) most are from different markets. Indeed, we have rarely sampled more than one hair salon from a small market. Second, our simple Markov process (1) implies that, within the same market, a firm's age is independent of its efficiency, and hence independent of a rival firm's age.

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If all $\bar{\star}\star\star(\star)\bar{\ }$ are less than the critical value, we accept the null hypothesis of equal distributions. For $\star = 10$ and $\star = 1\star5\star10\star20$ the critical values are 3.29, 2.80, 2.56 and 2.29. In both Table 3 and Table 4 below, all $\star\star\star(\star)\star 2\star29$, and so we refer to $\bar{\ }\star\star\star\bar{\ }\acute{\ }\max_\star\star\star\star(\star_\star)\bar{\ }$. We also report results from the test proposed by Anderson (1996).

7.3 Results

Table 3 shows the results for the test statistics of Anderson (1996) and Davidson and Duclos (2000). We use 10 grid points so as to divide the age distribution for the full sample into eleven intervals with an approximately equal number of observations (see Tse and Zhang (2000)). In the ¯rst three columns of Table 3, we split the sample into two (equally large) subsamples of \small" and \large" markets, and test whether the age distribution in the subsample of smaller markets ¯rst-order stochastically dominates that in the subsample of larger markets. For this split, we report the Davidson and Duclos test statistic for each of the 10 grid points, as well as the maximum value of the Anderson test statistic. We also report the maximum value of the Davidson and Duclos test statistic when comparing the age distribution in the smallest third of markets with that in the largest third. This split of the sample should be less sensitive to errors in measuring market-size. We refer to the Davidson and Duclos maximum test statistics under the two splits as $\bar{\ }\star_{1\star2}^{\star\star}\bar{\ }$ and $\bar{\ }\star_{1\star3}^{\star\star}\bar{\ }$, and that of Anderson as $\bar{\ }\star_{1\star2}^{\star}\bar{\ }$. In the last three columns of the table, we conduct analogous splits for our variable $\star\star\star\star$. In Table 3, large negative values support our predictions.

Before examining the statistical results it is useful to ¯rst look at the raw data. Figure 3 shows the cumulative frequencies of $\star\star\star$ in small and large markets, conditional on $\star\ \star\star\star\ \star 75{,}000$ (this corresponds to the second column in Table 3). Over virtually the entire range of ¯rm ages, the cumulative frequency in the set of large markets is above that in the set of small markets. This is in line with our prediction that ¯rms small markets should tend to be older than those in larger markets. Figure 4 gives the corresponding picture for the distribution of $\star\star\star$ in markets with low and high $\star\star\star\star$, again conditional on $\star\ \star\star\star\ \star 75{,}000$. Here, the youngest ¯rms tend to be in the set of markets with high rents, which is what we expect from our theory. However, the gap between the two curves narrows with increasing age, and the two curves intersect to the left of $\star\star\star = 20$; at higher age, the gap between the curves remains small.

In the ¯rst column we con¯ne attention to markets with a population below 25,000. We ¯nd that $\bar{\ }\star_{1\star2}^{\star\star}\bar{\ } = 2\star52\star 2\star29 = \star_{20\star10\star1}$ and $\bar{\ }\star_{1\star2}^{\star}\bar{\ } = 2\star67\star 2\star56 = \star_{10\star10\star1}$. The FOSD-test becomes signi¯cant at the 1%-level when using the 1/3-split, $\bar{\ }\star_{1\star3}^{\star\star}\bar{\ } = 3\star79\star \star_{1\star10\star1}$. As noted above, the result from the 1/3-split should be more reliable as it is less sensitive to measurement problems in $\star\ \star\star\star$. This suggests that ¯rms in larger markets tend to be younger (in the sense of FOSD).

Including all markets with up to 75,000 inhabitants yields statistically stronger results: all test statistics show signi¯cance at the 1%-level. However, for the full sample the 1/2-split is only border-line signi¯cant at the 20%-level although $\bar{\ }\star_{1\star3}^{\star\star}\bar{\ }$ remains highly signi¯cant. One explanation for this is that the very largest towns contain a number of small submarkets, where competition is less intense (and hence ¯rms are older) than in the city centre.

The last columns of Table 3 are concerned with the e®ects of $\star\star\star\star$ on the age distribution of ¯rms. In the fourth column, where we restrict the sample to markets with less than 25,000 inhabitants, $\bar{\ }\star_{1\star2}^{\star\star}\bar{\ } = 2\star88\star \star_{5\star10\star1}$. This indicates that ¯rms tend to be younger (in the the sense of FOSD) in markets with high ¯xed costs, as predicted by our theory. Also, the sample of markets with less than 75,000 inhabitants produces test statistics at the 1%-level.[28] Finally, the same is true for the 1/2-split

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[28]As seen in 4, the two curves intersect to the left of $\star\star\star = 20$. The grid points we use are $\star\star\star = 20$ (in 3:5,

even when including the very largest markets. The surprisingly signi¯cant test statistics in the full sample may be due to the fact that our variable ⋆ ⋆ ⋆ ⋆ captures di®erences in rents across postal codes within the same postal area; in contrast, we assign the same value of ⋆ ⋆⋆⋆ ⋆ to all ¯rms, even in large towns (which may explain the less signi¯cant results for ⋆ ⋆⋆⋆ ⋆ in the full sample).

It is encouraging that the results in Table 3 conform with our predictions. The caveat is, however, that ⋆ ⋆⋆⋆ ⋆ and ⋆ ⋆ ⋆ ⋆ are highly collinear, and so it may not be too surprising to ¯nd similar results in the univariate comparisons. To address this issue, we need to separate the two e®ects so as to verify whether both are signi¯cant.

Using the medians of ⋆ ⋆⋆⋆ ⋆ and ⋆ ⋆ ⋆ ⋆ in markets with less than 75,000 inhabitants (which correspond to values of 15,889 and 2,509, respectively), we split the sample into four subsamples, which we call Q1 to Q4. Our theory makes predictions for ¯ve bilateral comparisons of age distributions across these four subsamples. For instance, conditional on being in a small market, the age distribution of hair salons in a low rent area should ¯rst-order stochastically dominate that of salons in high rent areas. For each of the four subsamples, Table 4 shows the cumulative age distributions at the ten grid points. In the table, we also report the test statistics $\bar{}\star^{\star\star}_{1\star2}\bar{}$ and $\bar{}\star^{\star}_{1\star2}\bar{}$ for the ¯ve bilateral comparisons.

Examining the test statistic for each of the ¯ve bilateral comparisons, it is striking that all are above the critical value at the 20%-level, and most are above that of the 5%-level.[29] The most straightforward comparison regards Q1 vs. Q4 (small markets with low rents vs. large markets with high rents), where the test statistics show signi¯cance at the 1%-level. Interestingly, the test statistics for those bilateral comparisons where ⋆ ⋆⋆⋆ ⋆ is varied and ⋆ ⋆ ⋆ ⋆ is kept constant (i.e., Q1 vs. Q3 and Q2 vs. Q4), tend to be more signi¯cant than those where ⋆ ⋆ ⋆ ⋆ is varied and ⋆ ⋆⋆⋆ ⋆ kept constant (i.e., Q1 vs. Q2 and Q3 vs. Q4).

In the ¯rst three columns in Table 5, we seek to identify the e®ects by least squares regressions with ⋆⋆(⋆ ⋆ ⋆) as dependent variable (using the same cut-o® levels for ⋆ ⋆⋆⋆ ⋆ as before to de¯ne the subsamples). The coe±cients on ⋆⋆(⋆ ⋆⋆⋆ ⋆) and ⋆⋆(⋆ ⋆ ⋆ ⋆) are always negative, as expected, but only the former is ever individually signi¯cant. Again, this is caused by the collinearity between the two, as evidenced by P-values below 0.02 for the test of the joint restriction that both coe±cients are zero. The low explanatory power (adjusted R-squared around 0.01) shows that little of the variation of ⋆⋆(⋆ ⋆ ⋆) can be attributed to di®erences in market size and ¯xed costs, which is not surprising in markets with high entry rates.

So far, we have implicitly assumed that markets di®er only in terms of size and ¯xed costs. We acknowledge that conditions may di®er also in other dimensions that could in°uence the age distribution. First, there are di®erences in demand growth (c.f. Section 5), measured here by the growth rate in municipal population and average per capita income over the period 1990-2000, ⋆ ⋆ ⋆ ⋆ ⋆ ⋆ ⋆ ⋆⋆ and ⋆⋆ ⋆ ⋆ ⋆ ⋆ ⋆ ⋆⋆. Second, there is more mobility of population in some areas which might give rise to more frequent shocks (c.f. the ⋆ parameter) either due to greater propensity of employees to move or change employer, or that customer relations are less stable. Our control variable, ⋆ ⋆⋆ ⋆ ⋆ ⋆ ⋆⋆ ⋆, is the ratio of the sum of inward and outward migration over the period 1990-2000 to the municipal population in 1995. Further, the age composition of the population across markets may di®er, something we capture with the fraction of the municipal population in 2000 that is aged 25 to 44, ⋆ ⋆ ⋆ ⋆ ⋆ ⋆ ⋆ ⋆. One reason for including ⋆ ⋆ ⋆ ⋆ ⋆ ⋆ ⋆ is to test the alternative explanation that large markets tend to have relatively more young people and the age of a hair salon is correlated with the age of its owner.

$\star^{\star\star}_{1\star2}$ =0.595) and ⋆ ⋆ ⋆ =35 (in 3:5, $\star^{\star\star}_{1\star2}$ = ¡ 0.607), and so one may ask whether our results are a®ected by the choice of grid points. Using ⋆ ⋆ ⋆ =28 rather than ⋆ ⋆ ⋆ =20 gives the highest value of $\star^{\star\star}_{1\star2}$ ⋆but it is only 0.874⋆ 2.29= ⋆ $_{20\star10\star1}$. Thus, the conclusion is robust to the choice of grid points.

[29]Note that while the test statistics are positive at some gridpoints (indicating that the graphs of the cumulative distribution functions intersect), the value is always less than 2⋆29, and hence there is never a statistically signi¯cant violation.

In the last three columns of Table 3 we report regressions with these as control variables.

Most importantly, the coefficients of key variables $**(* ****)$ and $**(* * * *)$ are only affected to a limited extent by the introduction of the control variables and their joint significance remains high. This addresses the serious concern that the market size effect on the age distribution is driven by large markets being systematically different in several dimensions. In other words, our results are not driven by large markets being those that have grown the fastest, have the most mobility, and have the youngest population.[30] The control variables are generally statistically insignificant ($** * * * * * **$ is significant at the 10%-level in column 4 but the coefficient changes considerably across subsamples). The joint restriction that all control variables are zero can not be rejected.

Overall, the lack of explanatory power of the control variables in the regressions strengthens our claim that the age distribution is driven largely by market size and fixed costs, as predicted by our theory. One point to note is that in both Tables 4 and 5, market size seems to have a statistically stronger effect than fixed cost. Potentially, $* * * *$ is not only correlated with fixed costs, but also with the level of sunk entry costs: upon entry, a salon is required to sign a lease contract for a minimum duration.[31] Furthermore, a new firm may need a certain time in the market to reach customers and to make an informed decision on exit. With the data at hand, we are not able to quantify the effects of $* * * *$ on fixed costs and entry costs.[32]

Summing up, our study of the age distribution of hair salons in different geographically defined markets supports the predictions of our theory: firms operating in larger markets, and those in locations where rents (being a proxy for fixed costs) are higher, tend to be younger (in the sense of FOSD).

Although our empirical focus has been on the determinants of firm turnover, we would like to point out that the model contains many testable predictions on the distribution of firm efficiencies. Indeed, Syverson (2002) explores variations in within-industry productivity for a sample of four-digit industries using a framework that builds on ours.[33]

8 Conclusion

Many empirical studies in industrial organization and labor economics have shown that industries differ substantially in the level of firm turnover and gross job reallocation. These differences are stable over time and similar across countries. This suggests that there are some systematic factors that determine the magnitude of reallocation of inputs and outputs within industries. This paper is concerned with an examination of the role played by industry characteristics such as entry costs, fixed production costs, and market size on market turbulence.

To this end, we have analyzed a stochastic dynamic model of an imperfectly competitive industry. Firms are heterogeneous and subject to idiosyncratic shocks to their "efficiencies". In our formulation, a firm's efficiency can be interpreted either as its productivity or as the perceived quality of its product.

Even in a stationary environment, the equilibrium exhibits simultaneous entry and exit: currently efficient firms survive while firms with sufficiently bad cost draws exit. Our analysis shows that the replacement of inefficient firms ("churning") is more rapid in markets with low entry costs and high

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[30] In our data, $* ****$ is postively correlated with $* * * * * * **$ ($* =0.56$), $* ** * * * ** $ ($* =0.29$), and $* * * * * * * *$ ($* =0.67$). $* ****$ is virtually unrelated to $** * * * * * **$ ($* =0.04$).

[31] Other costs for a hair salon do not appear to vary much across country. According to the interest organization Sveriges Frisörföretagare, wages show very little dispersion across regions. Equipment and material are typically bought from a few national distributors.

[32] Note that our theory predicts that both an increase in entry costs and an increase in fixed costs reduce the number of firms. Thus, the finding in Table 2 that the number of firms is negatively related to $* * * * * * * *$ is consistent with both effects.

[33] Syverson (2000) conducts a detailed examination of the efficiency distribution of plants producing ready-made concrete in the U.S., and relates the differences to variations in local demand density.

¯xed costs. The most important and novel prediction of our theory, however, is that the rate of ¯rm turnover is positively related to the size of the market.

The paper provides a number of results in addition to those on market turbulence. Most importantly, if the idiosyncratic shocks a®ect ¯rms' productivities, then the stationary equilibrium will exhibit a nondegenerate distribution of e±ciency levels. That ¯rms within an industry display considerable heterogeneity is empirically well-documented. Our model makes a number of testable predictions on the distribution of productivities. In particular, the model predicts that in larger markets ¯rms tend to be more e±cient. It has often been informally argued that \more intense product-market competition fosters e±ciency". In our model, the induced intensity of price competition may di®er across markets in that the endogenous distribution of ¯rm types may vary with changes in entry costs, ¯xed costs, or market size. However, if one were to correlate, in a cross section of markets, price-cost margins with the average e±ciency of active ¯rms, one may ¯nd a negative or positive correlation: if markets di®ered mainly in their ¯xed costs, then one would ¯nd that ¯rms are more e±cient in markets with higher price-costs margins, while the reverse would hold if markets di®ered mainly in their size (or entry costs).

To see the broader implications of this result, note that an increase in market size may be interpreted as the opening of industries to trade, e.g., as a move from two closed economies to a fully integrated economy. In a two-country model related to ours, Melitz (1999) analyzes the e®ect of trade costs on the distribution of e±ciency levels. In his model, a move from in¯nite trade costs to zero trade costs has no e®ect on average e±ciency and turnover levels. Our model, in contrast, predicts that average ¯rm e±ciency and turnover levels should rise as a result of economic integration.

In the empirical part of the paper, we test some of the model's predictions. The idea is to examine the age distribution of ¯rms that compete in the same sector but in di®erent geographical markets. This should avoid many of the measurement problems associated with cross-industry studies. To this end, we have collected data on hair salons in Sweden. We use the population in postal areas to capture di®erences in market size, and land values to proxy for di®erences in ¯xed costs (primarily rents). The empirical results are in line with the predictions. Hair salons tend to be younger in larger markets and in markets with higher ¯xed costs.

Appendix A

Properties of the Pro¯t Function in a Cournot Model. We want to show that assumptions A.1 and A.2 hold in a homogenous goods Cournot model, where ¯rms di®er in their (constant) marginal costs. Let $\star(\star\star)$ denote inverse demand when aggregate output is $\star$ and market size is $\star$. We assume that the demand function is downward-sloping, i.e. $\star^0(\mathbb{C}) \star 0$. In equilibrium, aggregate output $\star$ will be some (possibly complicated) function of the vector of ¯rms' marginal costs, i.e. $\star = \star\star(c)$, where c is the vector of ¯rms' marginal costs. It is therefore convenient to consider changes in aggregate output which re°ect changes in the underlying distribution of ¯rms' e±ciencies. Conditional on aggregate output $\star$, the equilibrium output of a ¯rm with constant marginal cost $\star$ is denoted by $\star\star(\star;\star)$. (The function $\star\star(\star;\mathbb{C})$ is sometimes called the backward-reaction function.) The ¯rst-order condition for pro¯t maximization is given by

$$\star(\star\star\star) \text{ ¡ } \star + \star(\star;\star)\star^0(\star\star\star) = 0\star \tag{15}$$

which implies

$$\star\star(\star;\star) = \text{ ¡ } \star\frac{\star(\star\star\star) \text{ ¡ } \star}{\star^0(\star\star\star)}\star$$

The associated second-order condition is given by

$$2\star^0(\star\star\star) + \star(\star;\star)\star^{00}(\star\star\star) \star 0\star \tag{16}$$

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It is straightforward to show that (15) and (16) imply that a ¯rm's equilibrium equilibrium pro¯t $\star\star(\star;\star)$ is strictly decreasing in industry output $\star$. Any change in the underlying distribution of e±ciencies which reduces ¯rms' pro¯ts must induce an increase in industry output $\star$. Hence, an increase in $\star$ is equivalent to an increase in the distribution of ¯rms as de¯ned in the main text. Moreover, the assumption of complete ordering of distributions (C.3) is satis¯ed. Conditional on industry output $\star$, the equilibrium pro¯t of a type-$\star$ ¯rm can be written as

$$\star\star(\star;\star) = \text{¡} \star \frac{(\star(\star\star\star)\text{¡}\star)^2}{\star^0(\star\star\star)}\star$$

We now consider an increase in the distribution of active ¯rms: suppose aggregate output increases from $\star$ to $\star^0$, $\star^0 \star \star$. Assumption A.2 says that the pro¯t ratio $\star(\star;\star^0)\star\star(\star;\star)$ is decreasing in $\star$ for all $\star$ such that $\star(\star;\star) \star 0$. It is immediate to see that this condition holds if and only if $\star(\star^0\star\star) \star \star(\star\star\star)$, which is clearly satis¯ed since the inverse demand function is downward-sloping. Assumption A.1 requires that the pro¯t di®erence $\star(\star;\star^0)\text{¡}\star(\star;\star)$ is increasing in $\star$ for all $\star$ such that $\star(\star;\star) \star 0$. Taking the derivative with respect to $\star$, we obtain that A.1 holds if and only if $\star(\star;\star^0) \star \star(\star;\star)$, i.e. a ¯rm's equilibrium output is decreasing in the distribution of active ¯rms. This inequality is satis¯ed if

$$\star^0(\star\star\star) + \star(\star;\star)\star^{00}(\star\star\star) \star 0\star$$

which is equivalent to the assumption that quantities are strategic substitutes (¯rms' reaction curves are downward-sloping). It is a rather weak (and standard) assumption in Cournot models. Hence, in a Cournot model with homogenous products and constant marginal costs, A.1 and A.2 hold under fairly general conditions on demand.[34]

Proof of Proposition 2. The proof proceeds in several steps.

Step one. Consider any positive measure $\star^0$ in M^π such that $\overline{\star}^*(1;\star^0) = 0$. Conditions (CON) and (FREE) ensure that $\star^0$ exists. Since $\overline{\star}^*(\text{¢};\star^0)$ is single-peaked, there are two possibilities.

(i) $\overline{\star}^*(\star;\star^0) \star 0$ for all $\star 2 [0\star1]\star$

(ii) $\overline{\star}^*(\star;\star^0) \star 0$ for some $\star 2 (0\star1)$.

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 $\star^{00}$, and the exit policy by $\star^{00}$. Since $\overline{\star}^*(\star;\star)$ is decreasing in $\star$, condition (E) implies that $\star^{00} Â \star^0$. It follows that $\overline{\star}^*(1;\star^{00}) \star \overline{\star}^*(\star^{00};\star^{00}) = 0$. Since $\overline{\star}^*(\text{¢};\star^{00})$ is single-peaked, we thus have $\star\star\overline{\star}^*(\star^{00};\star^{00})\star\star\star 0$, 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. From (DOM) and (CON), it follows that there exists a positive number $\star^0$ such that $\star_{\star^0} \gg \star^0$, where $\star_{\star^0}$ is the stationary distribution de¯ned by (10). (Indeed, (DOM) implies that for $\star$ su±ciently large, $\star_\star Â \star^0$, and for $\star$ su±ciently small, $\star_\star Â \star^0$. (CON) then implies that there exists a $\star^0$ such that $\star_{\star^0} \gg \star^0$.) It is easy to check that $(\star_{\star^0}\star0\star1)$ satis¯es conditions (5), (7), and (10). Note that there may exist a multiplicity of stationary equilibria. More precisely, there exists a nonempty interval of $\star$-values, $\underline{\star}\star\star$, with $\overline{\star} \text{ ¸ } \underline{\star}$, such that $(\star_\star\star0\star1)$, $\star 2 \underline{\star}\star\star$, forms a stationary equilibrium.

Step three. Consider case (ii), which can only arise if $\star \star \star(1\text{ ¡ }\star)\star$. We claim that, in this case, there exists a unique stationary equilibrium, which involves simultaneous entry and exit. Existence and

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[34] It is easy to check that assumptions C.1 to C.4 are satis¯ed as well. The ¯rst part of C.5 holds if $\lim_{\star\text{ ! }1}\star(\star) = 0$. The second part of C.5 is di±cult to interpret with a discrete number of ¯rms. But, essentially, it says that ¯xed costs and entry costs are su±ciently small so as to make entry of at least one ¯rm pro¯table.

uniqueness can be shown as follows. Starting from $\star^0$, we increase the measure of active ¯rms: in Figure 1, this shifts the curve $\overline{\star}^{*}$ downwards. (CON), (FREE), and single-peakedness of $\overline{\star}^{*}(\mathbb{C};\star)$ imply that there exists a measure $\star^{00}$ Ã $\star^0$ such that $\overline{\star}^{*}(\mathbb{C};\star^{00})$ assumes a unique maximum at some $\star^{\mathtt{n}} \star 1$ and $\overline{\star}^{*}(\star^{\mathtt{n}};\star^{00}) = 0$. (It is easy to see that the exit policy $\star^{\mathtt{n}}$ is unique.) From assumptions (DOM) and (CON), and condition (D), it follows that there exists a unique $\star$ such that $\star[\star^{\mathtt{n}}\star\,] \gg \star^{00}$. The unique equilibrium distribution is then given by $\star \; \acute{} \; \star[\star^{\mathtt{n}}\star\,]$.[35] ∎

Proof of Proposition 3. Abusing our previous notation, let us denote by $\overline{\star}^{*}(\star;\star;\star)$ the value of an entrant who uses exit policy $\star$ in the period of entry and behaves optimally thereafter, when the value of entry costs is given by $\star$. Note that $\overline{\star}^{*}(\star;\star;\star)$ is continuous (and decreasing) in $\star$. Assumptions (CON) and (FREE) ensure that there exists a positive measure $\mathbf{b}$ in $M^{\mathtt{n}}$ such that $\overline{\star}^{*}(1;\mathbf{b};0) = 0$. (MON) then implies that $\star\star(1;\mathbf{b}) \star \star \star \star\star(0;\mathbf{b})$. It follows that there exists an exit policy $\mathbf{b}\star 1$, such that

$$\overline{\star}^{*}(\mathbf{b};\mathbf{b};0) \star 0 = \overline{\star}^{*}(1;\mathbf{b};0)\star$$

Hence, for $\star$ su±ciently small, we have $\overline{\star}^{*}(\mathbf{b};\mathbf{b};\star) \star 0 \star \overline{\star}^{*}(1;\mathbf{b};\star)$. Then, there exists a measure $\star^0$ Á $\mathbf{b}$ such that

$$\overline{\star}^{*}(1;\star^0;\star) = 0 \star \overline{\star}^{*}(\mathbf{b};\star^0;\star)\star$$

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. ∎

Proof of Proposition 8. As pointed out in the main text, the future enters the equilibrium conditions only through the constant option value $\star\star$ in $(E_\star)$ and $(X_\star)$. Consequently, the change in market size in period $\star$ has no e®ect on endogenous variables in periods before $\star$. Moreover, again from the discussion in the main text, $\star^{\mathtt{n}}_\star$ and the equivalence class of $\star_\star$ are independent of future and past values of market size. The same applies to $\star_\star + \star_{\star i\,1}([0\star1])$. Using our comparative statics result on market size, Proposition 6, we then obtain the following characterization of endogenous variables: $\star^{\mathtt{n}}_\star = \star^{\mathtt{n}0}_\star$ for all $\star \, \mathbf{6} \, \star$, and $\star^{\mathtt{n}}_\star \star \star^{\mathtt{n}0}_\star$, $\star_\star = \star^0_\star$ for all $\star \, \mathbf{6} \, \star$, and $\star_\star$ Á $\star^0_\star$, $\star_\star = \star^0_\star$ for all $\star \cdot \star_i 1$ and $\star_{\,\,} \star + 2$, $\star_\star \star \star^0_\star$, and $\star_{\star+1} \star \star^0_{\star+1}$ if and only if $\star_\star([0\star1]) \star \star^0_\star([0\star1])$. The prediction on the evolution of exit rates follows immediately. Let us now show that $\star_\star \star \star^0_\star$. Condition $(D_\star)$ and $\star_{\star i\,1} = \star^0_{\star i\,1}$ imply

$$\frac{[\star^{\,0}_{\,\star} + \star_{\star i\,1}([0\star1])] \star (\star^{\mathtt{n}0}_\star)}{\star^0_\star([0\star1])} = 1 = \frac{[\star_\star + \star_{\star i\,1}([0\star1])] \star (\star^{\mathtt{n}}_\star)}{\star_\star([0\star1])}\star$$

Since $\star_\star \star \star^0_\star$, we then obtain

$$\frac{\star^{\,0}_\star \star (\star^{\mathtt{n}0}_\star)}{\star^0_\star([0\star1])} \star \frac{\star_\star \star (\star^{\mathtt{n}}_\star)}{\star_\star([0\star1])}\star$$

and hence

$$\frac{\star^{\,0}_\star}{\star^0_\star([0\star1])} \star \frac{\star_\star}{\star_\star([0\star1])}\star$$

which is the desired result.[36] The remaining characterization of the evolution of entry rates follows from the discussion in the main text. ∎

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[35]If $\star = \star(1_i\star)\star$ (which occurs with zero probability if the parameters are drawn from some continuous distribution), two cases can arise: either $\overline{\star}(\star^0) = 1$ or $\overline{\star}(\star^0) \star 1$. The former case is given by (i), i.e., there exists a stationary equilibrium, but it does not exhibit entry and exit. In the latter case, $\overline{\star}^{*}(\star;\star^0) \star 0$ for all $\star \, 2 \, [0\star\overline{\star}(\star^0))$ and $\overline{\star}^{*}(\star;\star^0) = 0$ for all $\star \, 2 \, [\overline{\star}(\star^0)\star1]$. In this case, there exists both a stationary equilibrium without entry and exit ($\star^{\mathtt{n}} = 1$) as well as a continuum of equilibria with simultaneous entry and exit, where $\star^{\mathtt{n}} \, 2 \, [\overline{\star}(\star^0)\star1)$ and $\star[\star^{\mathtt{n}}\star\,] \gg \star^0$.

[36]Observe that the ¯rst inequality implies that the result also holds when using the alternative entry measure $\mathbf{b}_\star = \star(\star^{\mathtt{n}})\star_\star$.

Proof of Proposition 9. Consider two exit policies, κ' and κ'', where $\kappa'' \geq \kappa'$. The regularity condition on the Markov process can then be written as

$$\frac{\mathbb{C}\mu_s(\kappa')}{\mu_{s-1}(\kappa')} \geq \frac{\mathbb{C}\mu_s(\kappa'')}{\mu_{s-1}(\kappa'')}, \tag{17}$$

where $\mathbb{C}\mu_s(\kappa) \equiv \mu_{s-1}(\kappa) - \mu_s(\kappa)$, and $\mu_0(\kappa) \equiv 1$. The first step in the proof consists in showing that (17) implies that $\mu_s(\kappa')/\mu_s(\kappa'')$ is decreasing in s. Using the identity

$$\frac{\mu_s(\kappa')}{\mu_s(\kappa'')} = \frac{\mu_{s-1}(\kappa') - \mathbb{C}\mu_s(\kappa')}{\mu_{s-1}(\kappa'') - \mathbb{C}\mu_s(\kappa'')},$$

it is straightforward to see that

$$\frac{\mu_s(\kappa')}{\mu_s(\kappa'')} \geq \frac{\mu_{s-1}(\kappa')}{\mu_{s-1}(\kappa'')}$$

whenever (17) holds. Let

$$\pi_s(\kappa) \equiv \frac{\mu_s(\kappa)}{\sum_{s=0}^{\infty}\mu_s(\kappa)},$$

and note that $\sum_{s=0}^{\infty}\pi_s(\kappa) = 1$. The second step in the proof consists in showing that there exists a $\hat{s} \geq 1$ such that $\pi_s(\kappa') \geq \pi_s(\kappa'')$ for all $s \leq \hat{s}$, and $\pi_s(\kappa') \leq \pi_s(\kappa'')$ for all $s \geq \hat{s}$. To see this, note first that $\pi_0(\kappa') \geq \pi_0(\kappa'')$ since $\mu_0(\kappa) \equiv 1$ and $\mu_s(\kappa)/\mu_s^{\kappa} \geq 0$ for all $s \geq 1$, and hence

$$\frac{\pi_0(\kappa')}{\pi_0(\kappa'')} = 1 \geq \frac{\sum_{s=0}^{\infty}\mu_s(\kappa')}{\sum_{s=0}^{\infty}\mu_s(\kappa'')}.$$

Next, since $\sum_{s=0}^{\infty}\pi_s(\kappa') = 1 = \sum_{s=0}^{\infty}\pi_s(\kappa'')$, there exists some s such that $\pi_s(\kappa') \leq \pi_s(\kappa'')$. Finally, since $\pi_s(\kappa')/\pi_s(\kappa'')$ is decreasing in s (as shown in the first step), there exists a $\hat{s} \geq 1$ such that

$$\frac{\pi_s(\kappa')}{\pi_s(\kappa'')} \leq (\geq) \frac{\sum_{s=0}^{\infty}\mu_s(\kappa')}{\sum_{s=0}^{\infty}\mu_s(\kappa'')} \quad \text{if } s \leq (\geq) \hat{s}.$$

This proves the assertion. The third and final step in the proof consists in showing that $\Pi(s|\kappa') \geq \Pi(s|\kappa'')$ for all $s \geq 1$. Note that $\Pi(s|\kappa) = \sum_{s=0}^{s-1}\pi_s(\kappa)$ and $\lim_{s \to \infty}\Pi(s|\kappa) = 1$. From the second step, $\Pi(1|\kappa') \geq \Pi(1|\kappa'')$. Moreover, $\Pi(s|\kappa') - \Pi(s|\kappa'')$ is increasing in s for all $s \leq \hat{s}+1$, and decreasing for all $s \geq \hat{s}+1$; i.e., $\Pi(s|\kappa') - \Pi(s|\kappa'')$ is single-peaked in s. Since $\lim_{s \to \infty}\{\Pi(s|\kappa') - \Pi(s|\kappa'')\} = 0$, it follows that $\Pi(s|\kappa') - \Pi(s|\kappa'') \geq 0$ for all $s \geq 1$. ∎

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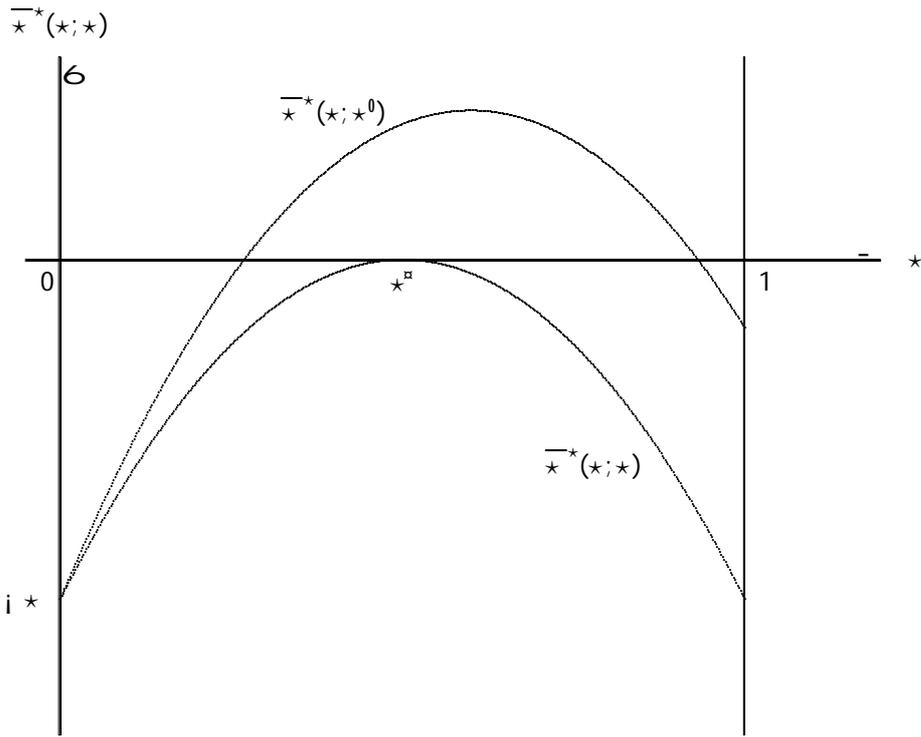
Appendix B: Figures and Tables

Figure 1: The e®ect of a decrease in the distribution of ¯rms ($\star^0$ Á $\star$) on the value of an entrant with exit policy $\star$.
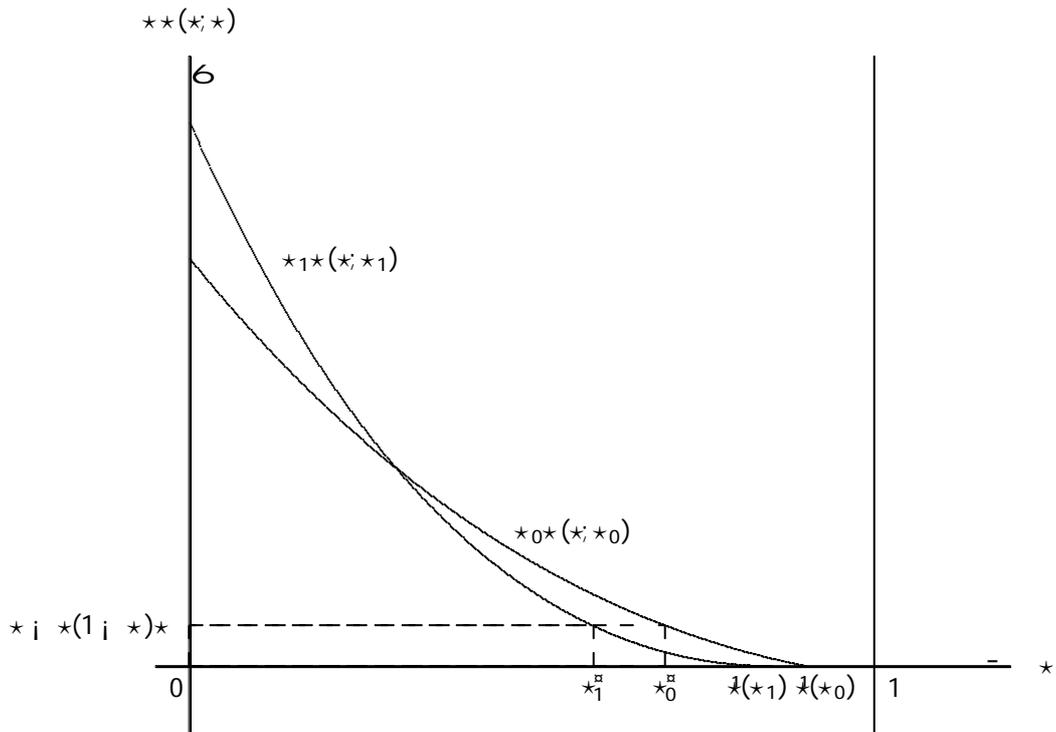
Figure 2: The e®ect of an increase of market size on gross pro¯ts: $\star_1 \star \star_0$, and hence $\star_1 \hat{A} \star_0$.

Table 1: Descriptive statistics.

	Mean	St.Dev	Min	10th	25th	50th	75th	90th	Max	Nobs
$\star\star\star$	10.89	9.27	0.01	2	4	9	15	25	58	1030
$\star \star\star\star$	72014	94541	355	2865	8271	27763	82788	277522	285981	1030
$\star \star\star \star$	103	174	1	2	7	24	77	459	577	1030
$\star\star\star \star$	3591	2649	209	1339	1942	2874	4370	6611	25580	1003
$\star\star\star \star\star \star\star\star$	4338	3790	559	1547	2112	3217	4810	7608	16113	1029
$\star\star\star\star\star\star \star\star$	0.0313	0.0827	-0.1377	-0.0686	-0.0218	0.0430	0.0921	0.1009	1.0825	1030
$\star\star \star\star\star\star \star\star$	0.3363	0.0411	0.2555	0.2877	0.3114	0.3285	0.3571	0.3930	0.5553	1030
$\star \star\star \star\star \star\star\star \star$	0.9276	0.2625	0.2868	0.6479	0.7159	0.9263	1.0695	1.1750	2.1168	1030
$\star \star\star \star\star \star\star \star$	0.2771	0.0395	0.1981	0.2324	0.2444	0.2695	0.3008	0.3494	0.3806	1030

Table 2: Tobit regressions. The number of ¯rms related to market size and ¯xed costs.

	★ ★★ ★ ★	★ ★★ ★ ★	★ ★★ ★ ★
★ ★★★ ★	1.2032***	1.1838***	0.5978***
	[0.0540]	[0.0380]	[0.0183]
★ ★★★ ★	-0.0107***	0.0001	0.0023***
	[0.0025]	[0.0007]	[0.0001]
★ ★★★ ★ ¤ ★ ★ ★ ★★ ★★★	-0.0274***	-0.0652***	0.0440***
	[0.0104]	[0.0063]	[0.0025]
Constant	-2.4489***	-3.0773***	-2.5400***
	[0.1463]	[0.1791]	[0.1998]
Sample	★ ★★★ ★ ★ 25	★ ★★★ ★ 75	Full
Nobs	1465	1523	1534
logL	2334.5	2890.3	3237.5
RlogL	1548.9	2067.5	3095.7
P-value	0.0000	0.0000	0.0000

Standard errors in brackets.

* signi¯cant at 10%; ** signi¯cant at 5%; *** signi¯cant at 1%.

Figure 3: Cumulative age distributions in small and large markets.

Figure 4: Cumulative age distribution in markets with low and high rents.

Table 3: Tests of ¯rst order stochastic dominance.

Split by	⋆ ⋆⋆⋆ ⋆	⋆ ⋆⋆⋆ ⋆	⋆ ⋆⋆⋆ ⋆	⋆⋆⋆ ⋆	⋆⋆⋆ ⋆	⋆⋆⋆ ⋆
⋆⋆⋆	TDD	TDD	TDD	TDD	TDD	TDD
1	-2.105	-2.889	-0.246	-2.567	-2.352	-2.585
2	-2.410	-3.441	-0.349	-2.295	-3.506	-3.327
3	-2.500	-3.545	0.015	-2.880	-4.008	-2.975
5	-2.103	-4.237	-1.068	-1.983	-2.828	-3.309
7	-2.022	-4.855	-2.196	-1.516	-2.254	-2.485
9	-2.524	-3.681	-1.570	-1.048	-0.681	-1.131
12	-2.251	-4.117	-1.946	-0.977	-1.057	-0.924
15	-1.475	-3.768	-2.275	-0.186	-0.619	-1.157
20	-0.146	-1.776	-1.010	0.595	0.427	0.263
35	0.578	-0.505	-0.867	-0.607	0.000	-0.867
Max TA	-2.671	-4.828	-2.307	-2.868	-3.955	-3.317
Max TDD (1/3-split)	-3.769	-3.745	-3.269	-2.951	-3.483	-3.167
Sample	⋆ ⋆⋆⋆ ⋆ ⋆ 25	⋆ ⋆⋆⋆ ⋆ 75	Full	⋆ ⋆⋆⋆ ⋆ 25	⋆ ⋆⋆⋆ ⋆ 75	Full
Nobs	494	762	1030	475	738	1003

Critical values at 1, 5, 10, and 20 percent levels: 3.29, 2.80, 2.56, and 2.29.

40

Table 4: Tests of first order stochastic dominance

	(Q1) SMALL LOW	(Q2) SMALL HIGH	(Q3) LARGE LOW	(Q4) LARGE HIGH
⋆ ⋆⋆⋆ ⋆ ⋆⋆⋆ ⋆				
⋆ ⋆ ⋆	Cum.Dens.	Cum.Dens.	Cum.Dens.	Cum.Dens.
1	0.02	0.09	0.10	0.09
2	0.08	0.15	0.13	0.20
3	0.12	0.19	0.15	0.27
5	0.23	0.27	0.31	0.38
7	0.33	0.34	0.46	0.50
9	0.57	0.50	0.67	0.68
12	0.66	0.61	0.77	0.78
15	0.74	0.67	0.82	0.84
20	0.85	0.81	0.90	0.88
35	0.97	0.97	0.99	0.98
Nobs	257	113	112	256
FOSD test	Max TDD	Max TA	at ⋆ ⋆ ⋆	
Q1 v Q2	-2.88	-2.30	1	
Q1 v Q3	-3.19	-2.52	1	
Q1 v Q4	-4.13	-4.23	3	
Q2 v Q4	-3.52	-3.28	15	
Q3 v Q4	-2.31	-2.60	3	

MSIZE SMALL: MSIZE ⋆ 15,889. RENT LOW: RENT⋆ 2,509.
Critical values at 1, 5, 10, and 20 percent levels: 3.29, 2.80, 2.56, and 2.29.

Table 5: Least squares regressions. Age of ¯rm related to market size and ¯xed costs.

	⋆⋆⋆⋆	⋆⋆⋆⋆	⋆⋆⋆⋆	⋆⋆⋆⋆	⋆⋆⋆⋆	⋆⋆⋆⋆
⋆⋆ ⋆⋆⋆⋆	-0.1413**	-0.1257***	-0.0359	-0.1436**	-0.1376***	-0.0731*
	[0.0597]	[0.0403]	[0.0301]	[0.0631]	[0.0459]	[0.0400]
⋆⋆⋆⋆⋆	-0.0309	-0.0726	-0.0848	-0.1495	-0.1103	-0.0879
	[0.1162]	[0.0934]	[0.0784]	[0.1305]	[0.1057]	[0.0905]
⋆⋆⋆⋆⋆⋆⋆ ⋆⋆				0.5987	0.3525	0.7014
				[1.0520]	[0.8264]	[0.7462]
⋆⋆ ⋆⋆⋆⋆⋆ ⋆⋆				3.0792*	-0.5331	-1.7139
				[1.7662]	[1.4304]	[1.0997]
⋆ ⋆⋆⋆⋆⋆⋆⋆ ⋆				0.1387	0.0894	0.0608
				[0.2988]	[0.2086]	[0.1940]
⋆⋆⋆⋆⋆⋆⋆				-0.1087	0.8352	1.1058
				[2.9561]	[2.3351]	[2.1280]
Constant	2.3448***	2.3425***	2.1696***	1.3056	2.2808***	2.4852***
	[0.1055]	[0.0881]	[0.0725]	[0.9407]	[0.6695]	[0.4917]
Sample	⋆ ⋆⋆⋆⋆ ⋆ 25	⋆ ⋆⋆⋆⋆ ⋆ 75	Full	⋆ ⋆⋆⋆⋆ ⋆ 25	⋆ ⋆⋆⋆⋆ ⋆ 75	Full
Nobs	476	738	1003	476	738	1003
Adj.R2	0.01442	0.02167	0.00614	0.02183	0.01871	0.0071
Test 1	0.0178	0.0001	0.0076	0.008	0.0003	0.0162
Test 2				0.1033	0.761	0.3297

Robust standard errors in brackets

* signi¯cant at 10%; ** signi¯cant at 5%; *** signi¯cant at 1

Test 1 is the P-value of the restriction ⋆MSIZE= ⋆RENT= 0

Test 2 is the P-value of the restriction POPGROWTH=INCGROWTH=MIGRATION=YOUNGPOP= 0