Openness and Productivity: a Model of Firm-Owners’ Effort, with an Illustration from Mexican Microenterprises\textsuperscript{*}

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May 2017

Abstract

This paper asks two questions. First, when countries open up, what are the incentives of firm owners to invest in the productivity of their firms? And why do they wait until the country opens up to do so? To explore these questions, I set up a simple model in which firm owners choose the optimal mix of profits and leisure. The key insight is that openness drives a wedge between “productive” and “unproductive” firm owners, driving up the price of leisure, and therefore the incentives to innovate. The model is modified to consider one further insight: when countries open up, the real price of a consumption basket goes down because consumers enjoy more variety, which again changes the relative price of leisure. I illustrate the model implications with a survey of small firm owners in Mexico.

\textsuperscript{*}This paper was previously circulated with the title “Openness and Productivity: Theory and some Evidence on International Competition and Firm-Owners’ Effort.” Eric Verhoogen and Chris Woodruff have graciously provided the ENAMIN data. My thanks to the many seminar participants at the Econometrics Society Summer Meeting, the Midwest International Trade Meetings, the Federal Reserve Bank of New York, Brandeis, Michigan State, University of Missouri, Oregon State, Penn State, Purdue and Syracuse, for very useful comments. Martin Pereyra has provided excellent research assistance.
1 Introduction

This paper studies the behavior of small firm-owners in choosing a certain productivity level for their firms, and how that choice changes with import competition. The paper offers a theoretical foundation for a positive impact of import competition on productivity, and it does so in a manner that is different from the current literature. In particular, the emphasis will be on within-firm efficiency gains, not on the across-firm compositional effects that have produced a robust research agenda, stemming from Melitz (2003).

A main assumption is that small firm-owners’ choice to increase their firms’ productivities is not costless, and they face a trade-off: they can choose to have more efficient firms that are able to face off the threat of import competition, but they can do so only at the cost of personal effort. The emphasis on “small” and on firm-“owners” simply allows me to focus on less-developed countries (a focus of some of the recent literature), and to side-step any principal-agent problems, by assuming that firm-owners act as their own managers.

One stylized fact from the empirical literature, and the main motivation for this paper, is that competitive forces, and in particular those that can be attributed to openness to international trade, tend to drive up within-firm (or within-plant) productivity.1 Pavcnik (2002), for example, uses Chilean data to construct a very careful estimate of plant-specific total factor productivity, which she then regresses on time dummies and trade orientation dummies. During the period immediately after Chile’s trade liberalization in the early 1980s, plants in the import-competing sector had productivity gains on average 3% to 10% higher than plants in the non-traded sector. She summarizes her results thus (her emphasis): “Using plant-level panel data on Chilean manufacturers, I find evidence of within plant productivity improvements that can be attributed to a liberalized trade for the plants in the import-competing sector.” Fernandes (2007) uses big variations in her (also Chilean) data to identify the impact of openness on plant productivity, and finds that trade protection has a negative impact on plant productivity. Trefler (2004) distinguishes between the short-run effects on job losses and the long-run impact of the US-Canada Free Trade Agreement on labor productivity, and finds the latter to be large and positive. It is also useful to mention Backus (2014), who, in a non-international trade context, concludes: “I find no evidence of greater selection or reallocation in more competitive markets; instead, my results suggest that measured productivity responds directly to competition.” Taken together, the evidence suggests that firms respond to an increase in the pressure of competition (and in particular import competition) with technological improvement.

In taking up the question of what could be called “innovation-upon-openness” one must face two puzzles. The first puzzle is: if an improvement in a firm’s production is profit-increasing, why is that improvement not implemented earlier,  

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1This would not be the place for a full review of such a large body of research. For extensive reviews that focus at least partly on within-firm effects (there are also several reviews focused on allocation effects, which do not concern us in this article), the reader is referred to De Loecker and Goldberg (2014) and Goldberg and Pavcnik (2017).
before the country opens up to international competition? Consider the conclusion of MacDonald’s (1994) paper (my emphases): “[T]he evidence presented strongly suggests that growing international rivalry can impose new competitive pressures on firms that were previously insulated from competition ... The results appear to be robust and also suggest that domestic market power may not necessarily translate directly into higher margins and profits, but rather that higher prices may allow for higher costs.” But even if protection “allows for higher costs,” why do profit-maximizing firms take advantage of that license? Why is their behavior different when they are “insulated”? It must be that an increase in openness does not shift the technology frontier available to a firm-owner. Rather, it shifts his or her incentives to move towards the frontier. This is why in this paper I look at firm-owners effort, and place a cost on that effort. This cost is of course subject to a variety of interpretations, ranging from a psychic cost of the effort expended, to the cost of hiring a consulting firm. Here, I simply posit that it is the opportunity cost of foregone leisure: to improve their firm’s production process, firm owners need to spend time.2

The second puzzle, stemming from the IO literature, is that it is hard to understand how increased competition can induce innovation, since competition reduces the rents that are often the very rewards to the innovation. In this view, competition is detrimental to innovation (Aghion and Howitt 1992), a negative position however that has been questioned by empirical IO evidence (see Blundell, Griffith and van Reenen 1999 and Aghion et al. 2005). This theoretical challenge has been taken up most successfully in the context of a single economy with an agency problem: see Scharfstein (1988) and Schmidt (1997), for example. As in my model, the latter paper considers what happens if managers can invest in cost reductions. Increased competition has two effects: first, it renders high-cost firms unprofitable, increasing the incentives to invest in cost reductions; second, it may also reduce the profits of existing firms, depressing managerial incentives. It is interesting that by introducing trade, openness may cause the opposite of Schmidt’s second effect, thereby unambiguously raising firm owners’ incentives to invest time in productivity enhancements. This paper contrasts with both Scharfstein (1988) and Schmidt (1997), by foregoing the formalism of the principal-agent problem, which may be a less important consideration for less developed countries, in which a large proportion of firms are one-plant establishments (90% in Pavcnik’s data set), and by instead con-

2 The reader attuned to the history of economic thought will no doubt hear echoes of the theory of X-inefficiency (Perelman 2011, Leibenstein 1966), a workable definition of which is that a firm can increase output without increasing inputs, just by changing managerial practice. Indeed, one possible interpretation of the results in Pavcnik (2002) (made by the author herself) is that there is a “fat-trimming” process. Borenstein and Farrell (2000) provide strong evidence (from interviews with firm managers) that firms do respond to times of profit declines by fat-trimming. One paper that links X-inefficiency with international trade is Horn, Lang and Lundgren (1995). They also deal with the problem of whether international competition can help with increasing firms’ efficiency. Unlike this paper, their focus is on the design of the correct contracts. While I make explicit mention to the theory of X-inefficiency, it is important to recognize that I reconcile it, as others have (see Stigler’s 1976 critique of X-inefficiency, cited in Perelman 2011) by incorporating management leisure. Once this is done, there is no inefficiency!
sidering the impact of international trade on competition and productivity.

A few papers also model the impact of openness on productivity. In Holmes and Schmitz (2001), firms face one basic trade-off: they can either engage in R&D, or they can block their rivals’ R&D efforts. Both activities can be profit-increasing. Assume that the domestic country opens up to trade. Adding the assumption that firms are only able to block the R&D of their domestic rivals, but not their foreign rivals, then openness shifts the incentives towards R&D, and to higher productivity. In Ederington and McCalman (2007), fixed costs of exporting result in ex-ante identical firms sorting themselves into exporters and non-exporters. Firms that endogenously decide to export have larger market shares and therefore have an incentive to adopt technology earlier.

Some empirical evidence does suggest that individual firm owners react differently to different environments, vis-a-vis how (and indeed whether) they maximize their firms’ profits (see for instance Bertrand and Mullainathan 2003). In this paper, firm owners will be modeled just as other consumers in the economy who optimize between some combination of consumption goods and leisure. Their incentives to “work hard” depend on the relative price of leisure and consumption goods, which will change when the country opens up. Thus the essential margin in the model is between the leisure of firm owners and their income, and this margin is tied up with a constraint that specifies that they can spend some of their leisure time in order to increase their productivity, and therefore their income.3

To understand (following Becker 1965) that the utility function, besides containing consumption, should also contain a term for leisure, let us consider the proverbial harried executive who buys home theaters, a yacht, vacations, but has little time to enjoy them: the home theater sits idle, the yacht rots by the sea, vacation time is spent answering emails. This executive’s retiree neighbor has the same goods, but surely derives more utility from them, having the time to do so. Becker (1965) formalizes this by positing that some goods require a time input for their enjoyment. The assumption of leisure in the utility function is consistent with results by Patterson (1991). Using UK data on consumption and prices for 19 goods and services, four liquid assets and leisure (where the price of leisure is the wage), he finds that restricting the system to only the 19 goods and services causes a number of violations of the General Axiom of Revealed Preferences (GARP). The number of violations is reduced (in one specification, to zero) by inclusion of the liquid assets and leisure. Thus only the inclusion of the latter two goods “allows” consumers to have a utility function, since GARP is direct consequence of utility maximization.

Using this basic idea, I set up two models, and thus identify two mechanisms

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3 The trade-off between income and leisure is of course a key concern in the business cycle literature (Kydland 1995 and Ríos-Rull 1993 are just two examples), but it has not been used, to my knowledge, in the literature of international trade. It is also important in labor economics, for instance in the theory of home production (see the survey by Gronau 1986), which draws directly from Becker’s (1965) work. For an application of leisure to the theory of endogenous growth, see Ladrón-de-Guevara, Ortigueira and Santos (1999), where countries with high levels of human capital have a high price for leisure, causing people to work harder and therefore the country to grow faster.
with which openness increases the relative price of leisure. The first mechanism is that market integration leads to more varieties produced, which increases the competitive pressure on firms, in that it increases the elasticity of demand for their goods. As a result, firm owners work harder, causing their firms to be more likely to increase in productivity. Since this is accompanied by a reduction of prices, the effect is unambiguously welfare increasing. However, it thus becomes apparent that this will only happen if the increased number of varieties increases the elasticity of substitution among different varieties. This reverses the usual stance of the endogenous growth literature that an increasing elasticity of substitution, by decreasing the rents accruing to innovators, is detrimental to innovation. The reason, as eloquently put by Aghion et al. (2005) in the context of an endogenous growth model, is that the incentives to innovate depend not only on the post-innovation rents, but also on the difference between the post- and pre-innovation rents. Increased competition renders pre-innovation rents increasingly small spurring firm owners to innovate. In sum, the first model illustrates the often expressed (but not often formalized) intuition that openness serves as a wake-up call to managers that live the “good life” (more formally, that produce at a point below their firms’ technological frontier).

I also adopt the model to study a second mechanism. There, I define leisure to be a consumption good in itself, rather than just an input in the consumption of other goods. When countries open up, a major gain for consumers is an increase in the number of varieties available. Feenstra (1994) made that point, with more recent work by Broda and Weinstein (2006). As a consequence, real prices decrease, again changing incentives towards income, and away from leisure. This may be one way to rationalize Chinese trade policy. While internally the Chinese government was encouraging the remarkable buildup of private enterprise, in its trade policy it gradually opened up not only to producer goods, but also to virtually all consumer goods (including politically sensitive ones, such as internet usage, foreign travel, and maid services). If one models the Chinese government as concerned mostly with growth (and not with the static gains from opening up to consumers), one would expect much less openness in consumer goods than in producer goods, since only the latter type of openness has an impact on the production possibilities of a country. Even a cursory overview of the consumption goods available to common citizens in the early nineteen eighties would convince anyone that they were not sufficient to provide incentives to work hard. It is perhaps not too much of a stretch to imagine that the Chinese government decided to open up to many imported consumption goods to spur entrepreneurs to work harder.

By focusing on less-developed countries, I explicitly set aside a number of interesting economic problems, for example the question of how capital markets would step in to ameliorate the problem of sub-optimal firm performance. I shall simply assume that the environment in which the firms of this paper exist is characterized by imperfectly functioning (or even non-functioning) capital markets. It is simply assumed that saviors are not available to rescue under-

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4 However, the story in this paper could be more formalized even in the context of a well-
performing firms. A closely related possibility would have the firm-owner simply hiring a consultant who would ideate the process innovation that the firm-owner is unwilling to do. Again, I shall simply assume that markets are so badly functioning that such a hire is difficult to secure, so difficult indeed that simply finding the right consultant requires enormous managerial effort - which is what the firm-owner is unwilling to expend in the first place!

2 Model setup

The first model in this paper is based on the well-known monopolistic competition model, augmented by a term for “leisure,” broadly defined as consisting of all non-pecuniary disincentives for firm owners to “work harder.” Thus, I assume that there is a trade-off between the rewards of hard work and the rewards of leisure. As we shall see, the model yields substitution effects between leisure and income, as the relative “price” of leisure changes. Why this relative price changes becomes an important piece of the story.

A. Consumption and Production

Assumption 1 (Consumers) Consumers constitute a continuum of mass \(L\). In any equilibrium, a continuum of goods with mass \(N\) is available. The utility of a consumer who consumes \(q(\omega)\) of variety \(\omega\) and who has leisure \(l\) is given by

\[
U = l \left( \int_0^N q(\omega)^\beta d\omega \right)^{1/\beta}.
\]

\(\beta\) defines the elasticity of substitution between two different varieties as \(\sigma = \frac{1}{1-\beta}\). I assume that \(0 < \beta < 1\) (therefore \(\sigma > 1\)). Each consumer is endowed with one unit of labor and with \(l\) units of leisure. Labor is the inelastically supplied numeraire good. In general, \(\sigma\) may be an increasing function of the number of varieties available, in which case it can be written as \(\sigma(N)^5\).

functioning credit market, when firm-owners have private information about how much effort they put in. For example, Tirole (2006, p. 117) shows that borrowers must have a minimum level of assets in order to secure a loan, even when the return on such a loan to a risk-neutral lender would be positive or zero. For my purposes, it suffices therefore to assume that firm-owners are sufficiently low-net-worth.

The main consequence of this assumption is that the elasticity of demand for each variety increases with the number of varieties. Krugman (1980) argues that this is “plausible, since the more finely differentiated are the products, the better substitutes they are likely to be for one another.” The appendix shows that this result can be made more rigorous in the context of a model with a finite number of varieties, even with constant \(\sigma\). Thus, openness will increase the competitive pressure facing firms. The closest evidence for this mechanism that I know of is provided by Krishna and Mitra (1998), who study the dramatic trade liberalization episode that took place in India, circa 1991. Their evidence suggests that there was a decrease in the price-cost mark-up, suggesting an increase in competitive pressure in precisely the way I model here.
The utility function above includes a term for leisure, \( l \), entering multiplicatively. This rationalizes the notion that many goods require time to be consumed.\(^6\)

Firm owners will simply be workers that decide to start a firm, and thus have the same preferences as the workers. Firm owners and workers differ in two aspects only: owners will generally have more income (from their profits); while enjoying less leisure.

The production structure is standard, with the labor required to produce quantity \( q(\omega) \) of variety \( \omega \) being initially given by:

\[
L(\omega) = f + \overline{m} q(\omega) .
\]

(2)

Here, \( f \) and \( \overline{m} \) are the fixed and the marginal costs (in labor units), respectively.

**B. Effort and Productivity**

Initially, firms do not produce on their technological frontiers: there is a better technology available, with marginal cost \( m < \overline{m} \), and firm owners may attempt to acquire it. Note two characteristics of such an attempt. First, it must require some effort, and therefore cause a loss of utility, which is represented here by a loss of leisure time. Time may be required, for instance, for the firm owner to search among different varieties of the new technology, until she finds one that integrates well with the firm’s production structure; for her to research better outlets for the firm’s planned higher-quality products; alternatively, time may be required to adapt product characteristics to the tastes of a specific market; and so on.\(^7\)

Second, the outcome of the owner’s efforts may well be uncertain. The new technology (some of whose characteristics are likely to be tacit in nature) may only “reveal” itself after it is brought into the firm, and may not integrate with the existent facilities, or with workers’ skills; the upgraded product may not match the tastes of the firm’s customers, in spite of all marketing studies; or the owner may simply waste her time in a search for better technology,

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\(^6\)Becker (1965) posits final consumption goods “produced” by households that combine time with market goods. This is done with the production function \( Z_i = f_i(x_i, T_i) \), where \( x_i \) is the quantity purchased of good \( i \), \( T_i \) is the time spent consuming it, and \( Z_i \) is the final consumption good. My approach is similar, with two simplifications. First, I write \( Z(\omega) = q(\omega)T(\omega) \), that is, I define the household’s “production function” to be Cobb-Douglas with equal weights on time and consumption. Second, I assume the symmetric equilibrium in which consumption time of all varieties is the same. Then, \( T(\omega) \) is a constant that comes factors out in equation (1). Simplifying the household’s production function in this manner loses the notion of a changeable productivity of time, which is central to Becker’s analysis, but is necessary for my purposes.

\(^7\)Some of these possibilities fall outside the purview of this model, and indeed of what is normally defined as “productivity.” However, the model can be easily extended to include any of them. Suppose, for example, that a firm facing import competition responds by upgrading its product quality. This can be analyzed by assuming that quantities and prices are actually measured per unit of quality, and in particular if, for example, the firm uses the same labor to produce the higher quality product, the model becomes formally equivalent to a reduction in marginal cost. Such equivalency is the norm in empirical studies that use revenue - not quantity - in estimating the production function. 

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having stopped the search before a desirable fit is found. The assumption below captures these characteristics of owner effort.

**Assumption 2 (Firm owner effort; productivity)** Firm owners may spend time in an attempt to increase the productivity of their firms. They are successful with probability $\theta$, in which case their marginal costs change from $\overline{m}$ to $\underline{m} < \overline{m}$. To get a probability of success $\theta$, firm owners need to spend an amount of time $t(\theta)$, and furthermore: $t(0) = 0$, $t(1) = \infty$, $t'(\theta) > 0$, $t''(\theta) > 0$.

The assumptions that $t(1) = \infty$ and $t(0) = 0$ mean that no finite amount of time guarantees success, while owners that spend no time at all have no possibility of success. The assumption that $t''(\theta) > 0$ is what one would expect if there are decreasing returns to the owners’ time.

### C. Timing

Finally, there is an assumption on the timing of different agents’ actions.

**Assumption 3 (Timing of the model)** First, each worker decides independently whether to become a firm owner. Firm owners spend the fixed cost $\phi$, which is then sunk. Second, first owners decide how much time to invest in increasing productivity. Third, once they obtain their technology pick ($\underline{m}$ or $\overline{m}$), they decide independently how much to produce. Their role as owners ends, but they remain in the economy as consumers. All markets clear.

### 3 Three-stage optimization

The model can be analyzed in three stages. The first stage, in which workers decide whether to start up a firm, yields an equation for free entry. This will in equilibrium determine the number of firms and of varieties produced. In the second stage, firm owners choose the optimal amount of time to spend searching for the better technology. Given the strict monotonicity of the time functions $t(\theta)$, they equivalently choose the optimal probability of success $\theta$. This will give us one more equation. The third stage, in which all owners know their technologies and decide how much to produce, will yield the last two equations: one for the optimal production by owners with marginal cost $\underline{m}$ (which I shall call “productive” owners), and one for owners with marginal cost $\overline{m}$ (henceforth the “unproductive” owners). The analysis proceeds by backward induction.

#### A. Third-stage consumer optimization

Suppose that a mass $N < L$ of workers had decided in stage one to start up a firm. No two owners will produce the same variety, as standard competition modes such as Bertrand would then erase the profits of at least one of them. Therefore, $N$ also denotes the mass of varieties produced. In the third stage, the leisure of firm owners is fixed at $(\overline{I} - t(\theta))$, where $\theta$ is the strategy that they picked in stage two, and the leisure of regular workers is also fixed, at $\overline{I}$. In stage three, then, consumers (firm owners and workers) maximize only the consumption portion of their utility. The problem is equivalent to a standard
CES optimization, in which an individual with income $I$ issues the following demand for the typical variety $\omega$:

$$d(\omega) = \frac{p(\omega)^{-\sigma}}{\int_0^N p(\omega)^{1-\sigma} d\omega} I,$$

where $p(\omega)$ is the price of variety $\omega$. Equation (3) is also the aggregate demand for $\omega$, if $I$ is replaced by the aggregate income in the economy. Note that even though in general the elasticity of substitution increases with the number of varieties, we assume that no economic agent is large enough for his actions to have an impact on it. Moreover, I assume that $N$ is large enough (alternatively, that each firm is a set of measure zero), so that no single firm has a measurable impact on the price integral in equation (3). Therefore, from the point of view of each firm, $\sigma$ is also the constant elasticity of demand.

It is a straightforward exercise to derive the indirect utility function from equation (3):

$$V(I, P, l) = l \left( \frac{I}{P} \right).$$

This is for a consumer with income $I$ and leisure $l$, where the “price index” $P$ is defined as

$$P = \left[ \int_0^N p(\omega)^{1-\sigma} d\omega \right]^{\frac{1}{1-\sigma}}. \quad (5)$$

### B. Third-stage profit maximization

Let us assume the symmetric result, in which all firm owners have picked in stage two the same probability of success $\theta$. Then, the economy has a mass $\theta N$ of firms with marginal cost $\underline{m}$ (the “productive” firms), and a mass $(1 - \theta)N$ of firms with marginal cost $\overline{m}$ (the “unproductive” firms). In what follows, I denote productive and unproductive firms’ variable profits by $\underline{\pi}$ and $\overline{\pi}$, respectively.

The prices charged by productive and unproductive owners are $\underline{p}$ and $\overline{p}$, respectively. After substitution of these prices into the demand functions (3), we can calculate the quantity produced by unproductive firms as follows:

$$\overline{q} = \frac{\overline{p}^{-\sigma}}{\theta \overline{p}^{1-\sigma} + (1 - \theta) \underline{p}^{1-\sigma}} \frac{L - N + \Pi}{N},$$

with an analogous expression for the quantity supplied by productive firms. Here, $\Pi$ is aggregate profits and $L - N$ is aggregate wages (recall that labor is the numeraire good), therefore $L - N + \Pi$ is the aggregate income in the economy.

Each firm faces an elasticity of demand $\sigma(N)$, which from its point of view is a constant. An unproductive firm owner charges the usual mark-up: $\overline{p} = \overline{m}/(1 - 1/\sigma) = \overline{m}/\beta$. Analogously, a productive firm owner prices his variety
at \( p = m/\beta \). Substituting these prices in the equation above implies that the variable profits of unproductive firms are:

\[
\pi = (\bar{p} - \bar{m})\bar{q} = \frac{(1 - \beta) m^\sigma - 1}{\bar{m}^\sigma - 1 + \theta(\bar{m}^\sigma - 1 - m^\sigma - 1)} \frac{L - N + \Pi}{N}.
\]

(6)

Note that \( \bar{m}^\sigma - 1 - m^\sigma - 1 > 0 \), because \( \bar{m} > m \) and \( \sigma > 1 \). Productive firms’ variable profits are analogously obtained, and are written as:

\[
\pi = \frac{(1 - \beta)\bar{m}^\sigma - 1}{\bar{m}^\sigma - 1 + \theta(\bar{m}^\sigma - 1 - m^\sigma - 1)} \frac{L - N + \Pi}{N}.
\]

(7)

Both expressions above include the aggregate profit on the right-hand side, itself the sum of all of the individual profits on the left. We can aggregate all of the individual profits and solve for aggregate profits, yielding: \( \Pi = (1/\beta - 1)(L - N) - Nf/\beta \). Therefore, aggregate income is:

\[
L - N + \Pi = \frac{L - N(1 + f)}{\beta}.
\]

(8)

That is, aggregate income in equilibrium is completely given by the (endogenously determined) mass of firm owners. Finally, we can substitute aggregate income back into the equations for individual profits to obtain:

\[
\pi = \frac{1/\beta - 1}{B + (1 - B)\theta} \left( \frac{L}{N} - f - 1 \right), \quad \text{(Maximum Profit)}
\]

(9)

where \( B \equiv B(N) \equiv (m/\bar{m})^{\sigma(N) - 1} < 1 \) is a “profit differential” parameter, in that it summarizes the incentives that firm owners face. Indeed, \( B \) scales productive profits to obtain unproductive profits:

\[
\pi = B\pi.
\]

(10)

The smaller \( B \) is, the larger the gap between productive and unproductive profits, and thus, all else equal, the larger the incentives to innovate.\(^8\) Note that \( B \) can become smaller in two ways: a decrease in \( m/\bar{m} \), or an increase in \( \sigma(N) \). The first effect could happen if the technological leap available became more pronounced (exogenously to this model). The second effect, which implies an increase in the competitive pressure for each firm, can happen endogenously through an increase in the number of varieties, and it will play an important role in the paper.

\[C. \text{Second-stage firm owner optimization}\]

\(^8\)The notion that the incentives to innovate depend not on the absolute size of post-innovation rents but on the difference between pre- and post-innovation rents (precisely what is measured by this parameter \( B \)) is common with some later Schumpeterian literature (see for example Aghion et al. 2005).
When firm owners optimize in the second stage they take third-stage indirect utility (equation 4), as a given function of income and leisure, and they also take the profits above (equations 9 and 10), as given. The second stage problem is then reduced to picking a probability of success \( \theta \) that maximizes the expected indirect utility:

\[
\max_{\theta} \frac{[\theta \pi + (1 - \theta)\pi - f] \left[ T - t(\theta) \right]}{P} \quad \text{s.t.} \quad 0 \leq \theta \leq 1. \tag{11}
\]

When an interior solution obtains, this yields the following first order condition:

\[
\pi = \frac{f}{B + (1 - B) \left[ \theta - \frac{T - t(\theta)}{t(\theta)} \right]}.
\tag{12}
\]

The expression on the right yields, at constant \( \pi \), an inverse relationship between \( B \) and \( \theta \): more competition (lower \( B \)) leads to more effort (higher \( \theta \)).

**D. First-stage free entry**

Finally, we can write down the equation for free entry. A worker who considers in the first stage whether to start a firm takes the subsequent equilibrium path as given, and the marginal worker is indifferent about becoming a firm owner, yielding:

\[
\frac{\pi (B + (1 - B)\theta - f) \left[ T - t(\theta) \right]}{P} = \frac{T}{P}.
\]

The left hand side represents the expected utility of starting a firm, and takes as given the optimal value achieved by problem (11). The right hand side is worker utility, with less income (equal to one, from their labor), but more leisure. This equation for free entry can be equivalently written as

\[
\pi = \frac{f + \frac{1}{1 - t(\theta)} T}{B + (1 - B)\theta}.
\tag{13}
\]

**4 openness and the income-leisure trade-off**

One of the most oft-cited advantages of increased international openness is that firms, when presented with the stark pressures of international competition, have added incentives to invest in their own productivity. A number of avenues have been proposed that articulate the fact they do so only after their country opens up, for instance those proposed by Holmes and Schmitz (2001), Thoenig and Verdier (2003) and Ederington and McCalman (2007). In this section I study how the incentives of firm owners change with openness, which I shall model as the integration of identical countries. I show that openness serves as an inducement mechanism for firm owners who value their leisure, if and only if openness brings about higher elasticities of substitution. Specifically, as we shall see, openness increases the “price” of leisure relative to income. Firm owners
respond by reducing their leisure time, thereby increasing expected productivity of their firms. The world as a whole gains, because the average higher productivity leads to lower prices, with gains to consumers. Note that firm owners are also better off, even though they are spending more time: first, because their higher efforts allow them to earn more; second, as all other consumers they reap the benefits of lower prices.

A. Intuitive properties of the equilibrium

The model reduces formally to three equations in three variables. Equation (9) is the outcome of productive owners’ profit maximization during the third stage. Equation (12) is due to owners choosing the optimal time to invest in the second stage. Finally, equation (13) makes the marginal worker indifferent about starting a firm. The three endogenous variables are: $N$, $\theta$, and $\pi$. At the end of this section I present a formal proof for the properties of the equilibrium. However, it builds intuition to look in this subsection at the properties of the equation for owner optimization. In the next subsection I add free entry to the system, and finally in subsection C, I add the last equation for a full general equilibrium result. As we shall see, something can be learned from each of these three steps.

Owners’ optimization (equation 11) is essentially an unconstrained optimization problem, but it can be transformed into a constrained choice that addresses the essence of the intuition. Owners’ expected income is $I = \pi(B + (1-B)\theta) - f$ and their leisure is $l = I - t(\theta)$. These two quantities are tied into a constraint through $\theta$, and therefore the typical owner’s optimization problem can be rewritten as

$$\max_{I,l} I \quad \text{s.t.} \quad l = I - t \left(\frac{I + f - B(N)\pi}{\pi - B(N)\pi}\right),$$

where both the endogenous $B(N)$ and $\pi$ are constants from the point of view of the owner. Thus the owner maximizes indirect utility, subject to a constraint that ties leisure to expected income. This optimization problem is represented as the two solid lines in figure 1a, which shows the level sets of the objective function $I \ l$, and the owners’ optimal point $O$. We see the essential trade-off between income and leisure. Note that the slope of the constraint is the opportunity cost of income in terms of leisure. It is insofar as openness changes this relative price that it will change the incentives of firm owners as they maximize expected utility.

So far, this exercise was conducted at constant $\pi$ and $N$. Suppose now that $\pi$ increases, keeping $N$ constant. This relaxes the constraint as represented by the dotted line, causing owners to choose both more income and more leisure, decreasing the optimal probability of success $\theta$.

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9 These equations imply that the labor market clears. Total labor demand equals

$$N \left[ f + \theta m g + (1 - \theta) m \eta \right] = N f + \frac{(1 - \theta) \beta m^{\alpha - 1} + \theta \beta m^{\alpha - 1} L - N(f + 1)}{m^{\alpha} - 1} = N f + L - N(f + 1) = L - N,$$

which is also the total labor supply, since firm owners leave the labor force.
Let us now analyze an increase in $\bar{\pi}$ at constant $\bar{\pi}$, the outcome of an increase in openness. Since the profit differential $B(N)$ decreases with $N$, and we know that $I + f < \bar{\pi}$, the argument of the function $t(.)$ in equation (14) increases, causing the income-leisure constraint to go down. Intuitively, if $\bar{\pi} = B\pi$ goes down, and if firm owners’ keep the same level of effort, their expected income goes down. This is represented as the dotted curve in figure 1b, which also retraces the original constraint through point $O$. If this were all that happened, of course, firm owners would lose. But since in this figure $N$ is changing, we need to take the free entry condition (13) into account. Because firm owners are now at a lower indifference curve than regular workers (whose indirect utility is $T$), they are not indifferent about entry. If we now fix $N$, the only way to make them indifferent would be to increase $\pi$, until firm owners get back on the same indifferent curve as before ($T$). As already seen, as $\pi$ increases, the constraint increases. It becomes the new constraint in figure 1b, through the new optimal point $O'$. Lemma 1 shows that the new constraint must be flatter at all incomes than the old constraint, immediately leading to the conclusion that the new optimal point $O'$ is to the right of the original optimal point $O$: that is, with increased openness, firm owners have more income but less leisure, the outcome of the added pressure of globalization.

**Lemma 1.** i) With a higher $N$, $\pi$ increases until the owners’ constraint in problem (14) is tangent to the “indifference curve” that has $I l = T$. ii) The new constraint after the increases in $N$ and $\pi$ is everywhere flatter than the old constraint.

**Proof:** i) Any endogenous changes in $N$ and $\pi$ must change the owners’ constraint in such a way that it is tangent to the indifference curve where $I l = T$, because only then are the owners both optimizing and indifferent about becoming a firm owner. ii) To show that the new constraint must be flatter, consider the derivative with respect to $I$ of the constraint: $-t'\left(\frac{1 + f - B(N)\pi}{\pi(1 - B(N))}\right) \frac{1}{\pi(1 - B(N))}$

This evidently decreases in absolute value with both $N$ and $\pi$.

The lemma spells out the essential intuition of this paper, namely that the price of leisure after the country opens up increases. As already pointed out in a different context by Aghion et al (2005), the incentive to innovate is given by the difference between pre- and post-innovation rents, here $\pi - \pi = \pi(1 - B(N))$. The increases in $\pi$ and $N$ both act in the same direction, that of accruing to this incentive. Higher profits are a consequence of free entry, and they increase directly the incentives to innovate. Higher international competition, leading to higher $\sigma$ and lower $B(N)$, has a positive effect on the profit differential, even as it decreases profits. Note that after the increases in $N$ and $\pi$, firm owners obtain the same (expected) utility as workers, just as they they did before the increases: the indirect utility of all agents is $T/P$. But it is the way in which firm owners arrive at the same utility that matters. The increase in the relative price of leisure causes them to work harder in the search for better technology.

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10 With increased international competition, some firms will exit (that is, $N/L$ will go down), which excludes remaining firms’ profits.
losing leisure but gaining income. Finally, note that all economic agents gain, as the indirect utility increases due to a lower price index $P$.

**B. The role of the elasticity of substitution**

It is widely argued that one consequence of globalization is higher elasticities of demand, which add to volatility in prices, decrease profits, and may intensify the insecurity felt by workers. In the context of this model, it is possible to show that the increase in the elasticity of substitution due to the increase in the number of varieties is essential for a positive impact of openness, namely the increased incentive to innovate. The easiest way to see this is to plot equation (12) for owners’ optimal effort, fully adding now a second building block: equation (13) for free entry. This is shown in figure 2, in which the solid lines are drawn at constant $\mathcal{E}$. We already saw in the previous sub-section that with constant $\mathcal{E}$, owners’ optimization leads to a decreasing relationship between $\Pi$ and $\tilde{\theta}$ (figure 1a), which is plotted as line $O$ (for optimization). Why should the free entry condition, represented as line $FE$, have a U shape? The free entry condition is a level set for the indirect utility function, the same function for which line $O$ is the local maximum with respect to $\tilde{\theta}$. Thus, the assumption that there is an interior solution $\tilde{\theta}$ for owner effort leads to the relationship between the two curves: moving along the $\tilde{\theta}$ direction, we encounter first the level $\mathcal{L}=\mathcal{E}$ for the indirect utility, then the maximum indirect utility at line $O$, and then we come down to the level $\mathcal{L}=\mathcal{E}$ again. For any given $\mathcal{E}$, the equilibrium happens when firm owners are both optimizing and indifferent about remaining as workers: that is, at point $e$.

The first observation that we can make from figure 2 and equations (12) and (13) is that the only way that $\Pi$ can change the equilibrium $\Pi$ and $\tilde{\theta}$ is through $B(N) = (m/m)\sigma(N)^{-1}$. If the elasticity of substitution were a constant, figure 2 would determine a unique equilibrium $\Pi$ and $\tilde{\theta}$. $L$ would affect the model only through equation (9), in which case $N$ just increases in proportion to $L$.

The second observation is that, when the elasticity of substitution increases with the number of varieties, the increase in $L$ does change figure 2, as depicted by the dashed lines. Let us suppose that it is still true, even with a variable $\sigma$, that an increase in $L$ leads to an increase in $N$ (this will be made rigorous in the next sub-section). The increase in line $O$ is simple to understand: at fixed $\Pi$, the higher elasticity of demand leads to a lower profit differential $B$, which raises the incentives to search for higher productivity.

In order to understand why $FE$ increases with $N$, note that you can promise two things to entering firm owners: higher profits, or more leisure. At fixed $\tilde{\theta}$, an increase in $N$ lowers the profit differential $B$, depressing expected profits. The only way to make firm owners indifferent about founding a firm is to increase the profits of productive firms $\Pi$. Note that it would still be possible that the two curves go up but $\tilde{\theta}$ decreased. The following lemma states that the change in $N$ unambiguously leads to a higher $\tilde{\theta}$.

**Lemma 2.** When $N$ goes up, the following is true for figure 2. i) If $\sigma$ is a constant, the figure remains unchanged. ii) If $\sigma$ is an increasing function of $N$, both $O$ and $FE$ go up. iii) The increase in the two curves is such that the
new equilibrium point has a higher $\pi$ and a higher $\theta$, as depicted. Proof: in the appendix.

The main intuition to get from this sub-section is that with openness, and the accompanying larger number of varieties, two effects act against each other: first the incentives of firm owners are enhanced, causing them to innovate more. We already saw this in the previous sub-section, and here we see that the rise in curve $O$ leads to higher $\theta$. However, the increase in openness also deters entry, which by itself secludes firms and makes firm owners more comfortable about their profits and about using more of their leisure. In figure 2, a rise of $FE$ leads to larger profits and lower effort $\theta$.$^{11}$ The key point here is that it will always be the case that the former effect dominates the latter, and the incentive of firm owners to innovate always increases in the presence of openness, even if (and because) openness leads to import competition, and therefore to firm exit.

C. Formal proof

We can now close the model by bringing in the third equation (equation 9 for profit maximization), which so far was kept in the background. Let us first combine equations (9) and (13) to obtain:

$$\frac{1}{\sigma(N)} - 1 \left( \frac{L}{N} - f - 1 \right) = f + \frac{1}{1 - t(\theta)/T}. \tag{15}$$

Then, combine equations (12) and (13) to obtain:

$$\frac{f - t(\theta)}{t'(\theta)} \left[ f \left( 1 - \frac{t(\theta)}{T} \right) + 1 \right] = \theta + \frac{1}{1/B(N) - 1}. \tag{16}$$

Note that we have eliminated $\pi$ from the system, and therefore equations (15) and (16) constitute two equations in two variables, $N$ and $\theta$, and are depicted in figure 3. The following proposition establishes the main result of the paper.

**Proposition 1.** Equation (15) defines a decreasing relationship, and equation (16) defines an increasing relationship between $N$ and $\theta$, as depicted in figure 3. When $L$ increases, the curve corresponding to equation (16) does not shift. The curve of equation (15) shifts up, such that at each value of $\theta$, $N$ increases less than proportionally with respect to $L$. As a consequence, the impact of the increase in $L$ on the three endogenous variables is as follows: i) $\theta$ increases. ii) $N$ increases, but with a decrease in $N/L$. iii) $\pi$ increases. Proof: in the appendix.

That equation (16) defines an increasing relationship between $N$ and $\theta$ should not be surprising. Indeed, that equation combines owner optimization with free entry, and we saw in the previous sub-section, as well as in figure 2, that combining those two conditions leads to the conclusion that an increasing $N$ increases

$^{11}$This kind of effect is what motivates some negative results on the impact of import competition on innovation. Thus, for example, Miyagiwa and Ohno (1995) study firms’ incentives to delay adoption of new technologies, as the price of adoption decays with time. With more liberal trade policies, a foreign firm encroaches on the turf of a domestic firm, decreasing the latter’s incentive to innovate.
effort level. Furthermore, because equation (16) combines two decisions that have nothing to do with the market size, the equation itself does not change with the market size.\footnote{While considering whether to become a firm owner, a worker takes profits, effort level, and fixed cost into account, but not the market size. The same is true for the firm owner considering the optimal effort level.}

The intuition for why equation (15) should define a decreasing relationship between $N$ and $\theta$ is less direct. Recall that equation (15) combines the outcome of profit maximization with free entry. Suppose that $N$ increased, at constant effort level $\theta$. Even with constant elasticity of substitution, this decreases profits, since the higher number of firms incurs in more fixed costs, correspondingly decreasing income. But then the only way for free entry to hold is to decrease the effort level $\theta$. Finally, with a larger market, profits increase, causing the curve for equation (15) to go up (recall from figure 1a that an increase in $\pi$ at constant $N$ leads to a higher $\theta$).

I end this section with a comparative statics exercise. It is motivated by the result in Fernandes (2007) that the impact of openness on productivity is larger the lesser the degree of competitiveness in an industry. I simulate that in figure 4, which depicts the changes in several variables, as the fixed cost $f$ increases. A low fixed cost implies a high level of competitiveness in an industry. Not surprisingly, as $f$ increases, the number of entrants decreases, and the effort level increases as rents increase. Of more interest is the third graph, which plots the ratio between the effort level with a large world size $L$ ($\theta_{high}$) and the effort level with a small world size ($\theta_{low}$). As $f$ increases, the change in $\theta$ also increases, even though $\theta$ was already large to begin with, confirming the expectation of a larger effect for less competitive industries.

5 The role of the price index

When consumers value variety, one further advantage of free trade is the increased number of varieties that are made available to them. This gain from trade has been highlighted by Feenstra (1994) and Broda and Weinstein (2006), who calculate the decrease in the price index ($P$, in this paper) that results from trade openness. This section modifies the model to ask: if the decrease in $P$ increases the shadow value of income, can we rationalize that firm owners would as a consequence shift out of leisure? The current utility function (equation 1), is not adequate to answer this question, because $P$ does not alter the margin between income and leisure when leisure is just a shift factor in the utility. This much is evident from the owners’ problem, equation (11). Therefore, I depart more radically from Becker (1965) by introducing a different utility function, one in which leisure is valued as an additional consumption good. The easiest way to do so is to enter it additively:
$U = \left( \int_0^N q(\omega)^\beta d\omega \right)^{1/\beta} + \nu(l).$  \hspace{1cm} (17)

Here, the function $\nu$ has the usual properties: $\nu' > 0$, $\nu'' < 0$. Contrary to the previous utility function, in which consumers need time to consume all other goods, but otherwise have no use for time, consumers with utility function (17) value the consumption of leisure time by itself. The argument of this paper is that both uses for leisure are likely to be present, and therefore by separating them into two different utility functions, we are able to isolate the consequences for each of them.

The expression for the indirect utility now becomes:

$$V(I, P, l) = \frac{I}{P} + \nu(l),$$

and the basic mechanism at play in this section can be simply described: free trade decreases $P$, raising the shadow value of income. Firm owners that had been optimizing now value income more, and substitute out of some of their leisure. Thus, for example, in a society like China, where a large number of consumer goods and services were made available as the country opened up, people were suddenly motivated to become better entrepreneurs. Besides this modification, the rest of the model follows relatively unscathed, and a terse presentation should suffice.

We again have three equations in the three endogenous variables: $N$, $\theta$, and $\pi$. Equation (9) for profit maximization remains unchanged, because that equation calculates the profits of the productive firm owners in the third stage of the problem, when all leisure decisions have been “sunk.” Equation (12) changes to:\footnote{I assume in this section that $\sigma$ (and therefore $B$) is a constant, an important simplification since the algebra in this section is somewhat more involved. Note that the intuition of this section has to do with how $P$ changes. Assuming that $\sigma$ is a constant thus has the advantage of isolating that effect. Also note that I am again assuming an interior solution for $\theta$.}

$$v'(I - t(\theta)) t'(\theta) = \frac{\pi(1 - B)}{P}. \hspace{1cm} (Optimal \ \text{effort}) \hspace{1cm} (19)$$

This equation matches the marginal cost of extra probability of success (less leisure, on the left) to the marginal benefit (extra profits, on the right).

Finally, equation (13) changes to

$$\frac{\pi(\theta + (1 - \theta)B) - f}{P} + v(I - t(\theta)) = \frac{1}{P} + v(I). \hspace{1cm} (Free \ \text{Entry}) \hspace{1cm} (20)$$

In words, firm owners’ higher income and lower leisure allows them to obtain the same utility as workers.

As before, we can combine the equations two by two to get a rigorous solution. Combining equations (9) and (20), we have:
\[
N \{ f + \beta P \left[ v (T) - v (T - t(\theta)) \right] \} = (L - N)(1 - \beta). \tag{21}
\]

Note that \( P \) is a function of both \( N \) and \( \theta \) (see the appendix for the properties of the price index). Lemma 3 finds simple sufficient conditions for equation (21) to define a decreasing relation \( N(\theta) \).

**Lemma 3.** If \( \beta > 1/2 \) (that is, if \( \sigma > 2 \)), and if \( t'(\theta) \) is sufficiently large (as defined in the proof), then the implicit function \( N(\theta) \) defined by equation (21) is a decreasing function of \( \theta \). **Proof:** see the appendix.

Note that the sufficient condition that \( \sigma > 2 \) is reasonable. Broda and Weinstein (2006)‘s elasticities of substitution lie around five and above. The sufficient condition that \( t'(\theta) \) be sufficiently large means that the demands on owner time must be substantial, for the impact of leisure to matter.

To find a solution for the model, we need one more equation in \( N \) and \( \theta \), for which we make use of the conditions for owners’ optimal effort level and for free entry, equations (19) and (20), obtaining:

\[
v' (T - t(\theta)) t'(\theta) \left( \frac{B}{1 - B} + \theta \right) = \frac{f}{P} + v (T) - v (T - t(\theta)). \tag{22}
\]

Note the dependence on \( N \) through \( P \). Under the same general type of sufficient condition as in lemma 3, equation (22) defines an increasing relationship of \( N \) with respect to \( \theta \).

**Lemma 4.** If \( t'(\theta) \) is sufficiently large (as defined in the proof), then equation (22) implicitly defines a function \( N(\theta) \) that is monotonically increasing. **Proof:** see the appendix.

Since as just proven, equations (21) and (22) define a decreasing and an increasing relationship between \( N \) and \( \theta \), respectively, we can re-use figure 3 to show them. Figure 3 guarantees that if an equilibrium exists, then it is unique.

The next proposition establishes what happens when \( L \) increases.

**Proposition 2.** When \( L \) increases, the curve for equation (22) does not shift. With the sufficient condition that \( \sigma > 2 \), as in lemma 3, the curve for equation (21) goes up. As a consequence, both \( N \) and \( \theta \) increase. **Proof:** note that equation (22) does not depend explicitly on \( L \). To see that \( N \) in equation (21) goes up with fixed \( \theta \), note that \( L \) increases the right side of the equation. Therefore, \( N \) must increase, in order for the left-hand side to increase and for the right-hand to decrease. Note that \( \sigma > 2 \) is sufficient to ensure that the left side of the equation increases with \( N \).

Again, as in the previous section, world integration has a positive impact on productivity. As before, world integration is parametrized by an increase in \( L \): as more countries integrate in the world economy, they reproduce the autarky equilibrium described above, except that the aggregate work force equals the sum of the integrated countries’ work forces.

Note that \( L \) has no effect on equation (22). The reason is similar to the previous model. That equation combines two conditions: the optimal decisions of workers, when they are considering whether to establish a firm; the optimal effort level picked by firm owners. Profits enter these equations in exactly the
same way, namely through the indirect utility of income, given by $I/P$. For the individual worker who is considering becoming a firm owner, the size of the economy does not play a role, only the individual profits ($\pi$ and $\bar{\pi}$), the costs associated with the decision ($f$ and the various $v(l)$), as well as the probability of success ($\theta$). Of these, only the first group (profits) depends on the size of the economy. But this is precisely the group that enters the other condition, that of owner optimization. Therefore, it should be possible to eliminate profits once we combine the two conditions, and indeed this is what happens. Thus, the end result is unrelated to $L$.

By contrast, increasing $L$ raises the curve for equation (21), which is shown in figure 3 as a dashed line. The reason for the shift is straightforward. Remember that equation (21) gives, for a fixed $N$, the optimal owner effort (combined with the condition for free entry). If $L$ increases at constant $N$, aggregate income increases, driving up profits. This induces firm owners to spend more time in search for better technologies, therefore $\theta$ increases at constant $N$.

Since the average marginal cost can be written $\theta m + (1 - \theta)\bar{m}$, and $m < \bar{m}$ by construction, world integration also leads unambiguously to lower average marginal costs, and therefore to higher average productivity, for the industry as a whole. Note that this result is by no means a foregone conclusion in this version of the model. Even though the size of the market naturally leads to higher expected profits, and therefore, to higher effort and thus to higher productivity when all else is equal, here all else is not equal. In particular, the general equilibrium consequence of the shift of equation (21) is mediated by equation (22). Had the latter been downward sloping, for instance, which is possible if the requirements on managerial time are not sufficiently large (if $t'(\theta)$ is too small), this could lead to lower owner effort.

6 An illustration: the case of Mexican small firm owners

The foregoing sections study theoretically the impact that international competitive pressure can have on small firm owners’ effort. To explore this effect empirically I use the year 1996 of the “Encuesta Nacional de Micronegocios” (ENAMIN) survey, supplied by the Mexican “Instituto Nacional de Estadística, Geografía e Informática” (INEGI). This survey of Mexican small firm owners asks two questions that are important for my purposes: what industry he or she is in; and how many hours he or she works in a typical week.

The survey needed to be linked to international trade data, a process that I describe in detail below. I used the NBER-UN trade data (see Feenstra et al. 2005 for documentation), which provides bilateral trade flows by 4-digit Standard International Trade Classification, revision 2 (SITC), for years 1962-2000.

The industry classification used in ENAMIN is CAE (“Codificador de Actividades Económicas”), and the first step was to construct a correspondence
between CAE and SITC. The main difficulty in doing this was that SITC classifies goods while CAE classifies activities. For example, it is difficult to match CAE 0401 (hunting, performed with the aim of selling its products) to any SITC good in any meaningful way. In practice, most economic activities are closely associated with a good or type of good, making a correspondence possible.

A few examples on how the correspondence was constructed should suffice.14 First, and whenever possible, each 4-digit CAE was matched to a 4-digit SITC, as long as the descriptions for the two codes overlapped significantly. Thus, CAE 5001 (“Cuchillería y Similares, Tijeras, Navajas”) was matched with SITC 6960 (“Cutlery”). In many instances, however, there were 4-digit CAEs that matched better to a 3-digit (or even 2-digit) SITC. For example, CAE 5011 (“Utensilios agrícolas y herramientas de mano, brocas”) corresponds better to SITC 695 (“Tools for Use in Hand or in Machines”) than to any of its 4-digit sub-industries. In such cases, the 4-digit CAE is matched to all sub-industries that comprise the aggregate. The point here is that imports from any of those industries are potential competitors against firms in the CAE industry. The opposite situation also occurs, that is, one 4-digit SITC is best matched to a 3- or 2-digit CAE. For example, SITC 6940 (“Nails, Screws, Nuts, Bolts etc. of Iron, Steel, Copper”) matches to CAE 502 (“Fabrica de Clavos, Tornillos y Similares”). In cases such as these, the 4-digit SITC is also corresponded to all CAE sub-industries. In a few cases, one SITC was corresponded to several CAEs that were not part of the same group. For example, SITC 0616 (“Natural Honey”) was corresponded both to CAE 0209 (“Apicultura”) and to CAE 1905 (“Tratamiento y envase de miel, miel de maíz, de maple”). The overriding principle was to link potential competition from imports to each 4-digit CAE industry where such link is possible. Subtler cases were decided by using the documentation for CAE. For example, CAE 3201 and 3202 refer to printed books and periodicals, while CAE 3211 and 3212 refer to printing services. The first two codes refer therefore to import-competing industries, and were corresponded accordingly, while the latter two were not corresponded to any SITC and were designated as services. More generally, for all CAE that were not matched with an SITC, a variable (Branch) was created, equal to zero, one and two, if the CAE activity was deemed to be in manufactures, services, or government, respectively. The final correspondence thus has four variables: Cae87, Cae94, Sitc, and Branch.15

This correspondence was then used to construct several measures of trade competition. For each CAE industry \( i \) for which there is a corresponding SITC, they are: World, Latam, Nafta, OECD, China, HKMac, and ROW, denoting imports from the World, Latin America, the US and Canada, the OECD, China, Hong-Kong and Macau, and the rest of the world, respectively. As a measure of the increase in the international competitive pressure, for each variable I average the volume of trade for 1995 and 1996, and calculate how much it has increased or decreased, as compared to the average of world imports for the five previous

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14 This correspondence table is available to other researchers upon request.

15 One complication was that there were two versions of the CAE code, which I call CAE87 and CAE94.
years. These variables are called \( d\text{World}, d\text{Latam}, \) etc.

Table 1 presents a first set of results. Beginning with the variable \( \text{Hours} \) (the number of hours worked in a normal week by the firm owner), and in order to control for idiosyncratic reasons to work more or less in each industry, I used the average number of hours worked in each CAE industry from the ENAMIN 1994 sample to construct the dependent variable \( d\text{Hours9496} \), which is the relative increase or decrease in hours worked, relative to the 1994 average. Size may arguably be correlated with number of hours worked, and some variables control for size: \( \text{Workers} \) (total workers employed), \( \text{Monthly costs} \), \( \text{Monthly revenue} \), and \( \text{Monthly earnings} \) (the last three in new pesos). \( \text{Position} \) is a categorical variable equal to 1 if the respondent identifies as a “boss” and to 2 if he or she identifies as a “self-employed worker.” \( \text{Maquila} \) is a dummy for whether the firm is a maquiladora. There are also a series of self-reported problems: problems with clients (\( \text{Prob\_clients} \)), credit problems (\( \text{Prob\_credit} \)), interest rates too high (\( \text{Prob\_interest} \)), lack of financial resources (\( \text{Prob\_resources} \)), low earnings (\( \text{Prob\_lowearnings} \)), problems with the authorities such as the police (\( \text{Prob\_authorities} \)), excessive competition (\( \text{Prob\_competition} \)), trouble with workers or partners (\( \text{Prob\_personnel} \)), clients slow in paying (\( \text{Prob\_slowpayments} \)), bad products or materials (\( \text{Prob\_production} \)), other problems (\( \text{Prob\_other} \)), and whether there are no problems at all (\( \text{Prob\_noprob} \)). These variables take the value 1 for yes and 2 for no. Finally, some characteristics of firm-owners are included, such as sex (\( \text{Ownersex} \)), age (\( \text{Ownerage} \)), married status (\( \text{Ownerstatus} \)), and years managing the firm (\( \text{Years} \)).

One good aspect of this dataset is the likely exogeneity of the trade data. Empirical studies of the impact of trade on a variable of interest often suffer from the problem that the variable of concern has a reverse impact on trade. For example, if the goal is to find the impact of trade on national wages of skilled and unskilled workers, then one needs to worry about the impact that a change of relative wages might have on trade flows. Given that this is a survey of very small firms within the much larger Mexican economy, such concerns are mitigated here.

Not surprisingly, average hours worked in 1994 are a determinant of the change in hours worked. This would always be true, and exhibiting a negative coefficient, just from a purely mechanical reason, since the dependent variable is change in the hours worked. The second fact to note is that firm size (as represented by \( \text{Workers} \)) enters with the expected sign. However, many other characteristics that one would expect to be determinants of owner effort in fact do not have statistically significant coefficients. For example, monthly revenue does not seem to be a factor, and the same is true for most of the problems reported. In the next set of regressions, most variables that show statistically insignificant coefficients are dropped.

Turning now to the trade variable, it may be surprising that \( d\text{World} \) does not enter significantly. However, the key to the model is that firm owners react to import competition, not just to imports in the same aggregate industry. Since an “industry” may aggregate quite disparate goods, and since Mexico
trades mostly with developed countries, goods in the same industry may not only pose no competitive threat to small owners in the sample, but even be of complementary goods (imports of car parts, which are helpful for firms engaged in rebuilding old cars, for example).

Because of this it makes sense to separate world imports into several aggregates, both from developed and less developed countries. Table 2 shows such results. The variable *Monthly earnings* is likely to be endogenous to the number of hours worked (these are personal earnings as opposed to the related but firm-wide *Sales* and *Costs*), and it is dropped in the second model shown. Referring to the latter results, we see that imports from NAFTA have a negative impact on hours worked, while imports from the other developed region (OECD) seem to have a negligible impact. It is surprising that imports from China have a negative effect on hours worked, which is contrary to the predictions of the model. However, note that in the mid-1990s Mexico gradually lowered its protection against China, and competition may have been so fierce that many firms simply lost their business, and this may be reflected in the results. Note that imports from the rest of the world, which are imports from less developed countries, do seem to induce firm owners to work harder, as the model predicts. It is interesting, and in the context of the model quite suggestive, that controlling for self-reported problems with low earnings, the problem of lack of clients also seems to induce firm owners to work harder.

### 7 Overview and the difference between the two stories

We do not know exactly how leisure would enter utility: it may lie somewhere “in between” the two models presented here, one in which leisure is a multiplier that explains how much enjoyment consumers derive from their (other) consumption goods, and the other in which leisure is itself a consumption good.

Therefore, it is important to distinguish between the implications of the two models. The first effect identified here has to do most directly with import competition. In it, firm owners that see their incomes dwindle decide “belatedly” to increase their productivity. They do so because in the presence of openness the relative price of leisure goes up, creating incentives for firm owners to switch away from leisure and into higher productivity. For this effect to arise, all that is needed is import competition in the sector in question. Of course, in this paper I only modeled one sector, but it is clear that in a model with many sectors, the effect would still be there if the country only opened in one sector, although the effect would be limited to the sector that opened up. The main driving mechanism is an increasing elasticity of demand when countries open up. Importantly, even though this reduces profits (and so it would seem to drive down the incentives to innovate), it reduces the profits of unproductive firm owners more than those of productive firm owners, increasing the profit *differential* between them and therefore the incentives to innovate.
In the model in which leisure is a consumption good in itself, in order to isolate the effect I assumed that the elasticity of substitution (the main driving force in the first model) was a constant. Here, what matters is that even at constant goods prices, openness, by making more varieties available, drives down the real price of consumption goods, increasing the value of income, and thus the relative price of leisure, which induces firm owners to innovate. Note that for this mechanism to work it does not suffice to open in the sector in question. It’s necessary that the economy as whole opens up, which is the main difference between the implications of the models. Here the importance of firm owners being at the same time consumers is heightened: with the increased variety of goods they will want to substitute some extra income for some leisure.

In sum, this paper introduces two mechanisms for the common but rarely-modeled idea that increased openness motivates firm owners to work harder.
References


APPENDICES

A Model with Finite Number of Varieties

For tractability, the main body of the text considers a model with a continuum of varieties, and assumes that producers of each variety face increasing elasticities of demand when the number of varieties increases. This appendix shows that such an assumption can be made more rigorous, by considering a model with a finite number of varieties. The utility function is written as:

\[ U = l \left( \sum_{i=1}^{N} q_i^\beta \right)^{1/\beta}, \]

with notation similar to the main text. A consumer with income \( I \) issues the following demand for variety \( i \):

\[ d_i = \frac{p_i^{-\sigma}}{\sum_{j=1}^{2n} p_j^{1-\sigma}} I. \]

The producer of variety \( i \) maximizes profits, which can be written as

\[ \pi_i = p_i q_i - m q_i = \frac{(p_i - m)p_i^{-\sigma} - \theta}{p_i^{-\sigma} + P_{-i}} I, \]

with the notation \( P_{-i} = \sum_{i \neq 1}^{N} p_i^{1-\sigma} \). In the expression above, \( m \) is the producer’s marginal cost, which is \( m \) or \( \bar{m} \) for productive and unproductive producers, respectively. The first order conditions for profit maximization of variety \( i \) can be written:

\[ \frac{m}{\beta} = p_i \left[ 1 - \frac{(p_i - m)p_i^{-\sigma}}{N (\theta p_i^{1-\sigma} + (1 - \theta) \bar{p}^{1-\sigma})} \right], \quad (23) \]

where \( \theta \) is the equilibrium proportion of productive producers and \( p, \bar{p} \) are the equilibrium prices of the two types of varieties available. By replacing \( p_i \) in the equation above by one of these prices we get an equation that is obeyed in equilibrium, for a total of two equations that could in principle be solved exactly in the two variables (the prices themselves). Note that such solutions will be functions of \( 1/N \). Taking into account that \( N \) is very large, we can Taylor-expand each of the two equations up to terms of order \( 1/N \):

\[ p_i(1/N) = p_i(0) + \left( \frac{\partial p_i(1/N)}{\partial(1/N)} \right)_{1/N=0} \frac{1}{N} + O(\frac{1}{N^2}). \]

Substituting \( 1/N = 0 \) in equation (23), we can solve for \( p_i(0) \). Taking the derivative of the same equation with respect to \( 1/N \), substituting \( 1/N = 0 \) allows
us to solve for \( \frac{\partial p_{1/N}}{\partial 1/N} \bigg|_{1/N=0} \). Substituting everything into the expression above yields for one of the equations:

\[
\frac{\pi}{\mu} = \frac{1}{\beta} + \frac{(1/\beta - 1)}{N(\theta + (1 - \theta)B)},
\]

with analogous expressions for the other price. The usual result of a constant mark-up is obtained in the limit when \( 1/N \) is very large: \( \frac{\pi}{\mu} = \frac{1}{\beta} \). Here, we wish to retain one more term, that of \( O(\frac{1}{N}) \). We see that the mark-up is decreasing with \( \mu \), which is consistent with fiercer competition as the number of varieties rises. In the main body of the paper I simply take the short-cut of an increasing elasticity of demand (which is directly related to the mark-up) when \( \mu \) increases.

**Proof of Lemma 2**

The argument for parts i) and ii) can be found in the main text. To prove part iii), consider a small negative change in \( \tau \), that is \( \delta \tau < 0 \). Starting from the initial equilibrium \( \varepsilon \), and a constant \( \nu \), the differential change in curves \( \pi \) and \( \pi' \) are calculated as follows:

\[
(d\pi)^O = \frac{\pi(-dB)(1 - \tilde{\theta})}{B + \theta(1 - B)},
\]

\[
(d\pi)^{FE} = \frac{\pi(-dB)(1 - \theta)}{B + \theta(1 - B)},
\]

respectively, where \( \tilde{\theta} \equiv \theta - \frac{T(t(\theta))}{t(\theta)} \). Since the expression \( \frac{1 - \theta}{B + \theta(1 - B)} = \left( B + \frac{1 - \theta}{\pi + 1 - \pi} \right)^{-1} \) goes down with \( \theta \), and \( \tilde{\theta} < \theta \), then \( (d\pi)^O > (d\pi)^{FE} \). This implies that the equilibrium point \( \varepsilon \) moves upward and to the right. Therefore the new equilibrium values of \( \theta \) and \( \pi \) verify: \( \theta' > \theta \) and \( \pi' > \pi \).

**Proof of Proposition 1**

Note that the right-hand side of equation (15) increases with \( \theta \) but does not vary with \( N \), while the left-hand side decreases with \( N \) (recall that \( \sigma \) increases with \( N \) and does not vary with \( \theta \)). This establishes that equation (15) defines a decreasing relationship between \( N \) and \( \theta \).

Next, suppose that \( \theta \) increases in equation (16). This increases the right-hand side and decreases the left-hand side, given the assumptions on \( t(.) \). Therefore \( N \) must adjust to decrease the right-hand side, which it can do by increasing \( \theta \) (recall that \( B(N) \) decreases with \( N \)). This establishes that equation (16) defines an increasing relationship between \( N \) and \( \theta \).

Let us now see what happens when \( L \) changes. Obviously, equation (16) does not depend on \( L \) at all, and therefore it does not shift. As for equation (15), imagine for one instant that \( \sigma \) were a constant. Then, at fixed \( \theta \), \( N \) would just increase in proportion to the increase in \( L \), such that \( L/N \) remained a constant. However, since \( \sigma \) actually increases as a consequence of the increase in \( N \), the left side of the equation becomes smaller than the right side. To compensate,
$N$ has to decrease somewhat, starting from the proportional increase. As a conclusion, at a fixed $\theta$, $N$ increases, but $N/L$ decreases.

This shift in the curve for equation (15) immediately leads to the conclusion that the equilibrium moves from $e$ to $e'$ in the figure, yielding a less than proportional increase in $N$, and a decrease in $\theta$. Once we establish that $N$ goes up, we can simply use Lemma 2 to imply that $\pi$ must go up.

**Properties of the “price index”**

The price index is defined by equation (5), which is repeated here for convenience:

$$P = \left[ \int_0^N p(\omega)^{1-\sigma} d\omega \right]^{\frac{1}{\pi}}.$$  

Given the prices charged by the productive and the unproductive firm owners, and their respective proportions, this expression becomes

$$\frac{1}{P} = N^{\frac{1}{\pi-1}} \beta \left( \frac{\theta}{m^\sigma-1} + \frac{1-\theta}{m^\sigma-1} \right)^{\frac{1}{\pi-1}}.$$  

(24)

Since $\sigma > 1$, $1/P$ is an increasing function of $N$. Furthermore, if the assumption that $\sigma > 2$ is made, as it is in section 6, then $1/P$ increases faster than $N$, as $N$ itself increases. In particular, it will then prove useful to calculate $\partial P / \partial N$. Since $P$ can be written as $P = N^{-\frac{1}{\pi-1}} C$, where $C$ does not depend on $N$, then $\frac{\partial P}{\partial N} = -\frac{1}{\pi-1} P$. It will also be useful to calculate $\frac{\partial P}{\partial \theta}$, which is done below:

$$\frac{\partial P}{\partial \theta} = -P \frac{1}{\sigma - 1} \left[ \frac{\theta}{m^\sigma-1} - \frac{1}{m^\sigma-1} \right]$$  

(25)

Note that this derivative is negative.

**Proof of Lemma 3**

We begin the proof by showing that the left hand side of equation (21) increases with $N$, at constant $\theta$. Note that $V(\theta) = v(\bar{I}) - v(I - t(\theta))$ is an increasing function of $\theta$, but it is not a function of $N$. Therefore, $\frac{\partial}{\partial N} [f + \beta PV(\theta)] > 0 \iff f + \beta PV(\theta) + N\beta \frac{\partial P}{\partial N} V(\theta) > 0$. We can use the expression for $\frac{\partial P}{\partial N}$ calculated above, to get $f + \beta PV(\theta) + N\beta \frac{\partial P}{\partial N} V(\theta) = f + \beta PV(\theta) - \frac{1}{\pi-1} \beta PV(\theta) = f + \beta PV(\theta) (2 - 1/\beta)$. Noting that both $P$ and $V(\theta)$ are positive, the condition $\beta > 1/2$ is sufficient (but not necessary) to ensure that the last expression is positive.
Let us now show that the left hand side of \(21\) increases with \(\omeg\), at constant \(N\), which amounts to show that \(\frac{\partial PV(\theta)}{\partial \theta} > 0\). Using the expression for \(\partial PV(\theta)\) obtained above, this is equivalent to:

\[
P \left[ v' \left( \bar{T} - t(\theta) \right) t'(\theta) \right] > VP \frac{1 - B}{\sigma - 1} \frac{1}{B + (1 - B)\theta},
\]

which can be simplified to

\[
t'(\theta) > \frac{V(\theta)}{(\sigma - 1)v' (\bar{T} - t(\theta)) \left[ \frac{B}{1 - B} + \theta \right]}.
\]

For any given utility of leisure \(v(l)\), the assumptions on its derivatives imply that \(v'(\bar{T} - t(\theta))\) and \(V(\theta)\) are bounded, and so is \(\theta < 1\). Therefore the right-hand side of inequality above is a positive bounded number, and the inequality becomes a condition on \(t'(\theta)\) being sufficient large, as stated by the lemma.

Given that the left-hand side of equation \((21)\) increases with both \(N\) and \(\omeg\), and that the right-hand side decreases with \(N\), the equation defines a decreasing relationship \(N(\theta)\).

**Proof of Lemma 4**

Let us first assume that both \(\theta\) is an interior solution, that is \(0 < \theta < \theta_{\text{max}}\), where \(\theta_{\text{max}}\) is defined as \(t(\theta_{\text{max}}) = \bar{T}\). Denote the left-hand side of equation \((22)\) by \(L(\theta)\), and its right-hand side by \(R(N, \theta)\). Let us show that both \(L(\theta)\) and \(R(N, \theta)\) increase with \(\theta\). This is because: first, as was shown above, \(\frac{\partial}{\partial \theta} (P) < 0\); second, \(V'(\theta) > 0\), where \(V(\theta)\) was defined in the proof of lemma 3; third, \(\frac{\partial}{\partial \theta} \left( v'(\bar{T} - t(\theta)) t'(\theta) \right) = v''(t'(\theta)) + v' t'' > 0\), where to avoid clutter all arguments (such as \(\theta\) or \(\bar{T} - t(\theta)\)) will be suppressed for the remainder of this proof.

It is also possible to show that if \(t'(\theta)\) is sufficiently large, then \(L'(\theta) > R'_s(N, \theta)\). This is equivalent to

\[
\left[ -v''(t'(\theta))^2 + v' t'' \right] \left( \frac{B}{1 - B} + \theta \right) + v' t' > f \frac{\partial}{\partial \theta} \left( \frac{1}{P} \right) + v' t' . \tag{26}
\]

By substitution from equation \((25)\), the inequality becomes

\[
\left( -v''(t'(\theta))^2 + v' t'' \right) \left( \frac{B}{1 - B} + \theta \right) > \frac{f}{\sigma - 1} \left( \frac{1}{P} \right) .
\]

Substituting from equation \((22)\) for \(f/P\), this is in turn equivalent to

\[
\left( -v''(t'(\theta))^2 + v' t'' \right) \left( \sigma - 1 \right) \left( \frac{B}{1 - B} + \theta \right)^2 > v' t' \left( \frac{B}{1 - B} + \theta \right) - V(\theta).
\]

Since \(V(\theta)\) is strictly positive and \(v' t''\) is positive, a *sufficient* condition for the inequality above is that
Now suppose that $N$ increases, with fixed $\theta$. Note that $L(\theta)$ does not depend on $N$, while since $\frac{d}{dN}$ increases with $N$, $R(N, \theta)$ increases with $N$. Since, as we just proved, $L'(\theta) > R'_0(N, \theta)$, $\theta$ must increase to recover the equality of equation (22), which therefore defines an increasing relationship between $\theta$ and $N$, as we wanted to prove.
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*Significant at the 10% level. **Significant at the 5% level. ***Significant at the 1% level.
Constraint: \( l = \bar{l} - \frac{I + f - B(N)\pi}{\pi - B(N)\pi} \)

Figure 1a – Owner’s constrained optimization, variable \( \pi \), constant \( N \).

Level set: \( II = \bar{l} \)

New constraint: higher \( N \) and \( \pi \)

Old constraint

Figure 1b – Owner’s constrained optimization, variable \( \pi \) and \( N \).
Figure 2 – Equations 12 (O – optimal effort) and 13 (FE – free entry), $N$ constant.
N increases less than proportionally in equation 15

Equation 16, equation 22

Equation 15, equation 21

Figure 3 – Change in the full equilibrium with increasing $L$. 
Figure 4 – Changes of endogenous variables with increasing $f$. 