

Competition, Innovation, and the Number of Firms[†]

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ABSTRACT

I look at manufacturing firms across countries and over time, and find that barriers to competition actually *increase* the number of firms. This finding contradicts a central feature of all current models of endogenous markups and free entry, that higher barriers should reduce competition and firm entry, thereby increasing markups. To rationalize this finding, I extend a standard model in two ways. First, I allow for multi-product firms. Second, I model barriers as increasing the cost of entering a product market, rather than the cost of starting a firm. Higher barriers to competition reduce the number of products per firm and per market, but increase markups and the total number of firms. While barriers increase market shares for each product in the model, encouraging innovation, firms also shrink their number of products, discouraging innovation. On net, barriers *decrease* firm-level innovation, consistent with a large empirical literature. I interpret an episode of product market deregulation (the Single Market Programme in the E.U.) through the lens of the model, and estimate an increase in productivity of 8.4% in deregulated industries. I show this estimate would be 20% lower if deregulation was mistakenly modeled as lowering firm startup costs. As evidence for the central mechanism in the model I show that across countries, higher barriers are associated with fewer products per firm.

Keywords: product market regulation, entry costs, firm size, productivity, innovation, markups, competition, multi-product firms.

JEL codes: L1, L5, O1, O3, O4.

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1 Introduction

There is now an abundance of empirical evidence that more competition (i.e., lower markups) and lower barriers to competition are associated with more firm-level innovation and higher aggregate productivity.¹ Current models with free entry and endogenous markups connect markups to the number of firms through Bertrand competition (Bento, 2014a; Peters, 2015), Cournot competition (Edmond, Midrigan, and Xu, 2015), Lancaster preferences (Desmet and Parente, 2010), and linear demand (Melitz and Ottaviano, 2008). Some of these models address the question of innovation, some do not. But a common feature across all of these models is that barriers to competition, modeled as barriers to starting a firm, should reduce the number of firms. Higher barriers lower the value of entry, which results in less entry and fewer firms. This consequence of high barriers is unambiguous, straightforward, and very intuitive. It is also, apparently, wrong.

Figure 1 shows how the number of firms per worker in a country's manufacturing sector varies with the level of product market regulation in a cross-section of 44 countries. These data, which I describe later in more detail, are from Bento and Restuccia (2017) and the OECD's Indicators of Product Market Regulation (PMR). In contrast to the predictions of current models, Figure 1 shows very clearly that countries with high barriers to competition have far *more* firms. For example India, which has the highest measured barriers in the sample, has about seven times as many firms per worker as the U.S., while Spain (median barriers) has twice as many firms per worker. This is not just a cross-country phenomenon. Using separate panel data from a number of European Union (EU) members and non-EU countries, I show that the implementation of the Single Market Programme (SMP), which lowered barriers to competition in certain industries in the early 1990s, led to a subsequent drop in the number of firms in affected industries, relative to industries and countries that were unaffected by the SMP. This contrast with theory is particularly puzzling because another prediction of the models, that markups should increase

¹For example, see Nickel (1996), Blundell, Griffith, and Van Reenen (1999), Nicoletti and Scarpetta (2003), Aghion, Braun, and Fedderke (2008), and Griffith, Harrison, and Simpson (2010).

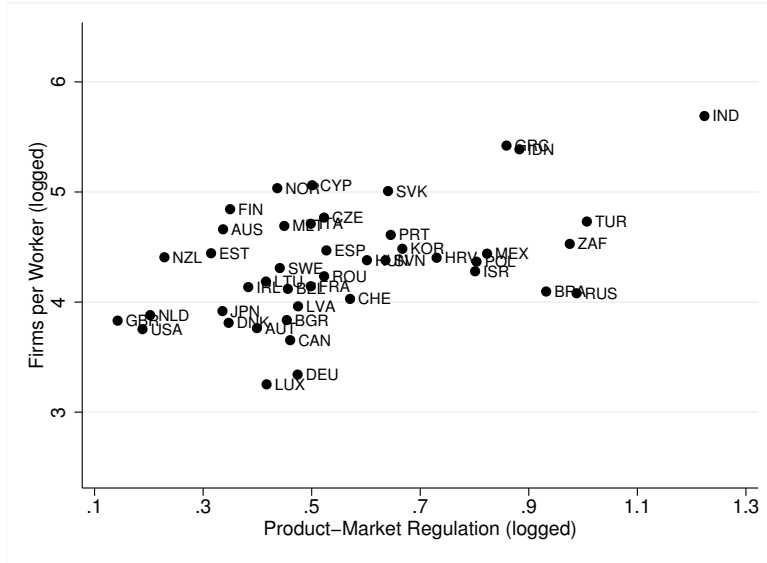


Figure 1: Product-Market Regulation and the Number of Firms

with barriers, seems to hold up empirically.

In this paper I show that all of these empirical phenomena can be rationalized by extending a standard model of endogenous markups and free entry in two very simple ways. First, I allow for multi-product firms. This breaks the link between the number of firms present in an industry and the number of firms competing in each product market. Second, I model barriers to competition as barriers to entry into a product market, rather than barriers to starting a firm.² I keep the model as simple as possible to highlight the central mechanism. Potential firms choose whether or not to become producers, how many product markets to enter, and how much to invest in firm-level productivity (I call this innovation). In each product market firms then produce a differentiated good in competition with other firms. I compare equilibria with different fixed costs of entering a product market, and find that higher market entry costs reduce the number of products per firm. For a given number of firms this must reduce the number of competitors within each product market. If markups are constant in the number of competitors, then both the total number of firms and innovation per firm are both unaffected (while fewer competitors mean higher market shares per product, the drop in the number of

²In a model with one-product firms, these two barriers would be indistinguishable.

products per firm exactly offsets this, leaving the incentives to enter and invest unchanged). But if markups increase when the number of competitors drop (say, due to Cournot competition), then these higher markups increase the value of starting a firm. As a result, entry and the number of firms increases. And as the price elasticity of demand is decreasing as the number of competitors drops, the incentive to innovate decreases, resulting in less innovation per firm.

The model developed in this paper is quite parsimonious, and can easily be taken to the data. By calibrating the model to match some relevant elasticities estimated in the empirical literature, as well as the estimated impacts on markups and the number of firms, I show how the model can be used to predict the quantitative impact of the Single Market Programme on outcomes. The impact is substantial. I estimate that in industries affected by the SMP, markups dropped by 9%, the number of firms dropped by 32%, productivity investment increased by 9% (as a share of output), and industry-level total factor productivity increased by 8.4%. I show that if I were to assume the drop in markups due to the SMP was driven by lower firm startup costs, then I would mistakenly predict a *drop* in productivity investment. As a result, the estimated increase in total factor productivity would be 20% lower.

In addition to rationalizing the empirical relationships between competition, markups, and innovation, the model generates one more testable implication - that countries with higher barriers to competition should have fewer products per firm. Using firm-level data from a number of countries, I present evidence suggesting exactly this.

The model is a very standard one of free entry and endogenous markups, extended to allow for both multi-product firms (as in Bernard, Redding, and Schott, 2010) and firm-level investment in productivity. I hasten to emphasize that none of the separate features of the model are new. The contribution of the model is to show how incorporating all of these features allows me to rationalize several empirical phenomena related to entry barriers and competition, and to quantify the impact of observed differences in entry barriers.

All current models with free entry and endogenous markups can generate the empirical link between markups and barriers to entry. Only one model (Bento, 2014a), to my knowledge, has been able to generate a negative relationship between entry barriers and firm-level innovation. But Bento's (2014a) model is somewhat stylized and difficult to take to the data. And of course, it has the inconvenient implication that barriers to entry must decrease the number of firms. Developing a model with free entry that predicts higher firm-level innovation when barriers to competition are reduced has proven to be difficult (see Holmes and Schmitz (2010) for a discussion of this point), as the lower market shares that result from higher firm entry should result in lower incentives to innovate - a point made by Schumpeter (1942). Related to this, a number of papers have developed mechanisms through which competition can somehow encourage innovation when the number of competitors is exogenous.³ But Etro (2007) suggests that this result disappears when entry is made endogenous. The model developed here offers a simple, very intuitive explanation for the empirical relationship between competition and firm-level innovation. The Schumpeterian mechanism is still present so in any given product market, the lower market share induced by lower barriers decreases the incentive to innovate. But the greater number of products per firm induced by lower barriers increases firm-level innovation, resulting in a net effect of either no change in innovation per firm (if markups are constant), or more innovation per firm (if markups decrease).

Although in this paper barriers to competition are interpreted as barriers to product market entry, they could just as easily be interpreted as barriers to entry into geographical markets.⁴ As such, the results of the model developed in this paper are consistent with the U.S. experience with barriers (and the reduction of barriers) to branch banking. Carlson and James (2006) document evidence of how the easing of restrictions on branch banking resulted in more bank branches and more competition between branches, but fewer banks, all consistent with the results of this paper.

³For example see Aghion, Dewatripont, and Rey (1999), Aghion and Griffith (2005), and Aghion et al. (2005).

⁴This is especially true for the service sector, where to a large extent firms must create a new establishment to serve each new market.

There is a long tradition in the antitrust literature (both in and outside of economics) of drawing a distinction between the number of firms in an industry and the number of firms competing in a market.⁵ The analysis in this paper confirms the importance of this distinction by showing how barriers to competition can lead to opposite effects on the number of competitors in a market, and the number of firms in an industry.

By analyzing the effects of entry barriers on the number of firms, both empirically and in theory, this paper contributes to the growing literature attempting to explain differences in average firm size (the inverse of the number of firms per worker) across countries. See, for example, Bhattacharya, Guner, and Ventura (2013), Hsieh and Klenow (2014), and Bento and Restuccia (2017), who point to policies and institutions causing both a misallocation of inputs across firms and a reduction in average firm size. The present paper complements this literature by showing how a specific type of policy (increasing barriers to competition) can increase firm size differences across countries.

In the next section I describe the data used to produce Figure 1 and show that the positive relationship between entry barriers and the number of firms is robust to including various controls. I provide further evidence of this relationship by analyzing the impact of the Single Market Programme on affected country-industries in the European Union. In Section 3 I describe the model, characterize equilibrium, and discuss its key implications. I calibrate the model in Section 4 and quantify the impact of observed entry barriers. In Section 5 I describe the data used to test the relationships between markups and products per firm, and show that the data is consistent with the implications of the model. The final section concludes.

⁵In economics, see for example Stigler and Sherwin (1985), who propose a method for market delineation based on price data.

2 Barriers to Competition and the Number of Firms

Here I provide evidence from both cross-country and panel data that barriers to competition increase the number of firms. I begin with the cross-country evidence.

2.1 Across Countries

I provide details about the data illustrated in Figure 1 and show that the relationship between barriers to competition and the number of firms is robust to controlling for other country-specific characteristics that could affect the number of firms. My measure of barriers to competition in this section is from the OECD's Indicators of Product Market Regulation (PMR). The PMR database reports an economy-wide index of how restrictive regulations are for competition in 47 countries, 34 of them OECD and 13 non-OECD. The PMR index is constructed using answers to over 700 survey questions asked of government officials in each country. The final index value given to each country can range from 0 to 6, with a higher value indicating a regulatory environment more restrictive to competition. The database contains measures of PMR for as many as four years between 1998 and 2013 for OECD countries and as many as two years (2008 and 2013) for non-OECD countries. Given the lack of data for non-OECD countries before 2008, I use each country's 2008 value when available, and its 2013 value otherwise. More details about the construction of the dataset are provided in Koske et al. (2015).

Data on the number of firms across countries is from Bento and Restuccia (2017), who use hundreds of census reports, business registries, and reports on representative surveys to construct a standardized measure of average establishment size in manufacturing, defined as the number of persons engaged per establishment, for 134 countries. The data is constructed in such a way as to be representative of all manufacturing establishments, large and small, formal and informal, employer and own-account. My measure of the number of firms per worker is the inverse of the measure used in Bento and Restuccia (BR), multiplied by 1000. Although only

13 countries in the sample report counts for both the number of establishments and the number of firms, it is worth noting that the number of establishments per firm across these countries shows no apparent relationship to GDP nor to the level of product market regulation. Of the 134 countries in the BR data, 44 are included in the PMR database.

Of course other country-specific institutions and policies besides barriers to competition could affect the number of firms.⁶ To control for these other factors, I use data from the World Bank's Doing Business project. Doing Business reports both the monetary cost and time involved in dealing with a host of regulations that impact the running of a business (and therefore, presumably, the incentive to start a firm). For each variable covered, an overall measure is constructed of how stifling are the relevant regulations. I use the values of these overall measures for the ease of setting up a limited liability company, securing a construction permit, registering a commercial property, obtaining an electricity connection, obtaining credit, complying with tax regulations, engaging in international trade, enforcing contracts, resolving insolvency, and protecting the rights of minority shareholders.⁷

The first column of Table 1 shows the results of an OLS regression of the (logged) number of firms in each country on each country's (logged) PMR Index value. The point estimate is statistically significant and suggests an increase in PMR of one percent is associated with a one percent increase in the number of firms. The second column shows that this estimate is only marginally lower (and still significant at the 5 percent level) when the ten variables from Doing Business are included in the regression. To ensure these results are not being driven by outliers, the third column reports the results of an OLS regression with India (which has the highest PMR score in the sample), Luxembourg (which has the lowest number of firms in the sample), and Germany (similarly low number of firms) excluded. Although not shown here, both the level of significance and the point estimate on PMR are marginally higher when only

⁶For example, Bento and Restuccia (2017) argue that policies and institutions which cause a misallocation of factor inputs across firms can lead to a greater number of firms.

⁷The Doing Business scores range from 0 to 100. Because I use logged variables in the regressions below, I replace 0 with 0.1 in 31 cases. Values for 2006 are used when available. Otherwise, the earliest available year after 2006 is used. See doingbusiness.org for more details about the data and methodology.

Table 1: PRODUCT MARKET REGULATION AND THE NUMBER OF FIRMS

dependent variable:	<i>number of firms</i>		
PMR	1.00*** (0.29)	0.95** (0.44)	0.92** (0.39)
controls included	no	yes	yes
outliers included	yes	yes	no
R^2	0.25	0.44	0.39
observations	44	44	41

Notes: PMR is from the OECD’s Indicators of Product Market Regulation, and number of firms per worker is from Bento and Restuccia (2017). All controls are from the World Bank’s Doing Business dataset. All variables are logged, and robust standard errors are in parentheses. *** and ** refer to one and five percent levels of significance.

India is excluded. Also, significance levels are marginally higher when variables are not logged.

2.2 A Natural Experiment

Despite the large number of controls included in the regressions of the previous section, the possibility always remains that omitted variables are driving the observed relationship between barriers to competition and the number of firms. To address this, I study a particular episode of product market deregulation. The Single Market Programme (SMP) was a large-scale program that set out to reduce barriers to competition and non-tariff barriers to trade within and between E.U. member countries. All reforms were intended to be implemented by the beginning of 1993. Many were not, but Notaro (2002) reports that 93% of all SMP reforms had been implemented by 1996. What makes this a particularly appealing episode to study is that the SMP was intended to reduce barriers to a common low level across industries in all E.U. countries. As a result, the effects of the SMP were expected to vary across industries and across countries within each industry depending on how high barriers were in each country-industry before the SMP was implemented. This allows me to use exogenous variation in the magnitude of reforms

across country-industries to identify the impact of the SMP on the number of firms within an industry. This episode has been exploited in several studies to identify the effects of barriers to competition on markups and innovation (for example, Griffith, Harrison, and Simpson, 2010, and Aghion et al., 2005). For more details, see Griffith, Harrison, and Simpson for an excellent summary of the Single Market Programme and the characteristics of the SMP that make it an appropriate episode for this type of analysis.

To identify industries within each country that were expected to be affected by the reforms, I use the industry-level classifications from a European Commission report by Buigues, Ilzkovitz, and Lebrun (1990). Potentially affected industries fall into four groups: SMP1, characterized as “high-technology public procurement” industries; SMP2 and SMP3, “traditional public-procurement and regulated markets” with high and low price dispersion (respectively); and SMP4, industries with at least moderate barriers to competition. Buigues, Ilzkovitz, and Lebrun remove a country-industry from a group if it uniquely faces lower barriers to competition than the same industry in other countries.

The firm count data I use for this analysis is from Eurostat’s Structural Business Statistics. Measures of the number of firms and the number of persons engaged by 2-digit industry are available for Denmark, France, and Portugal from 1990 to 2000. To control for differences in the size of each industry over time and across countries, I use the ratio of firms to persons engaged as my measure of the number of firms. Eurostat also reports firm counts for three non-E.U. countries, Finland, Japan, and Sweden, and I include these countries to help control for non-SMP sources of within-industry variation in the number of firms over time.⁸

⁸Other reforms were undertaken during the 1990s in SMP and non-SMP countries, and Finland and Sweden became members of the E.U. later on in the sample period. As in Griffith, Harrison, and Simpson (2010), my identification relies on the fact that the SMP involved relatively large reforms upon implementation and generated exogenous variation across country-industries. This analysis should be interpreted as evaluating the impact of the SMP relative to other changes in the economic environment happening during the sample period.

The equation I estimate is;

$$y_{c,i,t} = \alpha + D_{c,i,t} + \sum_k^4 \beta_k \cdot \text{SMPk}_{c,i,t} + \beta_5 \cdot \text{import ratio}_{c,i,t} + \epsilon_{c,i,t}, \quad (1)$$

where $y_{c,i,t}$ denotes the (logged) number of firms in a country-industry-year and $D_{c,i,t}$ includes a set of dummies to control for country, year, and industry fixed effects. Ideally SMPk , $k \in \{1, 2, 3, 4\}$, should be equal to one for affected country-industry-years (on or after 1992), and equal to zero otherwise. Unfortunately, Buigues, Ilzkovitz, and Lebrun (1990) list the 3-digit industries affected in each SMP group, while the Eurostat data on the number of firms is available only for 2-digit industries. I therefore construct 2-digit SMP measures following Griffith, Harrison, and Simpson (2010). For each 2-digit industry i , my SMPk measure is equal to the employment share (in 1987-88) of all 3-digit industries affected by SMPk within the 2-digit industry. In country-industries with no affected 3-digit industries, SMPk is equal to zero. I include the variable *import ratio* (the value of imports relative to gross output in industry i) to account for the fact that in addition to lowering barriers to domestic competition, the SMP also lowered non-tariff barriers to trade. Some trade models predict a decrease in the number of domestic firms in response to a surge in imports. The firm count data for each country excludes firms with less than some threshold number of workers, and this threshold is not constant across countries, so I include fixed country-industry effects to account for this difference. I include a time dummy to control for secular changes in the number of firms over time.

Table 2 reports the OLS estimates of the coefficients in equation (1) from several different specifications. Columns 1 through 3 show estimates for the effect of SMP4 that are negative and statistically significant, but the estimates for other SMPs, although consistently negative, are either not significant or only significant for some specifications. At first glance, it is not obvious how best to interpret these results. But Griffith, Harrison, and Simpson (2010) report that only industries in SMP4 responded to reforms with lower markups across all specifications (their results for SMP1 and SMP3 industries are insignificant, while their results for SMP2

Table 2: SMP AND THE NUMBER OF FIRMS

dependent variable:	<i>number of firms</i>			
	(1)	(2)	(3)	(4)
SMP1	-0.06 (0.14)	-0.02 (0.15)	-0.14 (0.18)	
SMP2	-0.33 (0.38)	-0.31 (0.36)	-0.33 (0.46)	
SMP3	-0.12** (0.06)	-0.11* (0.06)	-0.13 (0.10)	
SMP4	-0.30*** (0.09)	-0.30*** (0.09)	-0.39*** (0.12)	
SMPall				-0.27*** (0.09)
Import Ratio		0.06 (0.05)	0.06 (0.05)	0.06 (0.05)
industries	23	23	23	23
years	1990-2000,	1990-2000	1990-92, 1996-2000	1990-92, 1996-2000
R^2	0.94	0.94	0.95	0.95
observations	1374	1374	995	995

Notes: Number of firms and import ratio are from Eurostat, and SMP measures are from Buigues, Ilzkovitz, and Lebrun (1990) and Eurostat. Number of firms is logged, and standard errors are in parentheses. *** and ** refer to five and ten percent levels of significance.

are mixed). The results in Table 2 therefore suggest that *effective* product market reforms reduce the number of firms, consistent with the cross-country relationship between barriers to competition and the number of firms in the previous section. These results are also consistent with the model I develop in the next section, where lower markups driven by deregulation are essential in reducing the number of firms.

Turning to the point estimates, Column 1 shows estimated coefficients from a regression which includes all years, without controlling for imports. The estimate for SMP4 is -0.27, which implies a drop in the number of firms of 24%. Column 2 shows that controlling for imports changes some estimates, but only marginally. Column 3 provides estimates for my preferred

specification. It reports the results of a regression which includes only observations before 1992 and on or after 1996, removing any ambiguity about when the SMP reforms were actually implemented. Here the estimate for SMP4 is a much larger -0.39, implying a drop in the number of firms of 32%. Column 4 reports the results of a regression on SMPall, a variable that aggregates all of the SMP variables. The estimated coefficient is similar to those in Columns 1 and 2, and remains statistically significant.

Taken together, the evidence from cross-country data in Section 2.1 and from panel data in this section strongly suggest that the number of firms in an industry *drops* when barriers to competition are reduced.

3 Model

In this section I extend a standard model of free entry and endogenous markups to allow for multi-product firms. I show that by modeling barriers to competition as a higher fixed cost of entering a product market, the model can generate all of the empirical relationships discussed earlier. Consider a static economy where a representative final-good firm uses a variety of imperfectly substitutable inputs from each of a continuum of product markets (of measure one) to produce the final consumption good, which also serves as the numéraire. There is a stand-in household endowed with a continuum of members (of measure one), each supplying one unit of labor. There are a large number of identical potential intermediate firms, each of which may choose to pay a fixed cost to become a producer. Producers decide how many products to introduce (i.e., how many product markets to enter) and how much to invest in firm-level productivity.⁹ I study the decentralized equilibrium of the economy in which firms take the

⁹In what follows, all producers are identical in equilibrium. Heterogeneity across firms could be implemented easily by allowing firms to draw their fixed cost of introducing a product (denoted by c_v below) from a distribution upon entry. This would result in a distribution of firms characterized by a number of products per firm inversely related to the cost of product introduction. As long as firms learn their type after entry (as in Melitz, 2003, for example) then none of the qualitative or quantitative results analyzed below are affected.

wage and the decisions of rival firms as given, and free entry ensures the value of creating a firm is driven to zero. I then consider how barriers to market entry affect the number of firms, the number of products, markups, firm-level productivity, and aggregate output. I begin by describing the environment in more detail.

3.1 Environment

There is a continuum of identical consumers of measure one, each supplying one unit of labor to intermediate firms. I assume consumers only value consumption, and are indifferent about how their labor is used.

The market for final output is perfectly competitive, with a representative firm using inputs from intermediate firms to produce output according to the following production function;

$$Y = \exp \left(\frac{\sigma}{\sigma - 1} \int_0^1 \log \left[\sum_{n=1}^{N_m} (y_{nm})^{\frac{\sigma-1}{\sigma}} \right] dm \right) \quad (2)$$

where m indexes a continuum of product markets of measure one, y_{nm} is the quantity demanded of variety n from market m , N_m is the number of varieties of input m , and $\sigma > 1$ is the constant elasticity of substitution between varieties within a product market. For simplicity I assume the elasticity of substitution between product markets is equal to one, as this elasticity is irrelevant in this environment.

At the beginning of time, any of a large number of identical potential firms can choose to become producers by paying $(c_F + c_v v^{\gamma+1} + c_A A^\theta) \cdot w$ units of the final good, where v is the number of product markets entered by a firm, c_F is the cost of forming a firm, A is the productivity of the firm, $c_i > 0, \forall i \in \{F, v, A\}$, $\gamma > 1$, $\theta > 1$, and all costs are specified in units of labor.¹⁰ Given the finite number of competing varieties in each market, firms will choose to introduce only one

¹⁰Specifying these costs in terms of labor is consistent with Bollard, Klenow, and Li (2016), who argue using time-series data that fixed costs scale up with secular development.

product per market.¹¹ That the marginal cost of entering a product market is increasing in the number of markets entered helps to ensure that the number of products per firm is pinned down in equilibrium. Once investment and market-entry decisions are made, firms produce output (y) in each market using labor (ℓ) according to the following production function;

$$y = A\ell. \tag{3}$$

3.2 Equilibrium

I focus on the decentralized equilibrium of the economy in which producers in each product market take the real wage w and the behavior of their rivals as given, and choose their demand for labor to maximize profits. Each entrant chooses how many markets to enter (v) and how much to invest in firm-level productivity (A), and potential entrants enter if the value of doing so is non-negative. Given my assumptions all firms behave identically, choosing the same number of markets to enter, the same productivity, and the same demand for labor. As such, a *decentralized equilibrium* is defined as a (common) price for each variety P , labor demand for each variety ℓ , operating profits per variety π , productivity A , a number of varieties per market N , a number of products per firm v , a real wage w , and aggregate output Y , such that the above conditions hold, the market for labor clears, and the market for intermediate varieties clears.

The first order conditions for the final-good firm's problem imply the following inverted demand function for variety n in market m ;

$$P_{nm} = Y \frac{y_{nm}^{-\frac{1}{\sigma}}}{\sum_{n'=1}^{N_m} (y_{n'm})^{\frac{\sigma-1}{\sigma}}}. \tag{4}$$

¹¹As long as the cost of introducing a second product into a market is the same as the cost of introducing a product into a new market, each firm will choose to diversify in order to avoid cannibalizing its own profits.

Operating profits for firm n in market m are;

$$\pi_{nm} = P_{nm}y_{nm} - wy_{nm},$$

or

$$\pi_{nm} = \frac{(\mu_{nm}A_n - 1)y_{nm}w}{A_n}, \quad (5)$$

where $\mu_{nm} = P_{nm}/w$ and $\mu_{nm}A_n$ is firm- n 's markup (price over marginal cost) in market m . A firm's μ_{nm} depends on its output decision, but I make no assumption at this point about whether a firm takes the size of a market (the denominator in equation 4) as given or instead recognizes its effect on market size.

Each product market is identical, so from this point on I suppress subscripts except to avoid confusion. Taking μ as given, the value of forming a firm can now be expressed as;

$$V = v \cdot \pi(A) - (c_A A^\theta + c_v v^{\gamma+1} + c_F) \cdot w. \quad (6)$$

Each firm chooses productivity (A) and how many product markets to enter (v) to maximize V , resulting in the following first order conditions;

$$\text{productivity : } c_A A^\theta = \frac{vy}{\theta A}, \quad (7)$$

$$\text{products per firm : } c_v v^{\gamma+1} = \frac{v(\mu A - 1)y}{(\gamma + 1)A}. \quad (8)$$

Free entry ensures that the value of forming a firm is driven to zero, resulting in the following

free entry condition;

$$\text{free entry : } c_F = v \cdot \frac{\pi}{w} \left(\frac{\gamma}{\gamma + 1} \right) - \frac{vy}{\theta A} = \frac{vy}{\theta(\gamma + 1)A} (\theta\gamma(\mu A - 1) - \gamma - 1). \quad (9)$$

Denote the aggregate quantity of labor used for production as L_p . Then;

$$L_p = 1 - \frac{N}{v} (c_F + c_v v^{\gamma+1} + c_A A^\theta),$$

where $\frac{N}{v}$ is equal to the total number of firms in the economy. In equilibrium all firms produce the same quantity of each variety;

$$y = A\ell = A \frac{L_p}{N}. \quad (10)$$

Using equations (7) through (10), L_p can now be expressed as;

$$L_p = \frac{1}{MU}, \quad (11)$$

where MU is the markup, equal to μA .

Combining equations (7) through (11), the following three equations characterize the equilibrium values of firm-level productivity A , products per firm v , and products per market N ;

$$\text{productivity : } c_A A^\theta = \frac{c_F(\gamma + 1)}{\theta\gamma(MU - 1) - \gamma - 1}, \quad (12)$$

$$\text{products per firm : } c_v v^{\gamma+1} = \frac{\theta c_F (MU - 1)}{\theta\gamma(MU - 1) - \gamma - 1}, \quad (13)$$

$$\text{\# of firms : } \frac{N}{v} = \frac{\theta\gamma(MU - 1) - \gamma - 1}{\theta c_F (\gamma + 1) MU}. \quad (14)$$

All other variables of interest can be expressed as functions of A , v , and N . In particular, aggregate output (equal to consumption) can be expressed as;

$$Y = C = N^{\frac{1}{\sigma-1}} A. \quad (15)$$

3.3 Results

Here I examine how the equilibrium of the economy depends on a number of exogenous variables, and how these relationships depend on the nature of competition. I start by discussing the effects of higher barriers to competition, interpreted here as an increase in the cost of entering a product market c_v .

3.3.1 Market Entry Barriers

The impact of higher barriers to market entry (higher c_v) depends importantly on how the equilibrium markup MU is related to the number of competitors in a market N . If firms take the size of each market as given (ie, monopolistic competition) then the markup is simply $\frac{\sigma}{\sigma-1}$, independent of N . If each firm takes into account how its decisions affect the size of a market (Cournot competition) then the markup is equal to;

$$MU = \frac{\sigma}{\sigma-1} \left(\frac{N}{N-1} \right), \quad (16)$$

which is decreasing in the number of competitors.

If the equilibrium markup MU is independent of N , equations (12) and (14) show that an increase in market entry barriers c_v affects neither firm-level productivity nor the number of firms $\frac{N}{v}$. The entire adjustment to a higher c_v is through the number of products per firm (equation 13). v must drop, which implies a corresponding proportional drop in N . This drop

in the number of firms per market N increases the market share of each variety, which exactly offsets the lower profits per firm due to fewer product lines. As a result, firm-level productivity and the number of firms are left unchanged.

If the markup MU is decreasing in the number of competitors per market N , then the drop in N due to a higher c_v (discussed above) results in a higher markup. From equations (12) through (14), a higher markup is associated with lower productivity A , even fewer products per firm v , and *more* firms. Intuitively, the drop in N here reduces the price elasticity of demand, equal to $-\frac{\sigma N}{N+\sigma-1}$. If demand is less sensitive to the price charged by a firm, the incentive to lower the price through an increase in productivity is reduced, resulting in less productivity investment. Less investment in productivity and market entry (relative to the constant MU case) increases the value of creating a firm, and so free entry ensures that the number of firms is higher in equilibrium.

That the relationship between market entry barriers and the number of firms depends on whether markups respond to differences in entry barriers is consistent with the evidence presented in Section 2.2 with respect to the impact of the Single Market Programme in the EU. Combining my empirical findings with those of Griffith, Harrison, and Simpson (2010), the number of firms in EU country-industries dropped in response to lower barriers to competition only in those industries in which markups also fell. In industries where markups did not respond to lower barriers, the number of firms also did not respond. Griffith, Harrison, and Simpson also report higher innovation in industries where markups decreased. Again, this is consistent with the present model. Systematic evidence of the relationship between the number of products per firm and entry barriers is scant, due in large part to the absence of good product-level data until very recently. I address this in Section 5.

3.3.2 Other

A tax on productivity investment (i.e., an increase in c_A) leads to a decrease in productivity A , from equation (12). Since the resulting drop in the wage exactly offsets the increase in prices, the values of both forming a firm and entering a market do not change. As a result, v , N , markups, and the number of firms are left unchanged.

The qualitative effects of increasing the cost of forming a firm c_F do not depend on how markups are related to the number of competitors N . Consider first the case where MU is independent of N . Equations (12) through (14) show that productivity A and products per firm v are increasing in c_F , while the number of firms is decreasing. To see how N is affected, I combine equations (13) and (14) to get;

$$c_v v^\gamma = \frac{(MU - 1)}{MU \cdot N \cdot (\gamma + 1)}. \quad (17)$$

Given that v moves in the same direction as c_F , the number of competitors per market N must be decreasing in c_F . Now consider the case where the markup MU is decreasing in N . Since a higher cost of forming a firm results in fewer competitors per market, markups must increase. Equations (12) through (14) show that productivity A and products per firm v still increase, and the number of firms still decreases.

3.4 Barriers to Competition: c_F vs. c_v

It is common in the literature to model barriers to competition as increasing the cost of forming a firm c_F . But the results above show that increasing c_F in the model generates relationships between markups, innovation, and the number of firms that are at odds with the empirical relationships reported in this paper and in the literature. On the other hand, interpreting high barriers to competition as high barriers to market entry c_v in the model generates a positive

relationship between barriers and the number of firms, consistent with the findings documented in Section 2. And it helps to rationalize a persistent puzzle in the literature emphasized by Holmes and Schmitz (2010) and Etro (2007): How can lower barriers to competition lead to more competitors and lower market shares, but *more* innovation and *higher* productivity? The model presented here provides a possible, and very intuitive, answer - that lower barriers decrease market shares but *increase* the number of product markets firms compete in. To the extent that investment in productivity lowers production costs across all products produced by a firm, lower market entry barriers result in more investment and higher productivity, even while markups are lower.

4 Quantitative Analysis

In this section I quantify the impact on an economy of reducing barriers to market entry, and compare my results to those that would be obtained if market entry barriers were mistakenly interpreted as barriers to firm formation. I begin by quantifying the impact of lower barriers to market entry brought about by the implementation of the Single Market Programme.

4.1 Single Market Programme

The results in Section 2.2 suggest that the lower barriers to competition brought about by the implementation of the SMP reduced the number of firms in affected industries by 32% (relative to unaffected industries). Griffith, Harrison, and Simpson (2010) estimate that the SMP lowered average markups from 1.32 to 1.21.¹² Using equations (12), (14), and (15) from Section 3, I can express the factor change in aggregate output (equivalent to Total Factor Productivity, or

¹²Estimated changes in markups are from Table 3, Column 1 in Griffith, Harrison, and Simpson (2010), while initial markups in affected industries are from the OECD's STAN database for the years 1988-90. Here I focus on the impact of SMP on 'SMP4' industries, those industries with at least moderate barriers to competition before the implementation of the Single Market Programme.

TFP) due to the SMP as;

$$\frac{Y'}{Y} = \left(\frac{firms}{firms'} \right)^{\frac{1}{\theta}} \left(\frac{MU}{MU'} \right)^{\frac{1}{\theta}} \left(\frac{N'}{N} \right)^{\frac{1}{\sigma-1}}, \quad (18)$$

where primes indicate post-SMP variables, and ‘*firms*’ refers to the number of firms. In addition to the average markup MU and the number of firms before and after the SMP was implemented, using the above expression requires two parameter values - for θ and for σ . I use a value for σ equal to 10, which is the elasticity of substitution between varieties in a product market used by Atkeson and Burstein (2008). Using equation (16), the average markup before and after the SMP was implemented implies values for N and N' of 6 and 12. To obtain a value for θ , which determines (in part) the elasticity of productivity with respect to investment, I target the elasticity of revenue with respect to R&D investment reported by Hall, Mairesse, and Mohnen (2010).¹³ In Appendix A.1 I show that this elasticity in the model is equal to;

$$\frac{(\sigma - 1)(N - 1)}{\theta[N + 2(\sigma - 1)]}.$$

Using the obtained values for σ and N , the above expression suggests a value for θ of 66.9.¹⁴

The above values imply an increase in TFP in affected industries of 8.4%. To see where this aggregate impact is coming from, it is useful to express the changes in products per firm v and firm-level productivity A in the following way;

$$\frac{v'}{v} = \left(\frac{firms}{firms'} \right) \left(\frac{N'}{N} \right) \quad (19)$$

$$\left(\frac{A'}{A} \right)^{\theta} = \left(\frac{firms}{firms'} \right) \left(\frac{MU}{MU'} \right) \quad (20)$$

$$\frac{A' \text{ investment}}{A \text{ investment}} = \frac{MU}{MU'}. \quad (21)$$

¹³Hall, Mairesse, and Mohnen (2010) report a range of estimates for the R&D elasticity of revenue from a number of studies. I target a value of 0.05, which is the median value reported across all studies using within-firm variation in R&D and using data from the 1990s.

¹⁴The above calculations also imply a value for γ equal to 1.15.

Plugging in the values from above, the implied increases in products per firm and productivity investment (as a share of output) are 180% and 9%. Firm-level productivity increases by 0.7%. Most of the gains to TFP here are due to variety effects as the number of varieties per market roughly double. The increase in firm-level productivity plays a relatively small role.

To obtain the value of θ used above I target an elasticity of firm output with respect to productivity investment of 0.05, the median value reported by Hall, Mairesse, and Mohnen (2010) in their survey of the literature. The studies they survey report a range of elasticities, however, so for robustness I repeat the above exercise using targets of 0.025 and 0.1. The results are similar, with implied TFP gains of 8.0% and 9.2%, respectively.

4.2 Mistaking Market Entry Barriers for Startup Costs

How would the quantitative results above change if one were to assume that the change in markups brought about by the implementation of the Single Market Programme were due to lower firm startup costs? Consider an environment identical to that in Section 3, except that firms are constrained to produce in just one product market. If markups decrease due to lower startup costs (c_F), then equations (7) and (11) can be combined to show the resulting decrease in productivity A ;

$$\left(\frac{A'}{A}\right)^\theta = \left(\frac{N}{N'}\right) \left(\frac{MU}{MU'}\right). \quad (22)$$

The decrease in firm-level productivity implied by this expression is 1%, compared to an increase of 0.7% above. This translates into an increase in aggregate TFP of just 6.7%. Assuming that the change in markups due to the SMP are due to lower startup costs, rather than lower market entry costs, lowers the implied increase in TFP by 20%.

5 Barriers and Products per Firm

The model developed in Section 3 generates testable predictions for the effect of market entry barriers on both the number of products per firm. In particular, the model predicts that higher barriers to market entry should induce a lower number of products per firm. In this section I offer evidence consistent with this prediction.

For my measure of barriers to competition here, I again use the OECD's Indicators of Product Market Regulation (PMR), discussed in Section 2.1. For a measure of products per firm I use data from the World Bank's Enterprise Surveys (ES). Between 2002 and 2006, establishment- and firm-level data was collected through face-to-face surveys from mostly low- and middle-income countries. The ES dataset contains standardized information about sales, intermediate purchases, inputs, and a host of other variables. Manufacturing firms are categorized into fifteen industries, and efforts have been made to make these samples representative of the population of firms with at least five employees.¹⁵ Most importantly for my purposes, firms in a (smaller) number of countries were asked about their total number of product lines. Unfortunately, only five countries with product data are also present in the PMR dataset. But given the availability of other firm-level data, I can at least test the relationship between the number of products per firm and average markups across countries. For my measure of markups, I calculate a simple ratio of value added over a firm's wage bill and use the mean of this statistic across all firms within a country-industry.¹⁶ I neglect to include any measure of capital here because some countries and many firms within each country do not report capital. Including only firms that report capital would significantly reduce the total number of usable firms and drastically reduce the number of usable countries. Although neglecting capital will lead to a biased measure of the *level* of markups, this bias should remain constant across countries.¹⁷

¹⁵For more information about the Enterprise Surveys data, see enterprisesurveys.org.

¹⁶The wage bill in these calculations includes both wages and benefits paid for by a firm.

¹⁷More precisely, the magnitude of the bias relative to the true markup should remain constant. According to standard theory, cross-country differences in aggregate productivity should result in changes to both the real wage and the real capital stock, such that the ratio of value added to factor payments remains constant. And cross-country differences in the price of investment goods (due to tariffs on imported investment goods or taxes

Before estimating the relationship between products per firm and average markups, I first ensure that my cross-country measure of markups behaves consistently with other measures in the empirical literature. The first column of Table 3 reports the results of an OLS regression of markups on the PMR Index, controlling only for industry. Consistent with both the existing empirical literature and the model from Section 3 (as well as other models with endogenous markups), markups are higher in countries with higher barriers to competition. Column 2 shows that this result does not change when including the ten control variables from Section 2. In Column 3 I report the results of a weighted least squares regression, where each country-industry observation is weighted by the number of firm-level observations used to calculate the average markup. The estimate on PMR is again significant, and much greater in magnitude.

Table 3: MARKUPS AND PRODUCTS PER FIRM

dependent variables:	<i>markups</i>			<i>products per firm</i>		
	(1)	(2)	(3)	(4)	(5)	(6)
PMR	1.60*** (0.30)	1.64*** (0.60)	4.98*** (1.59)			
Markups				-0.24*** (0.08)	-0.23*** (0.08)	-0.25*** (0.09)
Controls	No	Yes	Yes	No	Yes	Yes
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.25	0.41	0.55	0.13	0.30	0.42
observations	204	204	204	192	192	192
countries	21	21	21	24	24	24
industries	14	14	14	14	14	14

Notes: PMR is from the OECD's Indicators of Product Market Regulation. Markups and products per firm are from the World Bank's Enterprise Surveys dataset. All controls are from the World Bank's Doing Business dataset. All variables are logged, and robust standard errors are in parentheses. *** refers to a one percent level of significance.

Column 4 from Table 3 reports the results of an OLS regression of products per firm on average on capital accumulation, for example) should result in offsetting differences in the capital stock, again leaving the ratio of value added to factor payments unaffected. As a result, using the ratio of value added to labor payments as my measure of markups should be robust to cross-country differences in capital intensity. See Restuccia and Urrutia (2001) for a discussion of these points and for evidence that the cross-country data is consistent with the theory.

markups, and Column 5 reports very similar results when the control variables from Section 2 are included. Consistent with the model, these results suggest that firms in countries with more restrictive barriers to competition produce significantly fewer products. Column 6 reports the results of a weighted least squares regression, where each country-industry observation is weighted by the number of firm-level observations used to calculate the average number of products per firm. The estimate on markups is again significant and of similar magnitude.

Taken together, the results documented in Table 3 suggest that higher barriers to competition result in both higher markups and fewer products per firm, consistent with the mechanism highlighted in Section 3.

6 Conclusion

In this paper I provide new evidence suggesting that barriers to competition actually *increase* the number of firms in an industry, in contrast to current models of endogenous markups with free entry. I rationalize this finding by extending a standard model to allow for multi-product firms which face barriers to entering a product market. In this environment, high barriers to market entry result in more, smaller firms with fewer products. The model rationalizes another empirical phenomenon that has been difficult to generate in models with free entry – that higher markups due to entry barriers tend to be associated with lower firm-level innovation. By breaking the link between firm-level and product-level innovation, the model is able to provide a novel yet intuitive explanation for this empirical phenomenon. While higher market shares encourage productivity investment for a firm with a given number of products, this is more than offset by the lower number of products per firm induced by higher entry barriers. I show that if a given drop in markups is mistakenly assumed to be driven by lower firm startup costs, the implied increase in TFP is substantially lower than the true increase.

Besides the relationship between barriers and the number of firms, the model generates an

additional prediction – that barriers to competition should reduce the number of products per firm. Using cross-country data on barriers, markups, and products per firm, I provide evidence consistent with this prediction.

A Appendix

A.1 Elasticity of Revenue with respect to Quality Investment

Here I derive the elasticity of firm revenue with respect to productivity investment. Because the estimated elasticities reported in Hall, Mairesse, and Mohnen (2010) are generally estimated using firm data over small periods of time, I abstract from changes in the number of products per firm in response to changes in productivity. Using equation (4), revenue for firm n in each market is equal to;

$$P_n y_n = Y \frac{y_n^{\frac{\sigma-1}{\sigma}}}{\sum_{n'=1}^N y_{n'}^{\frac{\sigma-1}{\sigma}}}, \quad (23)$$

and operating profits are;

$$\pi_n = P_n y_n - \frac{w y_n}{A_n}. \quad (24)$$

The elasticity of revenue with respect to productivity investment is;

$$\frac{\partial(P_n y_n)}{\partial A_n} \cdot \frac{A_n}{P_n y_n} \cdot \left(\frac{\partial(A_n^\theta)}{\partial A_n} \right)^{-1} \cdot \frac{A_n^\theta}{A_n} = \frac{\partial(P_n y_n)}{\partial A_n} \cdot \frac{A_n}{P_n y_n} \cdot \frac{1}{\theta}, \quad (25)$$

or

$$\frac{\partial(P_n y_n)}{\partial y_n} \cdot \frac{\partial y_n}{\partial A_n} \cdot \frac{A_n}{P_n y_n} \cdot \frac{1}{\theta}, \quad (26)$$

$\partial(P_n y_n)/\partial y_n$ is equal to;

$$Y \left(\frac{\sigma-1}{\sigma} \right) \frac{(N-1) y_n^{\frac{-1}{\sigma}} y_{n'}^{\frac{\sigma-1}{\sigma}}}{(N-1) y_{n'}^{\frac{\sigma-1}{\sigma}} + y_n^{\frac{\sigma-1}{\sigma}}}, \quad (27)$$

and the first order condition for y_n from the firm's maximization problem is;

$$\frac{\partial(P_n y_n)}{\partial y_n} = \frac{w}{A_n}. \quad (28)$$

To get $\partial y_n / \partial A_n$ I fully differentiate equation (29) with respect to A_n , then impose the equilibrium conditions $y_n = y_{n'} = \frac{A}{N \cdot MU}$ to get;

$$\frac{\partial y}{\partial A} = \frac{(\sigma - 1)(N - 1)}{N[N + 2(\sigma - 1)]}. \quad (29)$$

Taking into account that $P_y = Y/N$ and $Y = w$, the elasticity of revenue with respect to productivity investment is;

$$\frac{\partial(P_n y_n)}{\partial y_n} \cdot \frac{\partial y_n}{\partial A_n} \cdot \frac{A_n}{P_n y_n} \cdot \frac{1}{\theta} = \frac{(\sigma - 1)(N - 1)}{\theta[2(\sigma - 1) + N]}. \quad (30)$$

References

- [1] Aghion, Philippe, Nick Bloom, Richard Blundell, Rachel Griffith, and Peter Howitt, “Competition and Innovation: An Inverted-U Relationship,” *Quarterly Journal of Economics*, 120 (2005), 701-728.
- [2] Aghion, Philippe, Matius Braun, and Johannes Fedderke, “Competition and Productivity Growth in South Africa,” *Economics of Transition*, 16 (2008), 741-768.
- [3] Aghion, Philippe, Mathias Dewatripont, and Patrick Rey, “Competition, Financial Discipline, and Growth,” *Review of Economic Studies*, LXVI (1999), 825-852.
- [4] Aghion, Philippe and Rachel Griffith, *Competition and Growth* (Cambridge MA: MIT Press, 2005).
- [5] Atkeson, Andrew and Ariel Burstein, “Pricing-To-Market, Trade Costs, and International Relative Prices,” *American Economic Review*, 98 (2008), 1998-2031.
- [6] Bento, Pedro, “Competition as a Discovery Procedure: Schumpeter Meets Hayek in a Model of Innovation,” *American Economic Journal: Macroeconomics*, 6 (2014a), 124-152.
- [7] Bento, Pedro and Diego Restuccia, “Misallocation, Establishment Size, and Productivity,” *American Economic Journal: Macroeconomics*, forthcoming (2017).
- [8] Bernard, Andrew B., Stephen J. Redding, and Peter K. Schott, “Multiple-Product Firms and Product Switching,” *American Economic Review*, 100 (2010), 70-97.
- [9] Bhattacharya, Dhritiman, Nezh Guner, and Gustavo Ventura, “Distortions, Endogenous Managerial Skills and Productivity Differences,” *Review of Economic Dynamics*, 16 (2013), 11-25.
- [10] Blundell, Richard, Rachel Griffith, and John Van Reenen, “Market Share, Market Value and Innovation in a Panel of British Manufacturing Firms,” *Review of Economic Studies*, 66 (1999), 529-554.

- [11] Bollard, Albert, Peter J. Klenow, and Huiyu Li, “Entry Costs Rise with Development,” *manuscript*, (2016).
- [12] Buigues, Pierre-André, Fabienne Ilzkovitz, and J.F. Lebrun, “The Impact of the Internal Market by Industrial Sector: The Challenge for Member States,” *European Economy*, Special Issue (1990).
- [13] Carlson, Mark and Kris James, “Branch Banking, Bank Competition, and Financial Stability,” *Journal of Money, Credit and Banking*, 38 (2006), 1293-1328.
- [14] Desmet, Klaus and Stephen L. Parente, “Bigger is Better: Market Size, Demand Elasticity, and Innovation” *International Economic Review*, 51 (2010), 319-333.
- [15] Dutz, Mark A. and Aydin Hayri, “Does More Intense Competition Lead to Higher Growth?” *Policy Research Working Paper Series*, 2320 (2000).
- [16] Edmond, Chris, Virgiliu Midrigan, and Daniel Xu, “Competition, Markups and the Gains from International Trade” *American Economic Review*, 105 (2015) 3183-3221.
- [17] Etro, Federico, *Competition, Innovation, and Antitrust: A Theory of Market Leaders and Its Policy Implications* (New York: Springer, 2007).
- [18] Feenstra, Robert C., Robert Inklaar, and Marcel P. Timmer, “The Next Generation of the Penn World Table,” *American Economic Review*, 105 (2015), 3150-3182.
- [19] Griffith, Rachel, Rupert Harrison, and Helen Simpson, “Product Market Reform and Innovation in the EU,” *Scandinavian Journal of Economics*, 112 (2010).
- [20] Hall, Bronwyn H., Jacques Mairesse, and Pierre Mohnen, “Measuring the Returns to R&D,” in *Handbook of the Economics of Innovation*, ed: Bronwyn H. Hall and Nathan Rosenberg, 2 (2010) 733-1256.
- [21] Holmes, Thomas J. and James A. Schmitz, Jr., “Competition and Productivity: A Review of Evidence,” *Annual Review of Economics*, 2 (2010), 619-642.

- [22] Hsieh, Chang-Tai and Peter J. Klenow, “The Life Cycle of Plants in India and Mexico,” *Quarterly Journal of Economics*, 129 (2014), 1035-1084.
- [23] Koske, Isabell, Isabelle Wanner, Rosamaria Bitetti, and Omar Barbiero, “The 2013 Update of the OECD’s Database On Product Market Regulation,” *OECD Economics Department Working Papers*, 1200 (2015).
- [24] Melitz, Marc J., “The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity,” *Econometrica*, 71 (2003), 1695-1725.
- [25] Melitz, Marc J. and Giancarlo P. Ottaviano, “Market Size, Trade, and Productivity,” *Review of Economic Studies*, 75 (2008), 295-316.
- [26] Nickell, Stephen J., “Competition and Corporate Performance,” *Journal of Political Economy*, 104 (1996), 724-746.
- [27] Nicoletti, Giuseppe and Stefano Scarpetta, “Regulation, Productivity, and Growth: OECD Evidence,” *Economic Policy*, 18 (2003), 9-72.
- [28] Notaro, Giovanni, “European Integration and Productivity: Exploring the Gains of the Single Market,” *London Economics Working Paper*, (2002).
- [29] Peters, Michael, “Heterogeneous Mark-Ups, Growth and Endogenous Misallocation,” *manuscript*, (2013).
- [30] Restuccia, Diego and Carlos Urrutia, “Relative Prices and Investment Rates,” *Journal of Monetary Economics*, 47 (2001), 93-121.
- [31] Schumpeter, Joseph A., *Capitalism, Socialism and Democracy* (New York: Harper, 1942).
- [32] Stigler, George J. and Robert A. Sherwin, “The Extent of the Market,” *Journal of Law and Economics*, 28 (1985), 555-585.