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Centre for Economic Policy Research
33 Great Sutton Street, London EC1V 0DX, UK
Tel: +44 (0)20 7183 8801
www.cepr.org

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JEL Classification: F12, G30, L22, D23

Keywords: multi-product firms, trade and organization, Internal Capital Markets, Conglomerate discount, China shock

Sebastian Doerr - sebastian.doerr@bis.org
Bank for International Settlements

Dalia Marin - dalia.marin@tum.de
University of Munich and CEPR

Davide Suverato - suverato@kof.ethz.ch
ETH Zurich

Thierry Verdier - thierry.verdier@ens.fr
Paris School of Economics and CEPR

Mis-allocation Within Firms: Internal Finance and International Trade

Sebastian Doerr* Dalia Marin† Davide Suverato‡
Thierry Verdier§

14th February, 2020

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We develop a novel theory of mis-allocation within firms (rather than between firms) due to managers' empire building. We introduce an internal capital market into a two-factor model of multi-segment firms. We show that more open markets impose discipline on competition for capital within firms, which explains why exporters exhibit a lower conglomerate discount than non-exporters (a fact that we establish). Testing our model with data on US companies, we establish that import competition reduces mis-allocation within firms. A one standard deviation increase in Chinese imports lowers the conglomerate discount by 32% and over-reporting of costs by up to 15%.

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*Bank for International Settlements, sebastian.doerr@bis.org.

†TUM Technical University of Munich and CEPR, dalia.marin@tum.de.

‡ETH Zurich, suverato@kof.ethz.ch.

§Paris School of Economics and Ecole des Ponts ParisTech, PUC-Rio and CEPR, thierry.verdier@ens.fr.

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1 Introduction

A well-established observation in the trade literature is that conglomerate firms are more productive than single-product firms and dominate in international trade and manufacturing sales. They account for two-thirds of exporters, 98% of export value, and 91% of US manufacturing sales (Schoar, 2002; Bernard et al., 2018). These facts appear to be at odds with findings in the finance literature: multi-segment firms trade at a discount and have lower Tobin's Q than single-product firms (Lang and Stulz, 1994; Berger and Ofek, 1995; Ozbas and Scharfstein, 2009), because internal capital markets mis-allocate funds across divisions within firms (Rajan et al., 2000; Scharfstein and Stein, 2000).

In this paper, we reconcile these two conflicting views by embedding an internal capital market into a model of multi-product firms with monopolistic competition. In our model, managers of multi-product firms compete for funds within their firms. However, there are informational frictions between the headquarters and the divisional managers − the headquarters does not know the true marginal costs of its divisions, while the divisional managers do. These frictions allow managers who have a desire to run bigger divisions to mis-report their true marginal costs to receive more capital. Importantly, managers in better divisions have more room for mis-reporting. This results in a distorted allocation of capital across divisions: headquarters over-allocate capital to the best divisions, which reduces firms' return on assets and depresses Tobin's Q, resulting in a conglomerate discount.

We then introduce competition through international trade into our model and investigate how it affects the allocation of capital within firms. Competition lowers the cost level at which firms and their divisions can survive in the market. Because managers use this cut-off cost level as a benchmark when deciding by how much to mis-report costs, competition has a disciplining effect and reduces the scope for over-reporting. Our model thus predicts that competition leads to a re-allocation of capital within multi-segment firms, increases their profitability and Q, and hence reduces the conglomerate discount. We confirm these key predictions in the data. By exploiting exogenous variation in import competition from China at the sector level, we establish that the conglomerate discount declines more in industries that are subject to a stronger increase in import competition. The decline in conglomerate discount is caused by a fall in marginal costs and a rise in allocated capital to the best segments, confirming the model's predictions.

Traditional models of multi-segment firms in the trade literature predict that project funding goes to the most productive segments and that all projects with positive profits are financed (Eckel and Neary, 2010; Bernard et al., 2010; Nocke and Yeaple, 2014; Dhingra, 2013; Mayer et al., 2014). However, an internal capital market within an organisation is subject to informational frictions − it may not always allocate resources efficiently and it may not fund all projects with positive returns. To understand the type of products that firms finance, produce, and export, it is essential to examine the internal allocation of funds. This requires a theory of multi-segment firms that is micro-founded in an organisational theory of corporate finance. Our paper provides a first step towards such a theory.[1]

To model the internal capital market we combine the concepts of "winner picking" by Stein (1997) and "over-investment" by Rajan et al. (2000) and Scharfstein and Stein (2000). The former implies that headquarters rank segments by return on assets and allocate more capital to the best-ranked segment. Over-investment arises because the headquarters knows less about the true cost of a segment than its divisional managers, which leads to an over-allocation of capital to the segments. We then incorporate an internal capital market with these features into a two-factor version of the Mayer et al. (2014) monopolistic competition model of multi-product firms.

In our model, divisional managers compete for funds allocated by headquarters, subject to an informational asymmetry between the headquarters and divisional managers of firms. Specifically, the headquarters is responsible for allocating funds to the firm's various projects. To do so, it ranks projects relative to one another by their return (winner picking). However, the firm's divisional managers have an appetite for running bigger divisions: they are empire-builders and try to influence how headquarters allocates capital by not reporting their costs truthfully. Information asymmetry arises because the headquarters has inferior knowledge about the true costs of projects. Due to empire building, divisions over-report their costs (i.e. they pretend to be less efficient than they really are to secure more funds), while taking into account the distribution of costs of competing divisions. Therefore, the best divisions end up receiving more

[1] Internal capital markets represent an important source of funding in US publicly listed firms. Internal cash flow accounts for 83% of total funds in multi-segment firms. While it is equally important for exporters (80%), cash flow matters less in single-segment firms (30%); see also Marin and Schnitzer (2011).

capital than is optimal.

We show that the resulting mis-allocation of capital within firms leads to the conglomerate discount established in the finance literature (Rajan et al., 2000; Scharfstein and Stein, 2000).[2] Specifically, a distinct prediction of our model is that a firm's Q decreases with its average marginal cost, and increases with the dispersion in marginal costs across segments. Intuitively, more severe frictions increase average marginal costs, because managers over-report their costs to get more funding. Additionally, mis-allocation reduces dispersion in marginal costs across segments, because the relatively more pronounced over-reporting at better segments moves their costs closer to those of the worse segments. We find strong support for this relationship in the data.

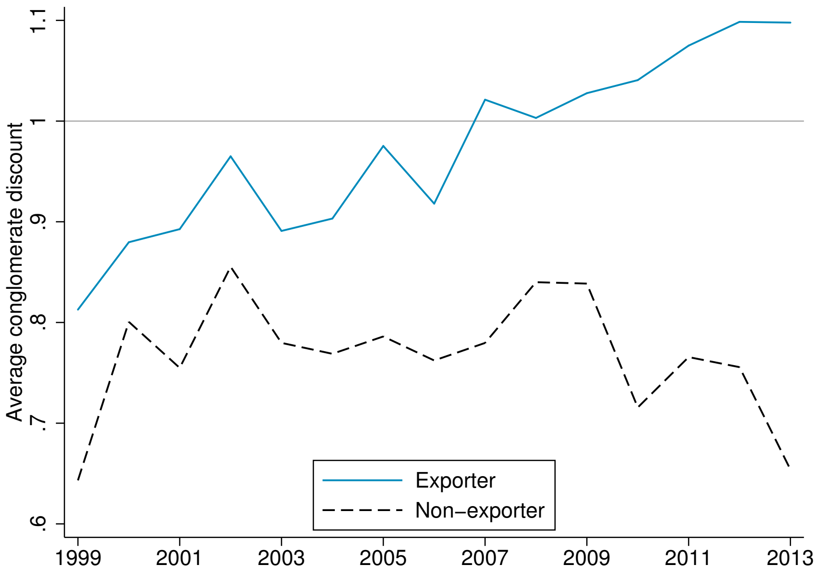
We then investigate the role of trade-induced competition on a firm's internal capital market. One novel empirical fact we establish is that exporters suffer from a lower conglomerate discount than domestic firms. Figure 1 plots the ratio of average Q of multi-segment firms over average Q of single-segment firms (the conglomerate discount) for each year in our sample. We split the sample into exporting (blue-solid line) and non-exporting (black-dashed line) firms. Our first observation is that multi-segment firms have lower Tobin's Q than single-segment firms. For both exporting and non-exporting firms, relative Q is below unity on average. The difference in Q represents the well-known conglomerate discount. The second observation is that the conglomerate discount is smaller for exporting firms: the blue-solid line for exporters lies above the black-dashed line for non-exporters in every year. Furthermore, the discount remains stable for non-exporters but declines over time for exporters (higher values on the y-axis denote a narrowing in the difference in Q between single- and multi-segment firms). For the years following the financial crisis of 2007–08, the ratio surpasses 1 and the discount turns into a premium.[3] The exporters' lower conglomerate discount suggests that firms exposed to open markets differ from domestically active conglomerates.

By taking the interplay between internal capital markets and international

[2]Lang and Stulz (1994) and Berger and Ofek (1995) document a diversification discount in which US conglomerates are valued less by the market than a comparable portfolio of single-segment firms.

[3]Pooling our sample across years, the average multi-segment firm has a 17% lower Q than a single-segment firm, after controlling for industry and firm size. The difference in Q averages 25% for non-exporters and 12% for exporters. In the Online Appendix, we show that the conglomerate time-series pattern holds after controlling for firm characteristics, industry*year, and firm size*year fixed effects.

Figure 1: **Conglomerate discount over time: by exporter status**



Note: This Figure plots the ratio of average Q of multi-segment firms over average Q of single-segment firms (the conglomerate discount) for each year in our sample. We split the sample into exporting (blue solid line) and non-exporting (black dashed line) firms. Figure 5 in the online appendix shows that the patterns are robust to the accounting for firm characteristics, as well as time-varying trends at the industry level.

competition into account, we open the black-box of multi-product firms, which allows us to explain these novel empirical patterns. The key insight that we gain from introducing an internal capital market into the theory of multi-product firms is that our model shows how mis-allocation of capital within firms is affected by international trade: a tougher trade environment improves the efficiency of the internal capital market. Tougher competition lowers the cost level at which firms and their divisions can survive in the market. Because managers use this cut-off cost level as a benchmark when deciding by how much to over-report costs when they ask for funds from the headquarters, tougher foreign competition leaves less room for over-reporting.

Our model predicts that rising competition reduces the conglomerate discount because it leads to a fall in marginal costs and a decrease in the allocation of capital to the best segments. In particular, marginal costs fall as the scope for over-reporting of costs declines most for managers in the best segments (i.e., those with the largest initial over-reporting). The fall in marginal costs in the best segments relative to worse segments implies an increase in dispersion of marginal costs across segments and a fall in the conglomerate discount.

We test the key predictions of our model in the empirical part of the paper. Based on our model, we derive four central predictions. Import competition leads to *i*) a fall in the cut-off cost and hence lower over-reporting; *ii*) a fall in relative marginal costs and *iii*) an increase in allocated assets for best segments in the same industry; and finally, *iv*) the induced fall in marginal costs and increase in allocated assets imply that competition reduces the conglomerate discount.

To test these predictions, we exploit the increase in import competition from China − the China shock − as a source of exogenous variation in industry-level competition. Following (Autor et al., 2013), we instrument US imports from China with Chinese imports in eight other advanced economies. Using detailed data on US manufacturing firms at the segment level from 1999–2007, provided by Worldscope, we test the relationship between competition, marginal costs, assets, and the conglomerate discount derived from the model. We first show that the conglomerate discount significantly declines in industries with a stronger increase in import penetration from China. We find that a one standard deviation increase in import penetration lowers the average conglomerate discount by 32%, or almost twice the mean change in the conglomerate discount over the sample period.

To shed light on the underlying channels, we then investigate how competition affects segment marginal costs and asset allocation. As predicted by our model, we find a significant decrease in marginal costs for the best segments in response to higher competition; as well as an increase in allocated assets. The underlying friction that gives rise to mis-allocation is asymmetric information. We thus expect the disciplining effects of import competition on segment marginal costs and assets to be particularly strong within firms that suffer more from informational asymmetries. Therefore, we use data on CEO tenure provided by BoardEx. We classify firms into those with high and low informational frictions by the average time that the CEOs spent on the board. The longer the time a CEO has served on the board of a company, the better she knows its segments and the lower the scope for over-reporting (and hence initial mis-allocation).[4]

We find the disciplining effects of competition (i.e. a decrease in marginal costs and increase in allocated assets to the best segments) to be particularly strong in firms subject to higher informational frictions. A one standard deviation

[4] In the Online Appendix, we show that results hold for two alternative measures of information asymmetries based on CEO time in company and CEO equity share out of total compensation.

increase in import competition from China reduces the marginal costs of better segments by approximately 5%. The same increase in imports increases assets allocated to the best segments by around 25%. Based on our model, we can use these estimates to infer the change in the over-reporting factor (i.e. by how much divisional managers adjust overstating true costs). We find that for a one standard deviation increase in imports from China the over-reporting factor declines by 15% in the best segments, relative to the worst segments. Taken together, our empirical results provide strong support for our main predictions. They suggest that competition causally reduces within-firm mis-allocation of capital and reduces the conglomerate discount by around 30%.

Our paper contributes to the literature in corporate finance that analyses firms' internal capital markets. In a landmark paper, Stein (1997) argues that the internal capital market can allocate capital more efficiently than external financing. In contrast, Scharfstein and Stein (2000) show that the internal capital market can be inefficient: managers of weak divisions are willing to spend more time trying to convince headquarters to get a larger capital budget. Consequently, weak divisions receive more capital at the expense of good divisions.[5] In our model, the internal capital market reflects both features. As in Stein (1997), headquarters engages in winner picking and has an incentive to allocate funds to projects with the highest return on assets. At the same time, the divisional managers distort the allocation of capital by over-reporting their true costs, as in Scharfstein and Stein (2000). Crucially, in our model the distortion affects the best divisions, rather than the weakest (unlike in Scharfstein and Stein (2000)). We provide empirical evidence in line with our predictions: mis-allocation of capital across segments of publicly listed US firms is most prominent in the best rather than weakest divisions. By establishing that competition reduces within-firm mis-allocation and the conglomerate discount, we also provide an explanation for the mixed empirical evidence on the efficiency of internal capital allocation in conglomerates (Maksimovic and Phillips, 2013). Not all conglomerates are alike, and the external environment matters.

We also speak to the literature in international trade. Workhorse models in the spirit of Mayer et al. (2014) abstract from financial issues. By micro-founding the theory of multi-product firms in a finance theory of organisation, we endogenously generate heterogeneity in firms' cost structure, which is typically

[5]For a review of the literature on internal capital markets, see Bolton and Scharfstein (1998); Stein (2003); Mueller (2016)

exogenous in the literature of multi-segment firms.[6] A distinct feature of our model is that the cost structure of a firm depends on its internal organisation. We also establish a novel fact in that exporters suffer from a lower conglomerate discount than domestic firms. We show that competition and its disciplining effect on managers' over-reporting can rationalise this finding.

Finally, our paper relates to literature on capital mis-allocation (Hsieh and Klenow, 2009).[7] Several papers identify financial constraints as a reason why the marginal products of capital are not equated across firms; that is, why capital does not move to the most productive firms (Banerjee and Moll, 2010; Caselli and Gennaioli, 2013; Gopinath et al., 2017; Doerr, 2018). These papers focus on inefficient allocation of resources across firms and they show that mis-allocation is an important factor explaining differences in productivity across countries. However, Kehrig and Vincent (2017) note that a sizeable share of overall mis-allocation occurs *within*, rather than between, firms. In our paper, mis-allocation of capital within firms arises due to an information asymmetry between headquarters and managers, which impedes an efficient allocation of capital. Importantly, mis-allocation within firms arises even in the absence of mis-allocation of capital across firms. We further provide a link from changes in economic competition to the allocation of capital within firms.

The rest of this paper is organised as follows. Sections 2 to 4 present the model. Section 5 takes the model to the data: it derives structural equations and testable predictions from the model, and then exploits the China shock to empirically test the causal effect of international trade on mis-allocation within publicly listed US firms. Finally Section 6 concludes.

2 A theory of multi-segment firms

We develop a general equilibrium model of heterogeneous firms in which single-segment firms (SSF) and multi-segment firms (MSF) coexist in a market structure of monopolistic competition. A single-segment firm produces one type of good and has a simple organisation, and the firm's owner has full control over production. A multi-segment firm produces different types of goods and has a two-layer organisation, in which the owner has control over the core segment

[6] For an exception, see the literature that introduces organisations into trade models, which shows that firms reorganise to a more decentralised organisation in a more competitive trade environment (Marin and Verdier, 2008, 2012, 2014; Caliendo and Rossi-Hansberg, 2012).

[7] See Hopenhayn (2014) and Restuccia and Rogerson (2017) for surveys.

only and delegates control over the non-core segments to the divisional managers. We build our theory of MSF by starting from the multi-product firm model of Mayer et al. (2014). We borrow the feature of flexible technology, in which a firm develops around a core competence that is specific to a certain type of good. The production of non-core types of goods occurs at greater variable costs. In contrast to other models of multi-product firms, such as Bernard et al. (2010), Eckel and Neary (2010), Dhingra (2013), or Nocke and Yeaple (2014), Mayer et al. (2014) do not rely on the so-called cannibalisation effect in which there is a cross-price elasticity among segments. Therefore, Mayer et al. (2014) is a suitable description of MSF that are characterised by price-unrelated products with dissimilar technologies.

2.1 Preferences and technology

A country is a production economy where L households are endowed with a fixed stock of capital and supply one unit of labor each. Households have identical preferences defined over a continuum of measure V of horizontally differentiated goods and two homogeneous goods, which are different in terms of their factor content. The utility function is given by:

$$U = q_l^c + \theta q_k^c + \alpha \int_0^V q_v^c dv - \frac{\gamma}{2} \int_0^V \left(q_v^c\right)^2 dv - \frac{\eta}{2} \left(\int_0^V q_v^c dv \right)^2, \tag{1}$$

where q_l^c and q_k^c represent household consumption of labor-based and capital-based goods, respectively, while q_v^c represents consumption of a variety v of a differentiated good. Parameter $\theta > 0$ indexes the relative taste for capital-based goods with respect to labor-based goods, while $\alpha > 0$ and $\eta > 0$ parameterise the substitution patterns between homogeneous goods and varieties of differentiated goods. The willingness to smooth consumption across differentiated goods increases with the parameter $\gamma > 0$, where higher γ implies lower substitution. Marginal utilities are bounded, so households might not have a positive demand for any particular good. We assume that homogeneous goods are always consumed, so $q_l^c, q_k^c > 0$. Thus, the homogeneous sector absorbs the residual expenditure (and resources) not allocated to the differentiated good sector.

The aggregate demand for a differentiated good $q_v = \frac{L}{\gamma} \left(\hat{p} - p_v\right)$ is zero at a certain choke price $\hat{p}$, which is specific to the measure of goods sold in the market V and their average price. Thus, there is no cross-price elasticity among differentiated goods and the own-price elasticity of demand for a certain good,

$\varepsilon_v = (\hat{p}/p_v - 1)^{-1}$, is increasing in its own price p_v relative to the choke price.[8]

Our specification of preferences does not distinguish between goods pooled in the same market segment and goods in different market segments.[9] While consumers can principally perceive goods in different market segments as more differentiated than goods within the same market segment, we abstract from demand-driven cross-segment linkages for clarity of exposition. In our theory, MSF are different from SSF only because the owner of a MSF does not know the technology of all of the products at her firm.

The production of one unit of the labor-based homogeneous good requires one unit of labor, whereas producing one unit of the capital-based homogeneous good requires to rent one unit of capital. The market for homogeneous goods and the factor markets are perfectly competitive. Consequently, wage and rental rate equal p_l and p_k. We choose labor as numeraire, which yields $p_l = 1$ and $p_k = \theta$.

Differentiated goods are supplied by firms that compete under a market structure of monopolistic competition. Goods are clustered in market segments by their technological characteristics. Within each segment, production employs labor and capital according to a constant returns to scale Cobb-Douglas technology, with a total factor productivity specific to the firm and the market segment. Firms supply at most one product in the same market segment and are eventually active in multiple market segments. The product with the lowest marginal cost at a firm defines a firm's *core product* and is indexed with $i = 0$. The others are *non-core products*, and are indexed with $i = 1, 2, ..., m$ for a discrete number of non-core products m. The marginal cost of product $i = 0, 1, 2, ...$ is $z_i c$, where $c > 0$ is the marginal cost of the core product and the factor $z_i \geq 1$ is a customisation cost that captures the technological difference between the non-core product i and the core product. The production function of a product i with customisation cost z_i in a firm with core competence cost c is given by:

$$y(z_i, c) = \frac{\varphi}{z_i c} \, l(z_i, c)^{\lambda} \, k(z_i, c)^{1-\lambda}, \tag{2}$$

[8]See Mayer et al. (2014) for a detailed analysis of the choke price $\hat{p}$ and of the properties of the demand system implied by (1). We report these derivations in the appendix.

[9]It does not distinguish between goods produced by the same firm relative to goods produced by different firms, either. We follow Mayer et al. (2014), who point out that there is no clear reason to enforce that products of the same firm should be closer substitutes than products of different firms. We consider this claim applicable to our case, where the same firm might sell in different market segments.

where $y(z_i, c)$ is output, $l(z_i, c)$ and $k(z_i, c)$ are labor and capital used in production. Coefficient $\lambda \in (0, 1)$ is the elasticity of output to labor and coefficient $\varphi = \left(\frac{1-\lambda}{\lambda\theta}\right)^{-(1-\lambda)} + \theta\left(\frac{\lambda\theta}{1-\lambda}\right)^{-\lambda}$ is a constant.Firms are heterogeneous in the core marginal cost c and in the vector of customisation cost $\boldsymbol{z} = \{z_i\}_{i=0}^{m}$. While referring to a certain firm, we sort products in increasing order by customisation cost, such that $z_0 = 1 < z_1 < z_2 < ... < z_m$.

2.2 Equilibrium allocation at the product level

Households maximise their utility (1) subject to the budget constraint. Firms maximise profit subject to technology (2). The equilibrium quantity and price that clear the market for a certain product with marginal cost $z_i c$ are:

$$q(z_i, c) = \frac{L}{2\gamma}(c_D - z_i c) \tag{3a}$$

$$p(z_i, c) = \frac{1}{2}(c_D + z_i c), \tag{3b}$$

where c_D is the maximum cost below which demand is positive. We refer to this variable as the "cutoff cost", which has to be determined in equilibrium and will be a sufficient statistic to summarise the degree of competition in the output market.

A firm's performance is fully determined by demand, prices, and technology. The equilibrium levels of capital, profit, and return on assets-measured as the ratio of profits over the cost of capital – for a certain product with customisation cost z_i supplied by a firm with core marginal cost c when the cutoff cost equals c_D are given by:

$$k(z_i, c) = \frac{1}{\varphi_k}\frac{L}{2\gamma}(c_D - z_i c) z_i c \tag{4a}$$

$$\pi(z_i, c) = \frac{L}{4\gamma}(c_D - z_i c)^2 \tag{4b}$$

$$roa(z_i, c) = \frac{\varphi_k}{2\theta}\left(\frac{c_D}{z_i c} - 1\right), \tag{4c}$$

where $\varphi_k = \left(\frac{\lambda\theta}{1-\lambda}\right)^{\lambda}\varphi$ is a constant. The firm's owners rent capital on the external market and finance divisions that yield a return on assets at least as high as the rental price for capital. This implies $roa(z_i, c) \geq \theta$ and defines an upper bound on the marginal cost of products of $z_i c \leq \delta c_D$, where $\delta = (1+2\theta^2/\varphi_k)^{-1} \in (1/2, 1]$ is a discount factor: the lower δ, the higher the profitability required to finance a certain product.[10] Incumbent firms produce at least the core product, thus a necessary condition for the firm to be in the market is $c \leq \delta c_D$. In a MSF with m non-core segments, the highest marginal cost satisfies the profitability condition $z_m c \leq \delta c_D$.

3 The internal capital market

MSF suffers from an agency problem between the firm owner and the division managers. The owners do not know the true cost of a non-core division, which is known to the manager only. Lack of common knowledge and contract incompleteness make the true cost of a non-core division unverifiable.[11] Consequently, the allocation of capital in the internal market of a MSF is characterised by

(i) *Empire building* by managers: who strategically misreport the true cost of their division to maximise their private benefit from running a bigger division;

(ii) *Winner picking* by owners: to allocate capital, the owner ranks managers by the divisions' return on assets, which subjects managers to competition for funds.[12]

Given this setup, the firm's owners decide on whether to run a SSF or a MSF, subject to maximisation of the expected value of the firm.

[10]Note that the threshold of return on assets does not have to be θ: it can be zero, or an arbitrary spread on the market price θ. If we set the threshold to zero, then the discount factor is $\delta = 1$ and the analysis goes through. The parametric restriction $\delta > \frac{1}{2}$ is convenient to mechanically avoid channels that are second order in our analysis when solving for the allocation of capital. By setting $\delta \in (\frac{1}{2}, 1]$ we capture the idea that the marginal product of capital in a competitive external market works as a lower bound for the profit per unit of capital.

[11]As shown by Aghion et al. (2012) and further discussed by Hart (2017), a revelation mechanism design cannot be implemented when there is a departure from common knowledge on the state of nature.

[12]Empire builder managers have been introduced by Jensen (1986). The idea of an internal capital market disciplined by winner picking has been proposed in Stein (1997). Both arguments have since been tested extensively finding support in the data; see Stein (2003) for a review.

3.1 The decision to become multi-segment

The owner of a firm with core competence cost c in a market with cutoff cost c_D makes a decision on whether to run a SSF (thus, $m = 0$) or a MSF ($m > 0$). The value from opening $m = 1, 2, ...$ non-core divisions is uncertain because the owner does not know the marginal costs at which managers will run their divisions. Instead, the managerial cost for $m = 1, 2, ...$ non-core divisions is known to the owner before making the decision on the number of non-core divisions. The managers are paid to solve the coordination problems arising at the firm level when integrating the production of their division with the rest of the MSF. Thus, we model the managerial cost as a coordination cost that increases when the pool of non-core divisions is more dissimilar.[13] The managerial costs per division at a firm with core competence c and m non-core divisions are given by:

$$s_m(c) = f_D + |\pi_m(c) - \pi(z_m, c)|, \tag{5}$$

where $f_D > 0$ is a market specific fixed cost and $|\pi_m(c) - \pi(z_m, c)|$ is the distance within the pool of non-core divisions, which is measured as the gap between the average profit from non-core products at the firm $\pi_m(c)$ and the profit from the last product at the firm $\pi(z_m, c)$.[14]

The managerial cost (5) depends on the complexity of the organisation. Because $\pi_1(c) = \pi(z_1, c)$, adding the first non-core division costs f_D for every firm or segment. Adding more non-core divisions increases the managerial cost, and more so when the technological difference between the new division and the previous ones is wider. We express the fixed component of the managerial salary as a fraction $f \in (0, 1)$ of the maximum profit attainable in the market $\hat{\pi}_D = \lim_{c \to 0} \pi(z_i, c) = \frac{Lc_D^2}{4\gamma}$. Subtracting the managerial cost $s_m(c)$ from the average profit of a non-core division at the firm $\pi_m(c)$ yields the average value to the owner from a non-core division:

$$v(z_m, c) = \hat{\pi}_D \left[(1 - f) - 2\frac{z_m c}{c_D} + \left(\frac{z_m c}{c_D} \right)^2 \right], \tag{6}$$

[13] Rajan et al. (2000) argue that firms with more dissimilar divisions have larger costs due to greater internal power struggles. In our framework, running a tournament with more diverse divisions becomes more difficult because divisions are harder to compare.

[14] Profits are a decreasing function of the marginal cost (4c), therefore a wider profit gap between two consecutive divisions of the same firm $\pi(z_i, c) - \pi(z_{i+1}, c) > 0$ originates from a larger difference in their customisation costs $z_i < z_{i+1}$. Using the profit gap as a measure of distance is convenient for tractability. But the same argument will apply using cost gap, revenue gap, or any other measure that is strictly monotonic in customisation cost.

which depends on the customisation cost of the most peripheral division z_m and on the core competence cost of the firm. The value $v(z_m, c)$ is decreasing for $\frac{z_m c}{c_D} \leq 1$ and positive for $\frac{z_m c}{c_D} \leq 1 - \sqrt{f}$. Therefore, a necessary condition for a firm to become multi-segment is:

$$c < \left(1 - \sqrt{f}\right) c_D. \tag{7}$$

Firm owners endowed with a core competence cost that satisfies condition (7) make the decision to run a MSF, while the others run a SSF.

The owner of a MSF opening $m = 1, 2, ...$ non-core divisions must hire m managers, each with the capability of running a division with a customisation costs $z_1 < z_2, ..., < z_m \leq \left(1 - \sqrt{f}\right) \frac{c_D}{c}$.[15] Thus, the distribution of customisation costs among selected managers that apply to a certain firm is conditional on the firm's core competence cost (c) and the number of divisions (m) to be financed. For the sake of simplicity and tractability, we assume an Inverse Pareto distribution with probability mass at the extremes of the feasible support $z_i = 1$ and $z_i = (1 - \sqrt{(f)})cD/c$, and continuity in-between:

$$\mathcal{K}_m(z_i|c) = \begin{cases} 0 & : z_i < 1 \\ \left(\frac{1}{m} \frac{z_i c}{\left(1-\sqrt{f}\right) c_D}\right)^{\frac{1}{m}} & : 1 \leq z_i < \left(1 - \sqrt{f}\right) \frac{c_D}{c} \\ 1 & : z_i \geq \left(1 - \sqrt{f}\right) \frac{c_D}{c} \end{cases}, \tag{8}$$

with the upper bound proportional to the number of divisions $z \leq m(1 - \sqrt{(f)})cD/c$. We set the dispersion parameter equal to $1/m$ such that the distribution of the maximum is a uniform distribution for tractability. This characterisation implies that calling for more managers increases the probability to obtain smaller customisation costs. Therefore, adding more divisions implies a trade-off between higher-return projects (equation (8)) and higher fixed costs (equation (5)).

The probability of m managers with a customisation cost lower than z is given by $\mathcal{K}(z|c) = \mathcal{K}_m(z_i|c)^m = \frac{1}{m} \frac{zc}{\left(1-\sqrt{f}\right) c_D}$. The expectation on $v(z, c)$ over the density $d\mathcal{K}(z|c)$ yields the expected value to the owner from a non-core division

[15] The parametric restriction $\sqrt{f} \geq 1 - \delta$ guarantees that all financed products have a return on assets at least as good as the rental price for capital in the external market.

$$\bar{v}_m(c) = \frac{1}{m}\frac{c}{\left(1-\sqrt{f}\right)c_D}\left[v(1,c) + \int_1^{\frac{(1-\sqrt{f})c_D}{c}} v\left(z,c\right)zdz\right] \tag{9}$$

in a firm with core competence cost c financing $m = 1, 2, ...$ non-core divisions. The assumption of an Inverse Pareto distribution for customisation costs makes our model tractable and yields expressions for empirical testing (see Mayer et al. (2014) for a discussion). Our specification of the density $\mathcal{K}_m(z_i|c)$ is tailored to deliver an expected value from non-core divisions $m\bar{v}_m(c)$ that does not depend on the actual number of non-core divisions. The reason for this is that the value from adding more divisions balances out exactly with the likelihood of these divisions having greater marginal costs. We observe this property if there are no economies of scope by managing more divisions. Because this channel is not necessary to obtain distinctive predictions on the internal capital market, we have chosen to characterise an equilibrium allocation that does not feature dis-economies of scope.[16]

3.2 The managers' private benefits

Only the manager knows the true customisation cost of her own division, which we denote by $x_i > 1$. Empire building managers have an appetite for running a bigger division, rather than maximising the value of the division that accrues to the owner. Hence, the managers are willing to deviate from a fair reporting of true costs, and contract incompleteness allows the reported customisation cost to differ from true marginal cost $z_i \neq x_i$.

We follow Scharfstein and Stein (2000) and model the private benefit of the manager as an excess of output capacity of form $\frac{z_i}{x_i}y(z_i, c) - q(z_i, c)$. Substituting for technology (2) and demand (3a) yields the private benefit from running a bigger division as a function of the misreporting factor $\mu = z_i/x_i$:

$$b\left(\mu; x_i, c, c_D\right) = \frac{L}{2\gamma}\left(\mu - 1\right)\left(c_D - \mu x_i c\right), \tag{10}$$

[16] Alternatively, a lower fixed cost associated to more non-core divisions (so f replaced by a decreasing function $f(m)$) would be sufficient to activate dis-economies of scope. This would make the model predict an optimal number of divisions given a core competence cost c and cutoff cost c_D. However, this comes at the cost of dealing with an integer solution for the number of divisions, which worsens the tractability of aggregation across firms without adding a significant insight on the functioning of the internal capital market.

for a manager running a division with reported customisation cost $z_i = \mu x_i$, in a firm with core competence cost c and given outside competition c_D.

A product will be financed as long as $\mu < \frac{(1-\sqrt{f})c_D}{x_i c} \equiv \bar{\mu}_i$, so $(c_D - \mu x_i c) > 0$. The private benefit is positive for $\mu \in (1, \bar{\mu}_i]$. Therefore, managers have an incentive to over-report the marginal cost of their division and the benefit grows with the factor of over-reporting μ. However, managers need to take into account that they might no be financed at all, which yields zero benefit. We assume that the managerial salary corresponds to the competitive price of managerial effort, such that the net payoff earned by managers who are financed amounts to the non-pecuniary private benefit (10).

3.3 Competition for funds

The owner of a firm with core competence cost $c < \left(1 - \sqrt{f}\right) c_D$ announces a tournament for filling arbitrarily many positions $m = 1, 2, ...$ at the firm as division manager:

1. The firm matches randomly with a pool of managers capable of running the division i at the firm with a true customisation cost $x_i < \left(1 - \sqrt{f}\right) \frac{c_D}{c}$, which is not observable by the owner.

2. Each manager proposes a customisation cost z_i and commits to run the division according to the equilibrium allocation (3a)-(4c), given the proposed customisation cost.

3. The owner ranks managers by the return on assets of the division given the proposed customisation cost $roa(z_i, c)$ and commits to finance the first m managers with the capital allocation $k(z_i, c)$.

After the tournament the firm owner earns the value from non-core divisions that consists of the actual profits $\pi(z_1, c)$, $\pi(z_2, c)$, ..., $\pi(z_m, c)$ net of the managerial cost.

We assume that the pool of applicants is large, that managers make their proposals simultaneously without coordination or recall, and that the owner does not make mistakes when anticipating the distribution of reported customisation cost. Consequently, a firm searching for m managers receives more than m proposals of customisation costs which arrive as independent draws from the distribution (8). The probability that a manger endowed with a customisation cost $x_i < \left(1-\sqrt{f}\right)\frac{c_D}{c}$ applying to a firm with core competence cost c and opening $m = 1, 2, ...$ non-core divisions is financed when reporting marginal cost $z_i = \mu x_i$ is given by:

$$\psi\left(\mu; x_i, c, m, c_D\right) = 1 - \frac{\mu}{m}\frac{x_i c}{\left(1-\sqrt{f}\right)c_D}. \tag{11}$$

Because of winner picking by the firm owner, each manager faces uncertainty about being financed. Managers are in competition for funds in the internal capital market of MSF and this mitigates the incentive to over-report: when the cost reported by a manager is higher, the probability that she does not receive funds is also higher.[17]

3.4 Strategic over-reporting

The manager of a given product $i = 1, 2, ...$ chooses μ_i in the interior of the compact set $[1, \bar{\mu}_i]$ to maximise the expected private benefit:

$$\mu_i^\star = \arg\max_{\mu\in[1,\bar{\mu}_i]} \psi\left(\mu; x_i, c, m, c_D\right) b\left(\mu; x_i, c, c_D\right) \tag{12}$$

Problem (12) has a unique solution.

Proposition 1. *A solution $\mu_i^\star\left(x_i, c, m, c_D\right)$ to the manager's problem (12) does exist and is unique. Managers over-report customisation cost $\mu_i^\star\left(x_i, c, m, c_D\right) > 1$ and the general equilibrium properties of managers' decision are such that*

(1.1) $\mu_i^\star$ *is decreasing in the true customisation cost of the division x_i*

(1.2) $\mu_i^\star$ *is decreasing in the core competence cost of the firm c*

(1.3) $\mu_i^\star$ *is increasing in the number of non-core divisions m of the firm*

(1.4) $\mu_i^\star$ *is increasing in the market cutoff cost c_D*

Proof. The proof of Proposition 1 is given in the Appendix.

The intuition behind Proposition 1 is that managers can only gain a positive private benefit by over-reporting the true cost. [18]

[17] However, the competition is not about how much capital each manager will receive in response to the capital allocated to others. The managers only care about the probability of being financed. This is an important implication of a setup in which firms are not financially constrained on the external capital market. The owner cannot reveal the true x_i by rewarding managers for lower offers of $z_i = \mu x_i$.

[18] In the Appendix, we show that the predictions of Proposition 1 can be extended to a broader definition of the private benefit. Measuring the private benefit in terms of other proxies for the size of a division (revenue or profit) does not change the qualitative implications.

Proposition 1, (1.1) and (1.2), implies that over-reporting is lower when the true customisation cost of a division and/or the firm core competence cost are higher. Intuitively, managers running a division with relatively low marginal costs have more room for over-reporting, while still facing a relatively high probability of being financed. Therefore, within-firms, managers of better products over-report their costs relatively more. Between firms, over-reporting is larger in better firms (with lower core marginal cost). Proposition 1, (1.3), predicts that over-reporting is larger in firms with more non-core divisions. When more slots are to be filled in a firm, it is more likely that the manager's offer will be in the range of selected offers after the firm has ranked the proposals by candidate managers. Consequently, conditional on a true customisation cost x_i, managers have less of an incentive to make a lower offer $z_i = \mu x_i$ when more slots are available.[19]

Finally, the result (1.4) states that over-reporting is lower the tougher competition in the output market. The reason is that the marginal cost of a division matters not in absolute terms but does matter relative to the market cutoff c_D. A lower market cutoff reduces the range of costs at which a division is financed. Managers internalise this channel when they over-report the cost of their division. The toughness of competition in the output market acts as a disciplining device on the managers' strategic over-reporting. Through this mechanism, which is distinctive to our theory, the marginal cost of a division in MSF $\mu_i (x_i, c, m, c_D) x_i c$ responds endogenously to market toughness. Therefore, the model delivers richer implications on how market toughness triggers resource reallocation within MSF, which go beyond the consequences of a reallocation of output market shares.[20]

A novel implication is that market toughness, through the managers' strategic over-reporting, distorts the allocation of capital within firms. The equilibrium allocation (4a) implies that capital $k(z_i, c)$ allocated to a certain product follows an inverted-U shaped function of the marginal cost $z_i c$.[21] The asymmetric over-

[19]In Figure 4 of the online appendix, we show that reported marginal costs in US listed companies are positively correlated with the number of segments at the company; which provides support to prediction (1.3).

[20]In Mayer et al. (2014), market toughness reallocates markets shares from the worst products to the best products of a multi-product firm. Results that go in the same direction are common in many models of multi-product firms, see Hopenhayn (2014). However, to the best of our knowledge, our theory of MSF is the first to highlight a mechanism in which the marginal cost responds endogenously to market toughness, while in the existing approaches it is exogenously fixed.

[21]The allocation of capital is increasing in $z_i c$ for $z_i c < \frac{1}{2} c_D$, while it decreases for higher marginal cost $z_i c > \frac{1}{2} c_D$. At the same time, the model does not rule out the possibility that some divisions are under-financed, and they will be the worst non-core divisions. However, we have assumed two parametric restrictions $\sqrt{f} \geq 1 - \delta$ and $\delta \leq 1/2$ that jointly guarantee

reporting of customisation cost, which is more pronounced for products with lower marginal cost, implies that: within the same MSF, the better non-core divisions are over-financed (receive more capital than under true reporting); and between firms, the better MSF allocate excessively more capital to their best non-core divisions.

The source of these distortions in capital allocation does not lie in dispersion of marginal products of capital around its rental rate, as is the case in Hsieh and Klenow (2009). Production occurs in all divisions and the firms equate their marginal product of capital to the rental price of capital in the external market. In our theory, capital mis-allocation results from an agency problem that characterises the internal functioning of MSF.

4 Open economy general equilibrium

Firms sell in the domestic market, where the equilibrium allocations (3a)-(4c) hold, and they might also export to a foreign market that is symmetric to the domestic one.[22] Output markets are internationally segmented and a product can be exported subject to an "*iceberg*" trade cost $\tau \geq 1$, where $\tau = 1$ for domestic sales. Symmetric markets, linearity of the cost function, and iceberg trade cost imply that a domestic producer with core marginal cost c would serve the foreign market as a local producer with core marginal cost τc. Products with a marginal cost $\tau z_i c \leq \delta c_D$ are sold in the domestic market and exported. Products with a marginal cost $z_i c$ such that $\tau z_i c > \delta c_D \geq z_i c$ are not exported.

Prior to entry, the owner makes an irreversible investment of $f_E > 0$ units of labor to research and develop a technology. Both core marginal cost and the vector of customisation costs are uncertain outcomes. The core marginal cost is revealed after entry as a random draw $c \sim G(c)$ from an exogenous Inverse Pareto distribution with cumulative density function $G(c) = \left(\frac{c}{c_M}\right)^{\rho}$, for $\rho > 1$. $c_M > 0$ is the exogenous maximum cost threshold. Unconditional on entry, the expected value to the owner in a market that can be served at trade cost $\tau \geq 1$ is given by:

that $z_i c < \frac{1}{2} c_D$. Under this circumstance, over-reporting always implies a greater allocation of capital, thus no division is under-financed in equilibrium.

[22] Mayer et al. (2014) show how the same structure of the output market than ours can be extended to allow for an asymmetric scenario in which market size and bilateral trade costs do not have to be the same among trading partners.

$$\Pi_E(c_D;\tau) = \int_0^{\frac{\delta c_D}{\tau}} \pi\left(1,\tau c\right) dG(c) + \int_0^{\frac{c_D}{2\tau}} m v_m\left(\tau c\right) dG(c) = \frac{\Omega \tau^{-\rho} L c_D^{\rho+2}}{\phi_c \gamma}, \quad (13)$$

where[23]

$$\int_0^{\frac{\delta c_D}{\tau}} \pi\left(1,\tau c\right) dG(c) = \frac{\tau^{-\rho} L c_D^{\rho+2}}{\phi_c \gamma}, \quad \phi_c = 4c_M^{\rho}\left[\delta^{\rho} - 2\delta^{\rho+1}\frac{\rho}{\rho+1} + \delta^{\rho+2}\frac{\rho}{\rho+2}\right]^{-1}$$

$$\int_0^{\frac{c_D}{2\tau}} m v_m\left(\tau c\right) dG(c) = \frac{\tau^{-\rho} L c_D^{\rho+2}}{\phi_v \gamma}, \quad \phi_v = 4c_M^{\rho}\left[\frac{2}{6}\left(\frac{1}{2}\right)^{\rho} - 2\frac{\rho}{\rho+2}\left(\frac{1}{2}\right)^{\rho+2} + \frac{4}{3}\frac{\rho}{\rho+3}\left(\frac{1}{2}\right)^{\rho+3}\right]^{-1}$$

$$\Omega = \left(1 + \phi_c \phi_v^{-1}\right).$$

In a symmetric open economy, both the domestic and foreign market are taken into account. In an equilibrium with free entry, the value of entry is driven to zero. The free entry condition

$$\Pi_E(c_D;1) + \Pi_E(c_D;\tau) = f_E \quad (14)$$

determines the cutoff cost c_D. Given the distribution of the core competence cost, the expected profit in the domestic market has a closed form solution. The cutoff cost that satisfies a free entry equilibrium is given by:

$$c_D = \left[\frac{\gamma \phi_c f_E}{\Omega(1+\tau^{-\rho})L}\right]^{\frac{1}{2+\rho}} \quad (15)$$

The cutoff cost in (15) is higher when the taste for differentiation γ is greater, and the entry cost f_E relative to the market size $(1+\tau^{-\rho})L$ is larger. Moreover, the cutoff cost increases in the ratio ϕ_c/Ω, which captures the contribution of the discount factor δ and of the exogenous parameters of the distribution of core marginal cost, c_M and ρ.

4.1 Endogenous heterogeneity within and across firms

In this section, we show how the introduction of an internal capital market allows us to endogenise the cost structure of multi-segment firms, which remains

[23] To simplify notation we present results for a particular value of the fraction $f \in (0,1)$, namely $f = 1/4$, without loss of generality.

exogenous in the multi-product-firms literature. Managers strategically over-report the cost of their divisions depending on the true customisation cost of the division x_i; the core marginal cost of the firm c; the number of non-core divisions m; and competition in the output market, through c_D (Proposition 1). Consequently, the cost structure of a firm becomes a distinct feature of the firm's organisation: the firm's organisation acts as a glue. The cost of a segment depends not only on its customisation costs but also on the competition for funds in the internal capital market and the number of segments a firm operates.

To illustrate this point, we compare the relative cost across divisions in Mayer et al. (2014) with our setup. In their model, the relative marginal cost between two products of the same firm, say i and j, is exogenously determined by the ratio of their customisation costs. In our model, the relative marginal cost between two products becomes endogenous to the four determinants of misreporting

$$\frac{z_i c}{z_j c} = \frac{\mu^\star(x_i, c, m, c_D)}{\mu^\star(x_j, c, m, c_D)} \frac{x_i}{x_j} \neq \frac{x_i}{x_j} \ ,$$

where the strategic over-reporting by the two managers generates a distortion to the allocation of capital. Because the allocation of capital is increasing in the reported marginal cost, both non-core divisions are characterised by an excess of capital $k(z_i, c) > k(x_i, c)$ and $k(z_j, c) > k(x_j, c)$.

This property extends to a comparison across firms. The marginal costs of two products with the same customisation cost but produced in different firms, say with core marginal costs c' and c'', and/or with m' and m'' non-core divisions:

$$\frac{z_i c'}{z_i c''} = \frac{\mu^\star(x_i, c', m, c_D)}{\mu^\star(x_i, c'', m, c_D)} \frac{c'}{c''} \neq \frac{c'}{c''} \quad \text{or} \quad \frac{z_i c'}{z_i c''} = \frac{\mu^\star(x_i, c', m', c_D)}{\mu^\star(x_i, c'', m'', c_D)} \frac{c'}{c''} \neq \frac{c'}{c''},$$

are no longer exogenous as in Mayer et al. (2014). Our model predicts that more capital is allocated to the division of the better firm (lower c) and, given the same core competence cost, to the division of the firm with a wider number of non-core segments (greater m).

Moreover, the result that changes in competition (such as a lower output market cutoff c_D) propagates through the cost structure of multi-segment firms and is a distinctive feature of our approach, due to the strategic behavior of managers as captured by the endogenous factor of misreporting $\mu^\star(x_i, c, m, c_D)$. Through this channel the policies that affect the output market have an heterogeneous impact on products and firms.

4.2 The conglomerate discount as a measure of within-firm mis-allocation

Total profits and capital of a firm with core marginal cost c and customisation costs $\boldsymbol{z} = \{z_0, z_1, ..., z_m\}$ are given by $\pi_{tot}(c) = \sum_{i=0}^{m} [\pi(z_i, \tau c) + \mathbf{1}_i \pi(z_i, \tau c)]$ and $k_{tot}(c) = \sum_{i=0}^{m} [k(z_i, \tau c) + \mathbf{1}_i k(z_i, \tau c)]$ respectively; where $\mathbf{1}_i = 1$ if the product is exported and zero otherwise. We refer to the value of total firm capital $\theta k_{tot}(\boldsymbol{z}, c)$ as "*book value*", and the discounted lifetime stream of profit $\frac{1+\theta}{\theta}\pi_{tot}(\boldsymbol{z}, c)$ as "*market value*" of the firm. The market-to-book ratio, or *Tobin's Q* is given by:

$$T(\boldsymbol{z}, c) = \frac{(1+\theta)\varphi_k}{2\theta^2} \, \frac{c_D^2 - 2c_D \mathbb{A}[\boldsymbol{z}c] + \mathbb{A}[(\boldsymbol{z}c)^2]}{c_D \mathbb{A}[\boldsymbol{z}c] - \mathbb{A}[(\boldsymbol{z}c)^2]}. \tag{16}$$

where $\mathbb{A}[\boldsymbol{z}c] = [1+m+\sum_{i=0}^{m} \mathbf{1}_i]^{-1} \sum_{i=0}^{m}(z_i + \mathbf{1}_i z_i \tau)c$ and $\mathbb{A}[(\boldsymbol{z}c)^2] = [(1+m)+\sum_{i=0}^{m} \mathbf{1}_i]^{-1} \sum_{i=0}^{m}(z_i^2 + \mathbf{1}_i z_i^2 \tau^2)c^2$ are, respectively, the first and second moment of the distribution of marginal cost across divisions of the firm. Tobin's Q decreases with average marginal cost $\mathbb{A}[\boldsymbol{z}c]$ and, conditional on the average, increases with the variance of marginal costs across divisions $\mathbb{A}[(\boldsymbol{z}c)^2] - \mathbb{A}[\boldsymbol{z}c]^2$.

Over-reporting affects Tobin's Q, and hence the conglomerate discount, through two channels. First, it increases average marginal cost $\mathbb{A}[\boldsymbol{z}c]$. Second, by holding average marginal cost fixed, the relatively more pronounced over-reporting at better divisions decreases the dispersion of marginal costs $\mathbb{A}[(\boldsymbol{z}c)^2] - \mathbb{A}[\boldsymbol{z}c]^2$, because costs of better divisions become closer to costs of worse divisions. Intuitively, the closer divisions are in their costs, the less valuable is the winner picking role of the internal capital market. Both channels decrease Tobin's Q of multi-segment firms.

Single-segment firms are not subject to cost over-reporting. The model thus predicts a "*conglomerate discount*": $\frac{T(\boldsymbol{z}, c_{msf})}{T(1, c_{ssf})} < 1$. The conglomerate discount arises as a consequence of an over-allocation of capital to better divisions within multi-segment firms. The conglomerate discount thus reflects mis-allocation in the internal capital market of multi-segment firms. In contrast to the mis-allocation literature, our model yields a novel form of capital mis-allocation within, rather than between firms: mis-allocation arises because of information asymmetry within the organisation. Note that the conglomerate discount arises if the difference in core marginal costs between single- and multi-segment firms $c_{ssf} - c_{msf} > 0$ is sufficiently small. Thus, highly productive MSFs may not exhibit a conglomerate discount, despite a distorted allocation of capital.[24]

5 Taking the model to the data

In this section we test key predictions of our model. We proceed in two steps. We first derive a set of structural equations that allow us to formulate predictions of the model. In the second step, we take the model to the data and test these predictions. We show that (*i*) the conglomerate discount is a measure of within-firm mis-allocation; (*ii*) that the relation between capital allocation and marginal costs across segments follows an inverse U-shape; and (*iii*) that informational frictions are an important determinant of capital allocation within multi-segment firms. Finally, we (*iv*) investigate the disciplining role of trade. We use rising Chinese imports as an exogenous shock and show that tougher competition causally reduces capital mis-allocation within US companies.

5.1 Structural equations

To derive the structural equations, we combine equations for capital allocation (4a) and equilibrium cutoff costs (15) with the definition of reported marginal cost $z_f c = \mu_f x_f c$. These equations yield our core set of structural equations:

$$ln\left(c_{Dt}\right) = \frac{1}{2+\rho}\left[ln\left(\frac{\gamma\phi f_e}{\Omega L}\right) - ln\left(1+\tau_t^{-\rho}\right)\right] \tag{17a}$$

$$ln\left(rmc_{fst}\right) = ln\left(\mu_{fst}\right) - ln\left(c_{Dt}\right) + ln\left(x_{if}c_f\right) \tag{17b}$$

$$ln(assets_{fst}) = ln\left[rmc_{fst}(1-rmc_{fst})\right] + 2ln\left(c_{Dt}\right) + ln\left(\frac{L}{2\gamma\varphi_k}\right), \tag{17c}$$

where f, s, and t refer to firm, segment, and year. The dynamics in our model are driven by time-varying variables trade cost (τ_t), cutoff cost (c_{Dt}), and over-reporting factors (μ_{fst}).[25] We model trade liberalisation as a permanent decrease

[24]Maksimovic and Phillips (2013) review recent literature on the presence of a conglomerate discount and conclude that empirical evidence is mixed. Our paper provides an explanation for why not all multi-segment firms suffer from a conglomerate discount. Conglomerates exposed to international competition may trade at a premium rather than a discount, due to the disciplining effect of competition on over-reporting of costs within multi-segment firms.

[25]Additional factors capturing market size (f_E, L), preferences (γ), and technology (Ω, ϕ, ρ, φ_k and $x_{fs}c_f$) are constant over time. In our estimation, we include fixed effects to control for these (unobservable) variables.

in trade costs: trade liberalisation is analogous to an increase in competition in our model.

Equation (17a) shows that a fall in trade costs implies a lower cutoff value. Equation (17b) relates marginal costs (*rmc*) to cutoff value and over-reporting factors. The key channel in our model is that falling trade costs, through a decline in the cutoff value, lead to a decline in the over-reporting factor: under pressure of higher competition, managers reduce the extent to which they over-report the cost of their division ($\mu_{fst} \downarrow$). We do not observe marginal costs directly in the data. However, equation (4c) shows that relative marginal costs are an inverse function of return on assets (RoA), which we observe at the segment level.[26] We thus calculate relative marginal costs as

$$rmc_{fst} = \frac{1}{1 + RoA_{fst}}. \tag{18}$$

Finally, equation (17c) shows how marginal costs and cutoff value affect segment assets, i.e. its allocated capital. In the following, we will refer to *marginal costs relative to the cut-off value* as either *relative marginal costs* or simply *marginal costs*. We will now use equations (17a)-(17c) to formulate testable predictions of our model.

5.2 Testable predictions

We begin by investigating the cross-sectional features of capital allocation across firms and segments. Our main data source is Worldscope. We use yearly data on publicly listed US firms with primary activity in manufacturing covering the period 1997–2013. In addition to balance sheet information consolidated at the firm level, we observe sales, assets, profits, and return on assets at the 4-digit SIC segment level.[27] We classify firms as single-segment if they only operate in one industry (i.e. only have one segment). Importantly, we follow the literature and focus on unrelated segments. To this end, we use BEA data on input-output

[26] In our theory, we express variables in terms of marginal cost relative to the cutoff value, $z_f c/c_D$. Rearranging, our model yields that relative marginal costs equal $rmc_{fst} = 1/(1 + \frac{2\theta}{\varphi_k} returns_{fst})$. θ is the rental price of capital on the external market and φ_k is the capital share of total cost, both of which are aggregate constants.

[27] We use the "Product Segment Data" section of Worldscope, as described in the Worldscope Database Datatype Definitions Guide. In our data construction, we follow the standard in the accounting and finance literature (see Ozbas and Scharfstein (2009)); we compute segment profits as operating income plus depreciation; and we compute return on assets as profit over asset. Firms can operate in up to ten industries (segments).

relationships among industries and exclude all vertically related industries (i.e. industries that buys/sells more than 10% of its inputs/outputs from/to the other industry).

Our second major data source is BoardEX, which provides detailed information on over 243,000 CEOs. BoardEx provides data on compensation, tenure, age, gender, and other variables. Our full sample covers 2,644 individual firms and 5,434 individual segments: 804 firms (30%) are multi-segment firms. The average firm has 3.3 segments. In some specifications, we restrict the sample to firms or segments of conglomerate firms with positive sales in 1999 and 2007, as well as information on CEO compensation, which reduces the sample to 665 firms. Table 1 provides summary statistics for our main variables at the firm, segment, and industry level.

Table 1: **Descriptive statistics**

	mean	sd	min	max	count
Panel (a): Firm					
Q	1.52	0.68	0.21	9.38	5909
mean(marginal costs)	0.17	0.09	0.00	1.00	5909
sd(marginal costs)	0.18	0.24	0.00	2.14	5909
number of segments	3.32	1.23	2.00	10.00	5909
assets	7354	36006	0.29	797769	5909
employment	14509	33380	2	364550	5858
investment ratio	0.04	0.03	0.00	0.35	5839
Δ Q	-0.30	1.80	-8.31	7.14	665
multi-segment	0.46	0.50	0.00	1.00	665
Panel (b): Segment					
multi-segment	0.83	0.38	0.00	1.00	21083
log(assets)	5.58	2.15	-5.90	13.26	21083
return on assets	0.12	0.37	-3.67	2.47	21026
ln(rmc(1-rmc))	-1.96	0.42	-4.22	-1.39	21083
efficient segments	0.49	0.50	0.00	1.00	344
Δ assets	0.56	0.98	-2.57	3.44	344
Δ MC	0.00	0.34	-1.15	3.48	344
Panel (c): Industry					
Δ China (1999-2007)	0.07	0.11	-0.00	0.70	126
Δ China IV (1999-2007)	0.05	0.09	-0.00	0.70	126

Note: This table shows descriptive statistics for main variables. Sample size varies due to different levels of analysis. In panel (a), the level of aggregation is the firm-year level, except for ΔQ and *multi-segment* that are on the firm level. *mean marginal costs* is standardized to range from zero to one. In panel (b), the level of aggregation is the firm-segment-year level, except for *efficient segment*, $\Delta assets$ and ΔMC (marginal costs) that are on the firm-segment level. Panel (c) reports values on the industry level. Industry variables Δ China are divided by 100 to improve readability of coefficients in regression tables.

5.2.1 The conglomerate discount measures within-firm mis-allocation

Prediction 1 *A firm's Q is decreasing in its average marginal costs across segments and increasing in the dispersion of marginal costs across segments, conditional on average marginal costs.*

Prediction 1 follows directly from equation (16). Higher marginal costs decrease average return on assets, directly reducing Q. Wider dispersion of marginal costs across segments makes the internal capital market's role of 'winner picking' more valuable, thereby increasing Q. To test the relationship in Prediction 1 empirically, we estimate the following regression on the firm-year level:

$$Q_{f,t} = \beta_1 \; \overline{rmc}_{f,t} + \beta_2 \; sd(rmc)_{f,t} + \theta_f + \epsilon_{f,t}, \tag{19}$$

where $\overline{rmc}$ denotes average marginal costs across segments of firm f in year t, and $sd(rmc)_{f,t}$ denotes the standard deviation of marginal costs across segments. We cluster standard errors on the firm level to account for serial correlation. θ_f denote firm fixed effects. The inclusion of firm fixed effects, combined with a dependent variable in levels, implies an interpretation in changes. The coefficients of interest indicate how a firm's Q changes when average marginal costs or their dispersion increase. Based on Prediction 1, we expect a negative coefficient on average marginal costs ($\beta_1 < 0$) and positive coefficient on their dispersion ($\beta_2 > 0$).[28]

Table 2 reports results. Column (1) shows that an increase in average marginal costs is significantly correlated with a reduction in Q ($\beta_1 < 0$). Column (2) adds $sd(rmc)$ and shows that, conditional on average marginal costs, an increase in dispersion of marginal costs goes hand-in-hand with a significant increase in Q ($\beta_2 > 0$). Columns (1) and (2) do not account for differential (unobservable) trends across industries or firms of different size, for example changes in competition or tariffs. Columns (3) and (4) replicate Columns (1) and (2) but include time-varying fixed effects at the industry level and firm size level (defined as

[28]There is a fundamental difference between our measure of mis-allocation within firms compared to the measure of mis-allocation across firms in the literature (Hsieh and Klenow, 2009). In our model, the headquarters is in charge of allocating capital across segments. Based on 'winner-picking', it re-allocates capital from segments with low return on assets to segments with high return on assets. Greater dispersion of marginal costs *within* firms indicates a greater role for the headquarters to reallocating capital across divisions. In this sense, more dispersion within firms is "good". In contrast, greater dispersion of marginal revenue products across firms signals that capital does not move to the firms with the highest returns and thus dispersion across firms indicates mis-allocation *across* firms in standard models of mis-allocation.

yearly quartiles in terms of total sales). When we compare firms within the same industry and size group in a given year, the coefficients keep sign and significance, and remain similar in terms of magnitude. Hence, Table 2 shows that Q is decreasing in average marginal costs and increasing in dispersion of marginal costs across segments, which provides empirical support for Prediction 1.

Table 2: **Tobin's Q and marginal costs**

VARIABLES	(1) Q	(2) Q	(3) Q	(4) Q
mean(marginal costs)	-0.136**	-0.766***	-0.122**	-0.747***
	(0.068)	(0.172)	(0.058)	(0.134)
sd(marginal costs)		0.562***		0.553***
		(0.110)		(0.092)
Observations	5,909	5,909	5,909	5,909
R-squared	0.631	0.638	0.800	0.804
Firm FE	✓	✓	✓	✓
Industry*Year FE	-	-	✓	✓
Size*Year FE	-	-	✓	✓

Note: Dependent variable is Tobin's Q; *mean*(*marignal costs*) denotes average marginal costs across segments of firm f in year t, and *sd*(*marignal costs*) the standard deviation of marginal costs across segments. Standard errors are clustered on the firm level. *** p<0.01, ** p<0.05, * p<0.1

5.2.2 Inversely U-shaped capital allocation

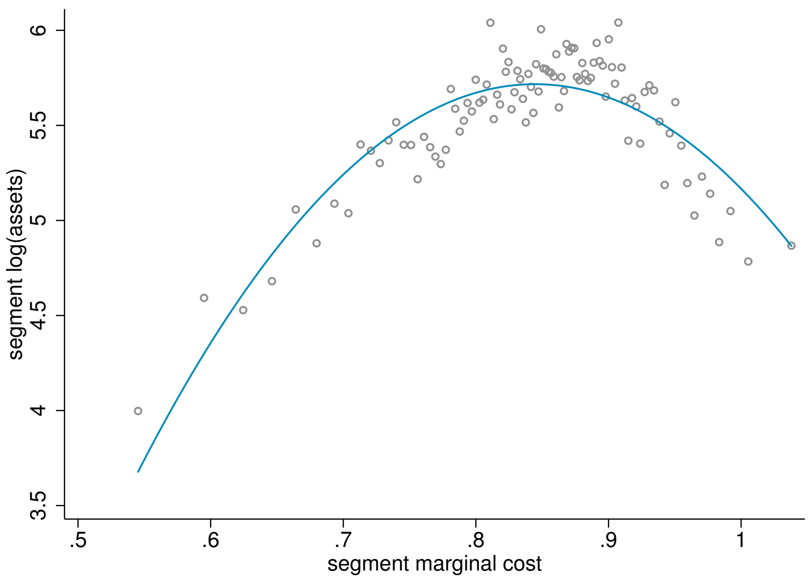
Prediction 2 *The relationship between relative marginal cost of a segment* (rmc_{fst}) *and its allocated capital* ($asset_{fst}$) *follows an inverse U-shape.*

Prediction 2 follows from equation (17c). The elasticity of assets to relative marginal costs, holding cutoff cost c_D constant, is given by:

$$\left.\frac{\partial \ln\left(asset_{fst}\right)}{\partial \ln\left(rmc_{fst}\right)}\right|_{\ln(c_{Dt})} = \frac{1-2rmc_{fst}}{1-rmc_{fst}}. \tag{20}$$

For lower values of relative marginal costs ($rmc_{fst} < \frac{1}{2}$) capital allocated to a segment increases with marginal costs, for higher values of relative marginal costs ($rmc_{fst} \geq \frac{1}{2}$) capital allocation declines.[29] The inverse U-shape arises due to opposing forces. On the one hand, two effects increase allocated capital when marginal costs increase. First, segments with higher marginal costs require more capital conditional on sales; we call this the *technology effect*. This arises because each additional product (or segment) a firm adds to its scope has higher marginal costs than existing products. Second, managers over-report the true cost of their divisions to receive more funding (*over-reporting effect*). On the other hand, segments with higher marginal costs must charge higher prices and hence face lower demand (*demand effect*), and managers of segments with high marginal costs face a higher probability of not being funded at all (which limits over-reporting). Both channels decrease allocated capital. With rising marginal costs, the demand effects increases in importance, while the technology effect decreases in importance and the positive effect of over-reporting on asset allocation eventually reverses.

Figure 2: **Segment capital allocation and efficiency**



Note: This Figure provides a binscatter plot of log segment assets on the y-axis against segment relative marginal costs on the x-axis. We condition on sector fixed effects to account for common factors that affect firms and segments within the same industry.

Note that the right-hand side in equation (20) is decreasing in relative marginal

[29]Note that the value of the turning point at 0.5 follows from our normalisation of $2\theta/\phi_k = 1$, which is a constant that can be arbitrarily re-scaled without loss of generality.

costs rmc_{fst}. This implies that asset allocation is more sensitive to a change in marginal costs in segments with low marginal costs. Figure 2 provides a binscatter plot of segment log assets on the y-axis against segment marginal costs on the x-axis. There is a clear hump-shaped pattern: for lower values of marginal costs, capital allocated to a segment increases with marginal costs. For higher values of marginal costs, capital allocation declines. Hence, in line with Prediction 2, as we move from more to less efficient segments, demand effect and over-reporting effect start to dominate the technology effect, which leads to a decline in capital allocated to a segment.[30]

5.2.3 Capital allocation and informational frictions

Prediction 3.1 *Within-firm mis-allocation: Multi-segment firms allocate more capital to their non-core segments than single-segment firms with similar core marginal costs.*

Prediction 3.2 *Informational frictions: The degree to which multi-segment firms over-allocate capital to non-core segments, relative to single-segment firms with similar core marginal costs, increases in informational asymmetries.*

Prediction 3.1 follows from mis-allocation arising within multi-segment firms due to over-reporting by segment managers. Informational frictions lie at the heart of mis-allocation in our model: the headquarters cannot verify true marginal costs of its divisions, so managers' desire for empire building leads to over-reporting of marginal costs. There is no such incentive conflict in single-segment firms. Consequently, Prediction 3.2 states that the problem of capital mis-allocation is worse in firms with higher informational frictions (i.e. in which theory predicts that managers have more room for over-reporting).

To test Prediction 3.1, we estimate the following regression equation, based on equation (17c):

[30]We test the hump-shaped relationship formally in the Online Appendix Table, where we regress log segment assets on marginal costs and marginal costs squared. The hump-shaped relationship holds after inclusion of firm fixed effects and industry*time fixed effects. In other words, even within the same firm and accounting for differential industry shocks over time, the relationship between capital allocation and marginal costs is hump-shaped.

$$\begin{aligned} log(assets)_{fst} = & \gamma_1 \; mutli \; segment_f + \gamma_2 \; ln\left[rmc_{fs}^{core}(1 - rmc_{fs}^{core})\right] \\ & + \gamma_3 \; mutli \; segment_f \times ln\left[rmc_{fs}^{core}(1 - rmc_{fs}^{core})\right] \\ & + \theta_g + \theta_i + \epsilon_{fst}, \end{aligned} \tag{21}$$

where $log(assets)$ is capital allocated to segment s of firm f in year t, $mutli \; segment_f$ denotes a dummy that takes on value one if a segment is part of a multi-segment firm, and rmc_{fs}^{core} denotes marginal costs of a firm's core segment, i.e. the most efficient segment. For single-segment firms, the core segment is equivalent to the firm. To control for constant factors affecting asset allocation across firms of similar size and in the same sector ($ln\left(\frac{L}{2\gamma\varphi_k}\right)$ in equation (17c)), we include dummies for firm size quartiles (θ_g) and industry fixed effects θ_i.We expect that, conditional on the same core marginal costs, multi-segment firms allocate more assets to a segment ($\gamma_3 > 0$). Standard errors are clustered on the firm level.

Table 3: **Within-firm mis-allocation and informational frictions**

VARIABLES	(1) log(assets)	(2) log(assets)	(3) low friction log(assets)	(4) high friction log(assets)
multi-segment	1.118***	1.749***	0.935**	2.251***
	(0.320)	(0.342)	(0.453)	(0.470)
marginal costs	-0.224***	-0.364***	-0.029	-0.502***
	(0.082)	(0.101)	(0.140)	(0.114)
multi-segment × marginal costs	0.377**	0.687***	0.396*	0.826***
	(0.152)	(0.160)	(0.215)	(0.214)
Observations	21,083	21,082	11,319	9,757
R-squared	0.574	0.645	0.686	0.633
Industry FE	-	✓	✓	✓
Size FE	✓	✓	✓	✓

Note: Dependent variable is log assets at the segment-year level. *multi-segment* is a dummy with value one for multi-segment firms and zero for single-segment firms, *marginal costs* denotes relative marginal costs in a firm's core segment, measured as $ln(rmc_{if}^{core}(1 - rmc_{if}^{core}))$. *low/high friction* refer to firms in which the time the average CEO sits on the board is above/below the sample median. All regressions control for firm size, investment, and efficiency. Standard errors are clustered on the firm level. *** p<0.01, ** p<0.05, * p<0.1

Column (1) in Table 3 shows that single-segment firms with higher marginal costs are allocated less capital ($\gamma_2 < 0$) than single-segment firms with lower marginal costs. The positive and significant interaction term indicates that multi-segment firms allocate more capital to segments than single-segment firms, conditional on the same core marginal costs ($\gamma_3 > 0$). In other words, given the same efficiency, multi-segment firm segments are larger than single-segment firms. This pattern is more pronounced when we compare segments in the same industry in Column (2), where we include industry fixed effects. Hence, Columns (1) and (2) support Prediction 3.1. Comparing segments of two firms, one at the 75^{th} and one at the 25^{th} percentile in terms of core marginal costs, multi-segment firms allocate 24% more assets to the segment at the 75^{th} percentile than single segment firms.

In Columns (3) and (4) we test Prediction 3.2 and highlight the role of informational frictions. Therefore, we classify firms into those with high and low informational frictions. Our preferred measure is the average time that CEOs spent on the board of a firm. The reasoning is as follows: the longer the time that a CEO has served on the board of a company, the better she knows its segments and hence the better she knows the true marginal costs of each segment. This limits the managers' scope to over-report and hence mis-allocation should be less severe. Data on CEO tenure is provided by BoardEx. We split firms along the median in each year. Firms in which the average CEOs has spent comparatively little time on the board are classified as *high friction* firms; firms in which the average CEO served a relatively long time on the board are classified as *low friction*.[31]

Columns (3) and (4) show results when we classify companies according to informational frictions between CEOs and divisional managers. Comparing coefficients on the interaction term in Column (3) for low-friction firms with Column (4) for high-friction firms, we see that it is around twice as large in Column (4). The larger coefficient suggests that the problem of allocating too much capital to the best segments (relative to single-segment firms) is stronger for multi-segment

[31] In the Online Appendix we show that our results are robust to two additional measures. First, we build on literature on limited cognitive load and classify firms by the number of boards the average CEO sits on; see Eppler and Mengis (2004) for a survey. The intuition is that CEOs serving on boards of several companies are less familiar with individual segments of these companies. Second, we collect data on the share of total compensation for managers that takes the form of equity. While not directly related to informational frictions, we reason that a higher ownership share aligns incentives of managers and owners and hence leads to less over-reporting, since divisional managers directly benefit from overall success of the firm (and not just the size of their segment). In other words, if incentive problems lead to over-allocation of capital to the best segments in multi-segment firms, then the firms in which managers own a larger share should allocate less capital to these segments when compared to single-segment firms. The correlation between the three metrics ranges from 0.13 to 0.18, thus they capture different dimensions of informational asymmetries.

firms in which informational frictions are more severe, supporting Prediction 3.2.

5.3 The China shock and within-firm mis-allocation

In this section, we exploit an exogenous shock to competition − rising imports from China − and investigate how it affects capital allocation and the conglomerate discount.

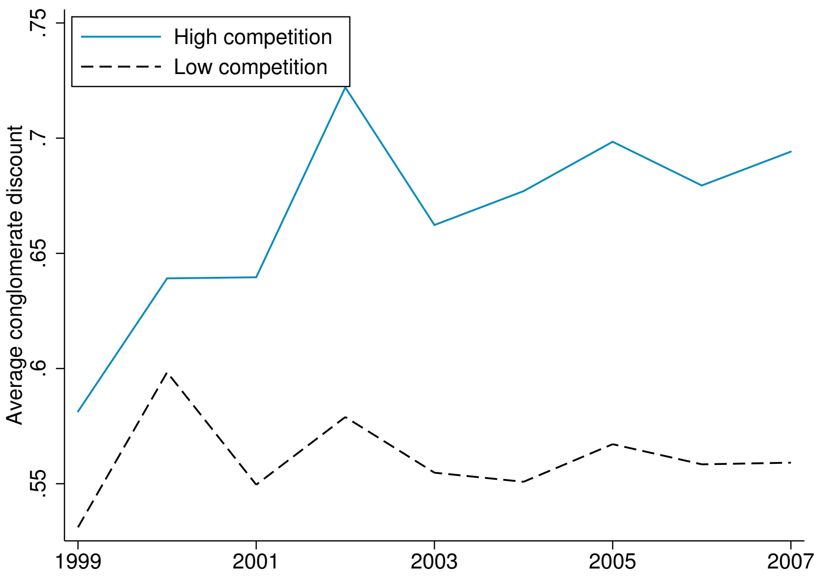
Prediction 4.1 *An increase in import competition reduces the conglomerate discount.*

As detailed in Section 5.1, tougher import competition reduces cut-off value c_D. Because the managers' scope for over-reporting is constrained by c_D, competition reduces over-reporting. The incentive to over-report declines most for managers in segments with lowest relative marginal costs, which follows directly from Proposition 1. The fall in marginal costs in the best segments, relative to worse segments, implies that there is an increase in dispersion in marginal costs across segments. Equation (16) shows that wider dispersion increases multi-segments firm's Q and hence reduces the conglomerate discount.

We follow Autor et al. (2013) and define $\Delta China_i$ as the change in import penetration for four-digit SIC industry i from 1999–2007.[32] Industries with a stronger increase in Chinese imports are subject to tougher competition. Figure 3 shows the disciplining effect of competition on the conglomerate discount in a non-parametric way. It plots the average conglomerate discount over time from 1999–2007, where we split the sample into industries with a strong increase in competition (blue line, *high competition*), and industries with a modest increase in competition (black-dashed line, *low competition*). High (low) competition industries see an increase in imports from China ($\Delta China_i$) above (below) the median across industries. While the conglomerate discount decreases for industries with a strong rise in competition − that is, there is an increase in multi-segment firms' Q relative to single-segment firms − there is no change for industries that

[32] Autor et al. (2013) define the growth of Chinese import penetration for industry s from 1999–2007 as $\Delta China_i = \Delta M_i/(Y_{i0} + M_{i0} - X_{i0})$, where ΔM_i is the growth in US imports from China from 1999–2007, which is divided by initial absorption (US industry shipments plus net imports, $Y_{i0} + M_{i0} - X_{i0}$) in the base period 1991, which is near the start of China's export boom. The authors argue that rising imports from China reflect a supply shock. China's falling prices, rising quality, and diminishing trade and tariff costs in these surging sectors are causes of its manufacturing export growth.

Figure 3: **Conglomerate discount over time: by China import competition**



Note: This Figure plots the ratio of average Q of multi-segment firms over average Q of single-segment firms (the conglomerate discount) for the time period covered in our 'China shock' sample. We split the sample into firms within industries with an above-median increase in import penetration from China ('High competition', blue solid line) and those with an below-median increase ('Low competition', black dashed line) firms.

saw little-to-no change in competition.

We investigate the effect of competition on the conglomerate discount more rigorously in Table 4. We estimate a firm level regression in changes from 1999–2007:

$$\Delta Q_{fi} = \delta_1 \; multi\ segment_f + \delta_2 \; \Delta China_i \\ + \delta_3 \; multi\ segment_f \times \Delta China_i + \theta_g + \theta_i + \epsilon_{fi}. \tag{22}$$

ΔQ denotes the change in Tobin's Q of firm f in industry i. *multi segment* is a dummy with value one if firm f is a multi-segment firm, $\Delta China$ denotes the change in Chinese imports from $1999 - 2007$ in industry i. Similar to firm level regression (21), we include dummies for firm size quartiles (θ_g) and industry fixed effects (θ_i) to control for factors common to firms of similar size and within three-digit industries. All regressions cluster standard errors on the level of the shock (i.e. the industry level). The coefficient δ_1 indicates the change in conglomerate discount for the average multi-segment firm, absent any change in competition. δ_3

indicates how the discount changes differentially for firms in response to tougher competition, depending on whether or not a firm is a multi-segment firm. While our theory makes no prediction for the sign of δ_1, Prediction 4.1 implies that $\delta_3 > 0$: the conglomerate discount declines faster in industries with a stronger rise in Chinese imports.

Table 4: **Import competition and the conglomerate discount**

	(1)	(2)	(3)	(4)	(5) IV
VARIABLES	Δ Q	Δ Q	Δ Q	Δ Q	Δ Q
multi-segment	0.651***	0.531***	0.368***	0.362***	0.178
	(0.145)	(0.143)	(0.119)	(0.116)	(0.147)
Δ China (1999-2007)		-1.317**	0.052	0.049	-0.527
		(0.593)	(0.899)	(0.903)	(0.780)
multi-segment × Δ China (1999-2007)		1.272*	1.386*	1.341*	3.338***
		(0.712)	(0.793)	(0.762)	(1.203)
Observations	665	665	665	665	665
R-squared	0.068	0.075	0.194	0.199	0.040
Industry FE	-	-	✓	✓	✓
Size FE	-	-	-	✓	✓

Note: Dependent variable is Tobin's Q. *multi-segment* is a dummy with value one for multi-segment firms and zero for single-segment firms, Δ China (1999-2007) denotes the change in Chinese import penetration at the industry level from 1999 to 2007. Column (5) instruments Δ China (1999-2007) with Chinese imports in 8 other advanced economies. All regressions control for firm size, investment, and efficiency. Standard errors are clustered on the industry level. *** p<0.01, ** p<0.05, * p<0.1

However, a simple OLS regression could suffer from omitted variable bias or reverse causality. For example, imports could rise the most in industries where domestic (US) multi-segment firms are of particularly low quality. Then, we would falsely attribute any change in conglomerate discount to changing competition, and our coefficients would likely be downward-biased. To address endogeneity concerns, we employ an instrumental variables (IV) strategy and instrument actual US imports from China with imports from China to eight other advanced economies.[33] As Autor et al. (2013) argue, the instrument isolates the supply component in observed imports (i.e. the variation in imports that is due to rising productivity in China and not due to changes in the US economy). Based on the assumption of a likely negative correlation between (unobserved) firm quality and import penetration, our OLS estimates will understate the true effect of competition. Hence, we expect $\beta_3^{IV} > \beta_3^{OLS}$.

[33] Australia, Denmark, Finland, Germany, Japan, New Zealand, Spain, and Switzerland.

Table 4, Column (1) shows that Q increases faster for multi-segment firms, relative to single-segment firms over the sample period; that is, absent any competition, the conglomerate discount declined over the sample period. Column (2) adds interaction terms. Coefficient β_3 is significant and positive, indicating that the discount declines faster in industries with a stronger rise in competition. Columns (3) and (4) add industry and size fixed effects, and results remain qualitatively and quantitatively similar. That is, even for firms of similar size and within the same three-digit industry, rising competition reduces the conglomerate discount. Hence, OLS regressions suggest that an increase in competition reduces the conglomerate discount − in line with Figure 3.

To address the potential bias in OLS regressions, Column (5) instruments Chinese imports to the United States with Chinese imports to other advanced economies. The effect of Chinese imports on the conglomerate discount of multi-segment firms is highly significant and large in magnitude. It increases by a factor of 2.5, relative to non-IV regressions, which suggests that there is a negative relationship between (unobserved) firm quality and import penetration. In terms of magnitude, a one standard deviation increase in predicted competition $\Delta China$ leads to a 32% stronger decline in the conglomerate discount in Column (5). The baseline decline in conglomerate discount absent any change in competition equals 17.8%, so the effect of competition is large and economically meaningful. In conclusion, firm level results in Table 4 suggest that rising competition reduces the conglomerate discount. To further shed light on the underlying mechanism, we proceed to the segment level.

We begin by taking a closer look at the effect of competition on marginal costs. A decline in trade cost τ_t reduces cut-off value c_{Dt} and over-reporting factor μ_{fst}. To see how trade affects marginal costs through a change in cutoff costs c_{Dt}, the derivative of equation (17b) with respect to c_D yields:

$$\frac{\partial \ln (rmc_{fst})}{\partial \ln (c_{Dt})} = \underbrace{\frac{\partial \ln (\mu_{fst})}{\partial \ln (c_{Dt})}}_{\text{OVER-REPORTING EFFECT}} - 1 \qquad (23)$$

Expression $\frac{\partial \ln(\mu_{fst})}{\partial \ln(c_{Dt})}$ reflects the *over-reporting effect.* As long as the elasticity of μ_{fst} with respect to a change in c_D is larger than one (i.e. the change in c_{Dt} itself), then a decline in trade costs has a direct negative effect on segment marginal costs. If this is the case, then the over-reporting effect implies that marginal costs decline in response to competition. Due to the hump-shaped relationship between assets and marginal costs, this effect is expected to be strongest for the best segments. The endogenous response of marginal costs to trade costs is a distinctive feature of our theory, while alternative theories in the field (along the lines of Mayer et al. (2014)) assume no correlation between marginal costs and trade.

In addition to marginal costs, we analyze the effect of competition on segment capital allocation. We use equation (17c) to decompose the overall change in asset allocation into two components: the *demand effect*, which works directly through sales; and the over-reporting effect, which works through marginal costs:

$$\underbrace{\left.\frac{\partial \ln\left(asset_{fst}\right)}{\partial \ln\left(c_{Dt}\right)}\right|_{\ln\left(rmc_{fst}\right)}}_{\text{DEMAND EFFECT}} = 2 \tag{24}$$

$$\underbrace{\left.\frac{\partial \ln\left(asset_{fst}\right)}{\partial \ln\left(rmc_{fst}\right)}\right|_{\ln(c_D)}}_{\text{OVER-REPORTING EFFECT}} = \frac{1-2\ rmc_{fst}}{1-rmc_{fst}} \tag{25}$$

The *demand effect* captures the direct increase in segment assets when segment sales increase (through the change in c_{Dt}), conditional on marginal costs. The *over-reporting effect* captures the indirect effect of lower c_{Dt} through marginal costs on segment assets. In response to a trade shock over-reporting declines, segment marginal costs fall, and fewer assets are allocated to the respective segment. This effect will be particularly strong for the best segments. The overall effect depends on which of the two effects dominates.[34] Thus, our model yields the following two predictions of the effect of trade on segment marginal costs and assets:

Prediction 4.2 *An increase in import competition reduces reported marginal costs in the best segments if the elasticity of over-reporting factor μ with respect to cutoff value c_D is greater one.*

[34]Note that the derivative of log assets w.r.t. log rmc (over-reporting effect) in equation (25) is positive for $rmc \leq 0.5$ and surpasses -2 (the direct effect of c_D on log assets) only at around $rmc \geq 0.7$. This means that we only expect the over-reporting effect to dominate the demand effect in the least-efficient segments.

Prediction 4.3 *An increase in import competition increases the allocation of capital to the best segments if the demand effect dominates the over-reporting effect.*

To investigate the effect of competition on segment assets and marginal costs in the best segments, we estimate segment-level regressions in the cross-section.[35]

$$\begin{aligned}\Delta y_{fsi} =& \xi_1 \text{ } \textit{efficient segment}_{fs} + \xi_2 \text{ } \Delta China_i \\ &+ \xi_3 \text{ } \textit{efficient segment}_{fs} \times \Delta China_i + \epsilon_{fs},\end{aligned} \tag{26}$$

where Δy is the 1999–2007 change in marginal costs or log assets of segment s of firm f in segment industry i. $\Delta China$ is the 1999–2007 change in import penetration of segment industry i, *efficient segment* is a dummy with value one if a segment is among the two segments with lowest marginal costs as of 1999.[36] The coefficient of interest is ξ_3: under the assumption that the elasticity of μ w.r.t. c_D is larger one, for marginal costs we expect that competition decreases marginal costs of better segments ($\xi_3 < 0$); for assets the effect of competition on segment size of better segments depends on the relative strength of demand vs. over-reporting effect. If $\xi_3 > 0$, then we conclude that an increase in import competition increases allocated capital and that the demand effect dominates the over-reporting effect. All regressions include firm controls log employment, return on assets, and investment ratio, all as of 1999. We cluster standard errors at the segment industry level to account for correlation across segments subject to the same shock.

The underlying friction that gives rise to mis-allocation is asymmetric information. We thus expect the disciplining effects of import competition on segment marginal costs and assets to be particularly strong within firms that suffer more from informational asymmetries. Similar to the firm level analysis, we classify firms into those with high and low informational frictions along the median time that CEOs spent on the board in each year.[37]

Table 5, panel A, reports the results for OLS regressions. Columns (1)–(3)

[35] We restrict the sample to segments with positive sales in 1999 and 2007 to avoid selection effects through entry and exit of segments.

[36] The results are qualitatively similar if we classify only the most efficient or the three most-efficient segments as *efficient segment*.

[37] In the Online Appendix, we show that results hold for CEO time in company and CEO equity share out of total compensation.

Table 5: **Import competition and within-firm mis-allocation**

Panel A: OLS

VARIABLES	(1) Δ MC	(2) low friction Δ MC	(3) high friction Δ MC	(4) Δ assets	(5) low friction Δ assets	(6) high friction Δ assets
efficient segments	-0.063	-0.071**	-0.066	-0.051	0.148	-0.274**
	(0.041)	(0.035)	(0.074)	(0.100)	(0.151)	(0.132)
Δ China (1999-2007)	0.027	0.048	-0.029	0.044	-0.335	0.039
	(0.080)	(0.140)	(0.094)	(0.275)	(0.432)	(0.232)
efficient segments × Δ China (1999-2007)	-0.447***	-0.323**	-0.546***	1.165***	0.464	2.805***
	(0.115)	(0.153)	(0.194)	(0.277)	(0.542)	(0.387)
Observations	344	170	174	344	170	174
R-squared	0.038	0.109	0.032	0.124	0.087	0.246

Panel B: IV

VARIABLES	(1) IV Δ MC	(2) IV low friction Δ MC	(3) IV high friction Δ MC	(4) IV Δ assets	(5) IV low friction Δ assets	(6) IV high friction Δ assets
efficient segments	-0.065	-0.072**	-0.070	-0.027	0.170	-0.246*
	(0.042)	(0.035)	(0.077)	(0.100)	(0.150)	(0.130)
Δ China shock	0.011	0.138	-0.056	0.182	-0.456	0.091
	(0.076)	(0.110)	(0.120)	(0.322)	(0.516)	(0.354)
efficient segments × Δ China shock	-0.416***	-0.345**	-0.489**	0.849*	0.269	2.352***
	(0.119)	(0.155)	(0.204)	(0.466)	(0.711)	(0.484)
Observations	344	170	174	344	170	174
R-squared	0.038	0.106	0.032	0.124	0.086	0.244

Note: Dependent variable is the 1999-2007 change in segment marginal costs (MC) or log assets (assets). *efficient segment* is a dummy with value one for the two most-efficient segments within a firm in terms of average return on assets. Δ China (1999-2007) denotes the change in Chinese import penetration at the industry level from 1999 to 2007. Panel B instruments Δ China (1999-2007) with Chinese imports in 8 other advanced economies. *low/high friction* refer to firms in which the time the average CEO sits on the board is above/below the sample median. All regressions control for firm size, investment, and efficiency. Standard errors are clustered on the industry level. *** p<0.01, ** p<0.05, * p<0.1

use the change in marginal costs as dependent variable. Column (1) shows a significant decrease in marginal costs for better segments in response to higher competition. Splitting firms along the median CEO time on the board in Columns (2) and (3), we find that the decline in marginal costs is particularly large in firms where CEOs served less time on the board (i.e. where informational frictions are higher and the scope for a reduction in over-reporting larger). Relative to Column (2), the coefficient on the interaction term in Column (3) is around two-thirds larger. The negative coefficient suggests that the elasticity of over-reporting factor μ with respect to the cutoff value c_D is greater one.[38]

Columns (4)–(6) repeat the exercise with log change in segment assets as dependent variable. There is a significant increase in assets allocated to the best segments in Column (4). The change in asset allocation is particularly strong for firms with more severe frictions in Column (6), relative to firms with lower frictions in Column (5). The positive coefficient on the interaction term also suggests that the demand effect dominates the over-reporting effect. Panel A thus suggests that rising competition leads to an increase in the efficiency of the internal capital market by reducing reported marginal costs and increasing assets allocated to the best segments. Panel B instruments Chinese imports to the United States with Chinese imports to other advanced economies. IV results are similar in terms of sign, size, and significance to OLS results. There is a significant negative (positive) effect of competition on marginal costs (assets) of the best segments, see Columns (1) and (4).

The disciplining effect of competition is stronger for firms with more severe informational frictions (Columns (3) and (6)), relative to firms with lower frictions (Columns (2) and (4)). Taken together, Tables 4 and 5 suggest that increasing competition improves the allocation of capital through the internal capital market in multi-segment firms. A decline in over-reporting and an increase in capital allocated to the best segments lead to a decline in the conglomerate discount of multi-segment firms.

How large is the effect of rising imports on reported marginal costs and allocated assets? For marginal costs, in our preferred specification in Column (3) of Table 5 panel B, the coefficient on the interaction term *efficient segment* $\times$ Δ*China shock* equals -0.489. In our sample, the average increase in import competition from China from 1999–2007 is approximately tenfold. Thus, an increase in import competition from China reduces relative marginal costs of better segments (in multi-segment firms with high informational frictions) by approximately 4.9%.

We can use this estimate to measure the change in over-reporting factor μ. From equation (23) it follows that the elasticity of μ to a trade-induced change in c_D is equal to the elasticity of relative marginal cost to c_D plus one. This

[38]In Table 6 in the online appendix we run a placebo test which shows no statistical significant effect of rising Chinese imports on marginal costs of single-segment firms. This absence of any significant effect is to be expected because there is no informational friction between CEOs and divisional managers, and hence no over-reporting, in single-segment firms that could be reduced through a trade shock.

implies that the total elasticity of μ w.r.t. c_D equals 1.489. Consequently, for a tenfold increase in imports from China, segment marginal costs decline by 4.9% and the over-reporting factor by a sizeable 14.9% in efficient segments, relative to worse segments. Likewise, for assets in Column (6) of Table 5 panel B, the same increase in imports increases assets allocated to the best segments by around 25%. Coming back to Prediction 4.2 and Prediction 4.3, we thus conclude that the elasticity of μ w.r.t. c_D is greater than one, and that the demand effect dominates the over-reporting effect.

6 Conclusion

In this paper, we offer a novel theory of mis-allocation within firms (rather than between firms) that arises from the empire building motive of divisional managers in firms. Managers compete for capital and overstate their true costs to receive more funds. The best (and largest) divisions within firms end up getting "too much" capital when compared to an optimal allocation. Information asymmetry between firm owners and managers about the true costs of a division generate the mis-allocation of capital within firms.

In our model, we embed an internal capital market in a theory of multi-product firms. Merging these two elements from the finance and trade literature is key to answering the following two questions. First, what explains mis-allocation of resources in the economy, in particular mis-allocation *within* firms that is responsible for a significant share of overall mis-allocation (Kehrig and Vincent, 2017)? And second, why do exporters suffer from a lower conglomerate discount than domestic firms (a novel fact that we establish)?

Our model shows that an inefficient allocation of capital reduces firms' Tobin's Q and provides an explanation for the conglomerate discount puzzle raised in the finance literature. We further show that the conglomerate discount can be used as a measure of within firm mis-allocation. Using yearly data on publicly listed US firms in the period 1997–2013, we provide empirical evidence that over-reporting of costs by managers leads to lower Q in multi-product firms, and hence to a larger conglomerate discount.

We further show that international trade reduces within firm mis-allocation of capital through its disciplining effect of tougher competition. To quantify the efficiency gains in the internal capital market from more open markets, we exploit the increase in import competition from China − the China Shock − as a source of exogenous variation in industry level competition. We show that the conglomerate discount – our measure of capital mis-allocation – significantly declines in industries with a stronger increase in import penetration from China. A one standard deviation increase in import penetration lowers the conglomerate discount by 32% and reduces the over-reporting of costs by 15% in the best segments, relative to worse segments, of multi-product firms. Hence, trade-induced competition is one possible explanation why exporters have a lower conglomerate discount than non-exporters.

To highlight the importance of informational frictions for mis-allocation within firms, we use data on CEO tenure as a proxy for informational frictions. We argue that in firms where the CEOs have served on the board for only a short period of time, the CEOs know their segments less well. This increases the scope for over-reporting of costs by segment managers. We find strong empirical support that the disciplining effect of competition on over-reporting – and hence on capital allocation and the conglomerate discount – is strongest in firms subject to higher informational frictions.

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Appendix: For Online Publication

7 Appendix A

In this section of the Appendix, we outline the proof of Proposition 1 and we extend it for a more general characterisation of the manager's private benefit.

7.1 Proof of Proposition 1

Proof. Substituting for (10) and (11) in (12) yields:

$$\mu_i^\star = \arg\max_{\mu\in[1,\bar{\mu}_i]} (\mu - 1)(1 - \beta_i\mu)(1 - \chi\beta_i\mu)$$

but for a multiplicative constant, which does not depend on μ, and where $\beta_i = \frac{x_i c}{c_D} < \frac{1}{2}$ and $\chi = \frac{2}{m} \leq 2$. A necessary condition for the product to be financed is that $\mu_i\beta_i < \frac{1}{2}$, thus $\chi\mu_i\beta_i < 1$. It follows that a solution for which the expected private benefit is strictly positive and the product can be financed satisfies the necessary condition $1 < \mu_i^\star \leq \frac{1}{\chi\beta_i}$. Computing the first and second order conditions yields:

$$\begin{aligned} \text{f.o.c.} &\quad : \quad \mu_i^2 - 2\gamma_i\mu_i + \alpha_i = 0 \\ \text{s.o.c.} &\quad : \quad \mu_i - \gamma_i < 0 \end{aligned}$$

where $\gamma_i = \frac{\chi\beta_i+\beta_i+\chi\beta_i^2}{3\chi\beta_i^2} > 1$ and $\alpha_i = \frac{\chi\beta_i+\beta_i+1}{3\chi\beta_i^2} \equiv \gamma_i + \frac{1-\chi\beta_i^2}{3\chi\beta_i^2} > \gamma_i$. The roots of the f.o.c. are $\mu_{(-)} = \gamma_i - \sqrt{\gamma_i^2 - \alpha_i}$ and $\mu_{(+)} = \gamma_i + \sqrt{\gamma_i^2 - \alpha_i}$. The solutions are real if and only if $\gamma_i^2 - \gamma_i - \frac{1}{3}\frac{1-\chi\beta_i^2}{\chi\beta_i^2} > 0$, which is always the case for $\gamma_i > \frac{1}{2}\left(1 + \sqrt{1 - \frac{4}{3}\frac{1-\chi\beta_i^2}{\chi\beta_i^2}}\right)$, therefore $\gamma_i > 1$ is a sufficient condition and $\sqrt{\alpha_i} \leq \gamma_i < \alpha_i$. Both roots are real, positive, and they sort on the positive real segment as $0 < \mu_{(-)} < \gamma_i < \mu_{(+)}$. The expected private benefit increases for $\mu < \mu_{(-)}$, it then falls in the interval $\left(\mu_{(-)}, \mu_{(+)}\right)$, and it increases for $\mu > \mu_{(+)}$. The unique interior solution that solves the f.o.c. and satisfies the s.o.c. is $\mu_i^\star = \mu_{(-)}$,

$$\mu_i^\star = \gamma_i - \sqrt{\gamma_i^2 - \alpha_i}\ .$$

By applying the envelope theorem, we take the total derivative of the f.o.c. with respect to β_i and χ

$$\begin{aligned} \frac{d\mu_i^\star}{d\beta_i} &= -\frac{\mu_i^\star}{\gamma_i - \mu_i^\star}\left(\frac{d\gamma_i}{d\beta_i} - \frac{1}{2\mu_i^\star}\frac{d\alpha_i}{d\beta_i}\right) &= -\frac{\mu_i^\star}{\gamma_i - \mu_i^\star}\frac{d\gamma_i}{d\beta_i}\left(1 - \frac{1}{\mu_i^\star}\left[\frac{1}{2} - \frac{1}{(1+\chi)\beta_i}\right]\right) > 0 \\ \frac{d\mu_i^\star}{d\chi} &= -\frac{\mu_i^\star}{\gamma_i - \mu_i^\star}\left(\frac{d\gamma_i}{d\chi} - \frac{1}{2\mu_i^\star}\frac{d\alpha_i}{d\chi}\right) &= \frac{\mu_i^\star}{\gamma_i - \mu_i^\star}\frac{1}{3\chi^2\beta_i}\left[1 - \frac{1}{\mu_i^\star}\left(\frac{1}{2} + \frac{1}{2\beta_i}\right)\right] < 0 \end{aligned}$$

where we have inverted the expression for γ_i to obtain $\beta_i = \frac{1+\chi}{\chi(3\gamma_i - 1)}$ and indeed $\frac{d\beta_i}{d\gamma_i} = -\frac{3\chi}{(1+\chi)}\beta_i^2$, and $\frac{d\gamma_i}{d\chi} = -\frac{1}{3\chi^2\beta_i}$ and $\frac{d\alpha_i}{d\chi} = \frac{d\gamma_i}{d\chi} - \frac{1}{3\chi^2\beta_i^2}$. The sign in the first line is explained by $\frac{d\gamma_i}{d\beta_i} < 0$ and $\mu > 1 > \frac{1}{2} - \frac{1}{(1+\chi)\beta_i}$. The sign in the second line is explained by $\beta_i\mu_i^\star < \frac{1}{2} < \frac{1+\beta_i}{2}$. Since $\beta_i = \frac{x_i c}{c_D}$ and $\chi = \frac{2}{m}$, we conclude that $\frac{\partial \mu_i^\star}{\partial x_i} < 0$, $\frac{\partial \mu_i^\star}{\partial c} < 0$, $\frac{\partial \mu_i^\star}{\partial c_D} > 0$ and $\frac{\partial \mu_i^\star}{\partial m} > 0$. ■

7.2 A more general characterisation of the manager's private benefit

The assumption that manager's private benefit increases with the output of the division is in line with what has been done and motivated by the finance literature (see Stein (1997) and Scharfstein and Stein (2000) as an example). Nevertheless, a legitimate concern arises: how general are the results that we have derived?

Over-reporting the true cost of a division decreases the probability of being financed. Thus, a private benefit that is increasing with the reported cost is a necessary condition for the existence of optimal strategies. Nevertheless, it can be argued that the rational behind managers' private benefit is not the excess of production. However, it is possible to show that the implications of Proposition 1 hold whenever the private benefit of managers is positively correlated with an excess of revenue, profit, and the return on assets of a division.

Lemma 1. *The qualitative implications of Proposition 1 are robust to the case in which the private benefit is modeled as an excess of revenue $r(x_i, c) - r(z_i, c)$, profit $\pi(x_i, c) - \pi(z_i, c)$, return on assets $roa(x_i, c) - roa(z_i, c)$, and any positive convex combination of these measures with output of the division.*

Proof. Consider the performance measures of a division (4a)-(4c). Revenue, profit, and return on assets are decreasing functions of the marginal cost and increasing functions of the cutoff cost. The same monotonic patterns hold for the output of a division. Therefore, modeling the private benefit as any convex combination of revenue, profit, return on assets, and output of a division, where each component has a positive weight, yields the same qualitative predictions of Proposition 1. ■

8 Appendix B

In this section of the Appendix we discuss the data and the measurement of variables used in our empirical analysis.

8.1 A theory-based measure of relative marginal cost

Assume that we have observations of marginal costs at the level of a segment i and firm f pair. Consistently with the theory, the observed marginal costs would be the empirical counterpart of the reported marginal cost $z_{if}c_f$, and the highest marginal cost at which we do not observe losses would be the cutoff cost c_D. However, even if this ideal database was available, the observed marginal costs would come as realisations at different points in time and in different sectors of technological specialisation. Instead, it should be stressed that our theory exploits the variation between firm and segments, but within sector and time. In fact, segment level variables (3a)-(4c) can be described by means of the segment marginal cost relative to the cutoff cost $z_f c/c_D$. Given the observations at time t on marginal costs $\hat{z}_{fst}\hat{c}_{ft}$ for every segment-firm pair $\{f, s\}$ that belongs to a sector i, what we need to look at for taking our theory to the data is the observed marginal cost relative to the contemporaneous sector-specific cutoff cost. This measure of relative marginal cost is cleaned from sector variation and from the between-sector component of time variation.[39] Under these circumstances we would have a direct measure of relative marginal cost that fits our theory:

$$\ln(rmc_{fst}) \equiv \ln\left(\frac{\hat{z}_{fst}\hat{c}_{ft}}{\hat{c}^s_{Dt}}\right) \tag{27}$$

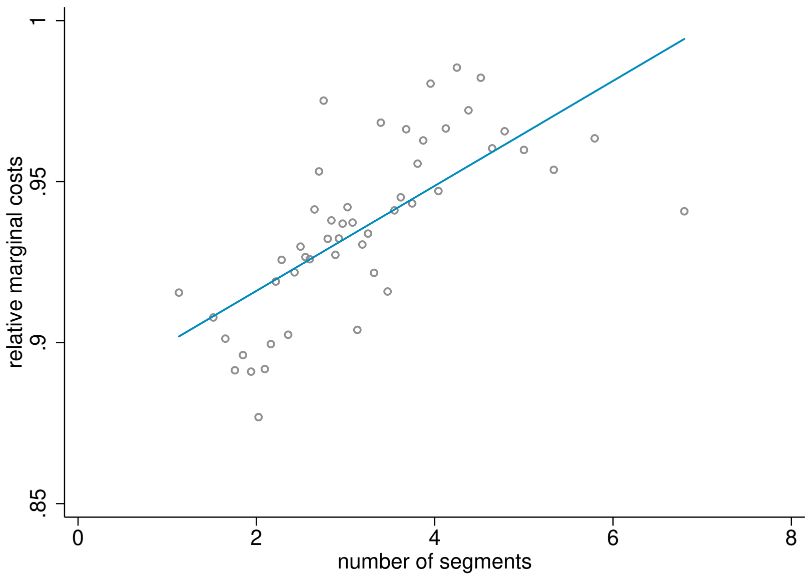
Moving from an ideal database to an actual database, we face the problem that we do not observe relative marginal costs, as in the right-hand side of (27). But to this purpose, the structure of the model turns out to be useful. The theoretical expression for the return on assets at the segment level (4c) is a function of the inverse of the relative marginal cost $\frac{roa_i}{\varphi_k/\theta} = \frac{1}{2}\left(\frac{c_D}{z_i c} - 1\right)$. As was the case for marginal costs, observed return on assets are subject to sector and time variation, which do not play a role in the theory. However, also in this case, to be consistent with the theory, we shall look at observations of return on assets $\hat{roa}_{fst}$ relative to a scaling factor $\hat{\varphi}^s_{kt}/\hat{\theta}^s_t$ that is sector and time specific. Let $\bar{roa}_{fst}$ be the return on assets of a segment s of firm f at time t purged by the sector fixed effect, then, the measure of relative marginal cost, as implied by the return on assets according to the model, is given by:

[39] Idiosyncratic changes over time at the segment-firm level might still be present, and shocks on this dimension would result into a change over time of the position of the segment-firm pair $\{f, s\}$ in the within-sector ranking of marginal costs. We have investigated this aspect in our actual database and the events of changes in the within-sector ranking over time are rare: on a yearly basis, less than 1% of the observations are in a different decile of the within sector distribution of marginal cost compared to the previous year.

$$\ln(rmc_{fst}) = \ln\left(\frac{1}{1 + r\bar{o}a_{fst}}\right) \tag{28}$$

8.2 Further empirical results

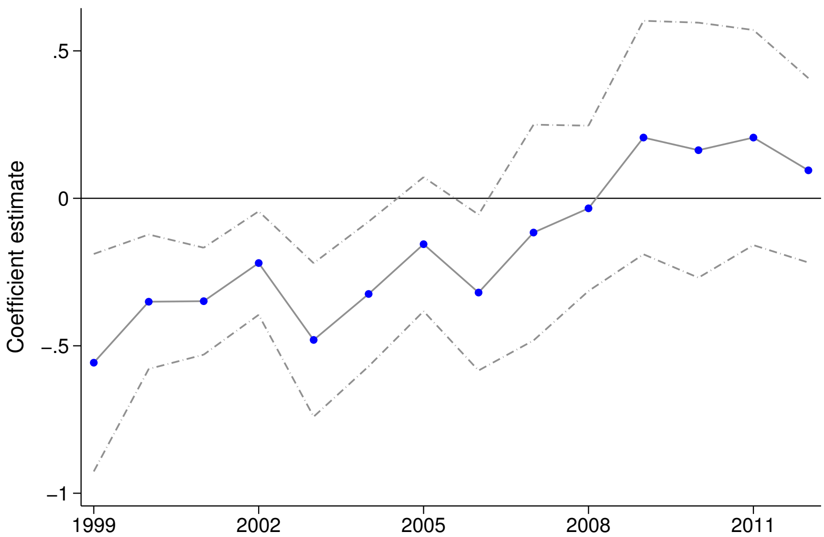
Figure 4: **Relative marginal costs and number of segments**



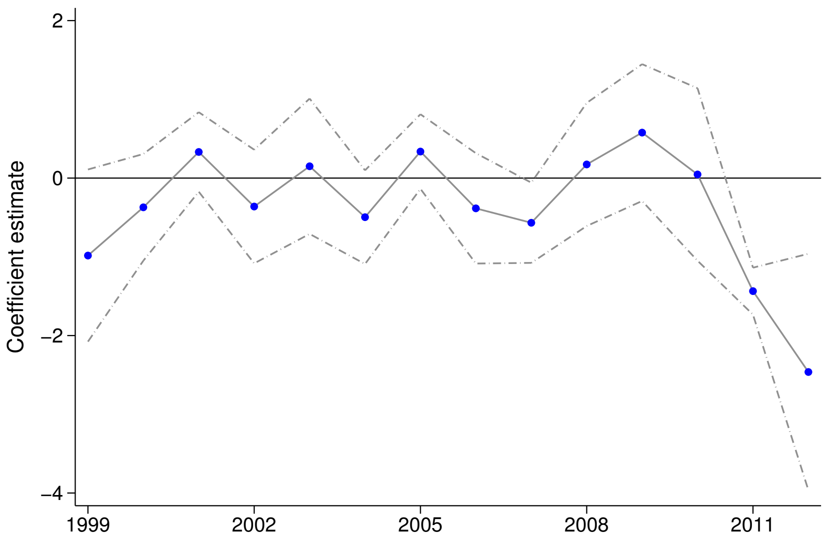
Note: This figure shows a binscatter plot of average marginal costs on the y-axis and number of segments on the x-axis, both on the firm-year level, and conditional on firm size (measured as log employment). The relationship between both variables is positive and significant at the 1% level, and robust to inclusion of firm fixed effects, firm and year fixed effects, or firm and industry*year fixed effects (unreported). Firms with more segments have, on average, higher relative marginal costs.

Figure 5: **The conglomerate discount: exporters and non-exporters**

Panel A: exporters



Panel B: non-exporters



Note: This figure shows a coefficient plot with 90% confidence intervals on yearly dummies of the following regression: $q_{f,t} = \sum \beta_t year_t + controls + \theta_{size,t} + \theta_{i,t} + \epsilon f$, for exporters and non-exporters. Each regression controls for firm size, return on assets, as well as investment ratio, and includes firm size*year and industry*year fixed effects. Exporters saw a decline in the conglomerate discount, while there was no change for non-exporters.

Table 6: **Placebo: import competition and marginal costs in single-segment firms**

	(1)	(2)
VARIABLES	Δ MC	Δ MC
Δ China (1999-2007)	0.324	0.188
	(0.577)	(0.618)
Observations	36	36
R-squared	0.357	0.356

Note: This table shows a regression of the change in marginal costs on import penetration from China for single segment firms. Dependent variable is the 1999-2007 change in segment marginal costs (MC). Δ China (1999–2007) denotes the change in Chinese import penetration at the industry level from 1999–2007. All regressions control for 1999 firm size, investment, and efficiency. Standard errors are clustered on the industry level. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 7: **Within-firm mis-allocation and informational frictions: alternative measures of asymmetric information**

	(1)	(2)	(3)	(4)	(5)	(6)
	nr. boards	nr. boards	nr. boards	equity share	equity share	equity share
		low friction	high friction		low friction	high friction
VARIABLES	log(assets)	log(assets)	log(assets)	log(assets)	log(assets)	log(assets)
multi-segment	-0.277***	-0.185*	-0.412***	-1.227***	-1.150***	-1.980***
	(0.082)	(0.096)	(0.126)	(0.263)	(0.269)	(0.312)
marginal costs	-0.369***	-0.331***	-0.567***	-0.928***	-0.661***	-0.967***
	(0.046)	(0.054)	(0.061)	(0.136)	(0.130)	(0.133)
multi-segment × marginal costs	0.494***	0.349***	0.621***	1.201***	0.774***	1.628***
	(0.066)	(0.087)	(0.082)	(0.210)	(0.205)	(0.289)
Observations	25,071	12,386	12,678	6,841	3,366	3,471
R-squared	0.658	0.663	0.673	0.590	0.580	0.613
Firm FE	✓	✓	✓	✓	✓	✓
Industry*Year FE	✓	✓	✓	✓	✓	✓

Note: Dependent variable denotes log assets at the segment-year level, *multi-segment* is a dummy with value one for multi-segment firms and zero for single-segment firms, *marginal costs* denotes relative marginal costs in a firm's core segment, measured as $ln(rmc_{if}^{core}(1 - rmc_{if}^{core}))$. *low/high friction* refer to firms in which the number of boards the average CEO sits on is above/below the sample median in Columns (2) and (3); and to the above/below median share of total compensation that takes the form of equity in Columns (5) and (6). All regressions control for firm size, investment, and efficiency. Standard errors are clustered on the firm level. *** p<0.01, ** p<0.05, * p<0.1

Table 8: **Import competition and within firm mis-allocation: number of boards**

Panel A: OLS

VARIABLES	(1) Δ MC	(2) low friction Δ MC	(3) high friction Δ MC	(4) Δ assets	(5) low friction Δ assets	(6) high friction Δ assets
efficient segments	-0.063	-0.167**	0.042	-0.051	0.077	-0.198
	(0.041)	(0.067)	(0.069)	(0.100)	(0.140)	(0.145)
Δ China shock	0.027	-0.018	0.035	0.044	-0.003	0.167
	(0.080)	(0.183)	(0.179)	(0.275)	(0.389)	(0.396)
efficient segments × Δ China shock	-0.447***	-0.162	-0.981***	1.165***	0.910**	1.665**
	(0.115)	(0.199)	(0.262)	(0.277)	(0.373)	(0.655)
Observations	344	172	172	344	172	172
R-squared	0.038	0.073	0.050	0.124	0.126	0.114

Panel B: IV

VARIABLES	(1) IV Δ MC	(2) IV low friction Δ MC	(3) IV high friction Δ MC	(4) IV Δ assets	(5) IV low friction Δ assets	(6) IV high friction Δ assets
efficient segments	-0.065	-0.169**	0.044	-0.027	0.125	-0.199
	(0.042)	(0.069)	(0.069)	(0.100)	(0.139)	(0.145)
Δ China shock	0.011	0.019	-0.028	0.182	0.291	0.211
	(0.076)	(0.180)	(0.159)	(0.322)	(0.604)	(0.411)
efficient segments × Δ China shock	-0.416***	-0.154	-1.019***	0.849*	0.368	1.682**
	(0.119)	(0.226)	(0.272)	(0.466)	(0.782)	(0.695)
Observations	344	172	172	344	172	172
R-squared	0.038	0.073	0.049	0.124	0.124	0.114

Note: Dependent variable is the 1999–2007 change in segment marginal costs (MC) or log assets (assets), *efficient segment* is a dummy with value one for the two most-efficient segments within a firm in terms of average return on assets. Δ China (1999–2007) denotes the change in Chinese import penetration at the industry level from 1999–2007. Panel B instruments Δ China (1999–2007) with Chinese imports in eight other advanced economies. *low/high friction* refer to firms in which the number of boards the average CEO sits on is above/below the sample median. All regressions control for firm size, investment, and efficiency. Standard errors are clustered on the industry level. *** p<0.01, ** p<0.05, * p<0.1

Table 9: **Import competition and within firm mis-allocation: equity share**

Panel A: OLS

VARIABLES	(1) Δ MC	(2) low friction Δ MC	(3) high friction Δ MC	(4) Δ assets	(5) low friction Δ assets	(6) high friction Δ assets
efficient segments	-0.048	-0.103	-0.033	-0.104	-0.025	-0.218
	(0.071)	(0.143)	(0.056)	(0.098)	(0.138)	(0.157)
Δ China shock	0.036	-0.408**	0.069	0.042	-0.730	0.019
	(0.093)	(0.197)	(0.097)	(0.268)	(0.921)	(0.234)
efficient segments × Δ China shock	-0.514**	-0.071	-0.536***	1.181***	1.000	2.140***
	(0.208)	(0.551)	(0.099)	(0.289)	(0.830)	(0.482)
Observations	352	176	176	352	176	176
R-squared	0.018	0.037	0.038	0.125	0.094	0.197

Panel B: IV

VARIABLES	(1) IV Δ MC	(2) IV low friction Δ MC	(3) IV high friction Δ MC	(4) IV Δ assets	(5) IV low friction Δ assets	(6) IV high friction Δ assets
efficient segments	-0.051	-0.101	-0.037	-0.081	-0.049	-0.197
	(0.071)	(0.147)	(0.057)	(0.098)	(0.145)	(0.153)
Δ China shock	0.010	-0.348	0.022	0.234	-1.885	0.220
	(0.082)	(0.256)	(0.103)	(0.366)	(1.262)	(0.413)
efficient segments × Δ China shock	-0.474**	-0.113	-0.492***	0.873	1.708	1.913***
	(0.206)	(0.624)	(0.115)	(0.537)	(1.202)	(0.651)
Observations	352	176	176	352	176	176
R-squared	0.018	0.037	0.037	0.124	0.088	0.196

Note: Dependent variable denotes the 1999–2007 change in segment marginal costs (MC) or log assets (assets), *efficient segment* is a dummy with value one for the two most-efficient segments within a firm in terms of average return on assets. Δ China (1999-2007) denotes the change in Chinese import penetration at the industry level from 1999–2007. Panel B instruments Δ China (1999-2007) with Chinese imports in eight other advanced economies. *low/high friction* refer to firms in which the share of total CEO compensation that takes the form of equity is above/below the sample median. All regressions control for firm size, investment, and efficiency. Standard errors are clustered on the industry level. *** p<0.01, ** p<0.05, * p<0.1

9 Appendix C

In this section of the appendix, we outline the computations behind the results of the model that are discussed in the main body of the paper.

Derivation of the GE properties of the model as in Mayer et al. (2014)

Varieties with marginal cost $z_i c \leq \delta \frac{c_D}{\tau}$ are produced, while others are not and yield zero profit. The expected profit unconditional on entry, in a market with access cost τ, is given by:

$$\Pi_E(c_D;\tau) =$$
$$\int_0^1 \sum_{i=0}^{\infty} \left\{ \int_0^{\omega^{-i\rho}} \int_0^{\omega^i \varepsilon_i^{1/\rho} \delta \frac{c_D}{\tau}} \frac{\tau^2 L}{4\gamma} \left[\left(\frac{c_D}{\tau}\right)^2 - 2\left(\frac{c_D}{\tau}\right) \omega^{-i} \varepsilon_i^{-1/\rho} c + \left(\omega^{-i}\varepsilon_i^{-1/\rho} c\right)^2 \right] \varphi^{\rho i} dG(c) d\mathcal{N}(\varepsilon_i|\omega) \right\}$$
$$\times dF(\omega)$$

The parametrisation of the technology $G(c) = (\frac{c}{c_M})^\rho$ implies $dG(c) = \frac{\rho}{c_M^\rho} c^{\rho-1} dc$ and this yields a closed form solution to the integrals involved in the expression for the expected profit, such that the expected profit is given by:

$$\Pi_E(c_D;\tau) =$$
$$\frac{L}{4\gamma}\frac{1}{c_M^\rho}\frac{c_D^{2+\rho}}{\tau^\rho} \int_0^1 \sum_{i=0}^{\infty} \left\{ \left[\delta^\rho \omega^{\rho i} - 2\frac{\rho}{\rho+1}\delta^{1+\rho}\omega^{\rho i} + \frac{\rho}{\rho+2}\delta^{2+\rho}\omega^{\rho i}\delta^\rho\omega^{\rho i} \right] \varphi^{\rho i} \int_0^{\omega^{-i\rho}} \varepsilon_i d\mathcal{N}(\varepsilon_i|\omega) \right\} dF(\omega)$$
$$= \frac{L}{4\gamma}\frac{1}{c_M^\rho}\frac{c_D^{2+\rho}}{\tau^\rho} \int_0^1 \sum_{i=0}^{\infty} \left\{ \left[\delta^\rho \omega^{\rho i} - 2\frac{\rho}{\rho+1}\delta^{1+\rho}\omega^{\rho i} + \frac{\rho}{\rho+2}\delta^{2+\rho}\omega^{\rho i} \right] \varphi^{\rho i} \right\} dF(\omega)$$
$$= \frac{L}{4\gamma} \frac{\delta^\rho [1 - 2\frac{\rho}{\rho+1}\delta + \frac{\rho}{\rho+2}\delta^2]}{c_M^\rho} \frac{c_D^{2+\rho}}{\tau^\rho} \int_0^1 \left(\sum_{i=0}^{\infty} (\varphi\omega)^{\rho i} \right)$$
$$\times dF(\omega)$$

where the second line exploits the fact that $\int_0^{\omega^{-i\rho}} \varepsilon_i d\mathcal{N}(\varepsilon_i|\omega) = 1$. The geometric series converges to $\sum_{i=0}^{\infty}(\varphi\omega)^{\rho i} = [1 - (\varphi\omega)^\rho]^{-1}$, and this yields a closed form expression for the expected profit unconditional on entry in a market with access cost τ:

$$\Pi_E(c_D;\tau) = \frac{\Omega L}{\phi\gamma} \frac{c_D^{2+\rho}}{\tau^\rho}$$

where $\phi = 4c_M^\rho \delta^{-\rho}[1 - 2\frac{\rho}{\rho+1}\delta + \frac{\rho}{\rho+2}\delta^2]^{-1}$ and $\Omega = \int_0^1 [1 - (\varphi\omega)^\rho]^{-1} dF(\omega)$ for a given value $\varphi \in (0,1)$. This yields $\Pi_E(c_D;\tau)$ and the sum of expected values in the domestic and in the foreign market yields $\Pi_E(c_D;1) + \Pi_E(c_D;\tau) = \frac{\Omega(1+\tau^{-\rho})L}{\phi\gamma} c_D^{2+\rho}$. ■

Let $\tilde{\Omega} = \int_0^1 [1 - \omega^\rho]^{-1} dF(\omega)$ and $\Delta = \tilde{\Omega} - \Omega > 0$. The sum of expected values in the domestic and in the foreign market can be written as $\frac{(1+\tau^{-\rho})L}{\phi\gamma} c_D^{2+\rho} \left[\tilde{\Omega} - \Delta\right]$. This expression can be obtained by subtracting an overhead cost $h(i) = h^i$ to the profit of each non-core division i

$$\Pi_E(c_D;\tau) =$$

$$\int_0^1 \sum_{i=0}^{\infty} \left\{ \int_0^{\omega^{-i\rho}} \int_0^{\omega^i \varepsilon_i^{1/\rho} \delta \frac{c_D}{\tau}} \frac{\tau^2 L}{4\gamma} \left[\left(\frac{c_D}{\tau}\right)^2 - 2\left(\frac{c_D}{\tau}\right) \omega^{-i} \varepsilon_i^{-1/\rho} c + \left(\omega^{-i}\varepsilon_i^{-1/\rho} c\right)^2 \right] dG(c) d\mathcal{N}(\varepsilon_i|\omega) - h(i) \right\}$$

$$\times\, dF(\omega)$$

which yields a sum of expected values in the domestic and in the foreign $\frac{\tilde{\Omega}(1+\tau^{-\rho})L}{\phi\gamma} c_D^{2+\rho} - \frac{1}{1-h}$ where the coefficient h is given by:

$$h = 1 - \frac{\Omega}{\tilde{\Omega} - \Omega} \frac{1}{f_E}$$

where we have substituted for $c_D = \left[\frac{\gamma\phi f_E}{\Omega(1+\tau^{-\rho})L}\right]^{\frac{1}{2+\rho}}$ from (15). ■

9.1 Determination of the aggregate variables in equilibrium

For each consumed variety, the inverse demand is $p_v = \alpha - \gamma q_v^c - \eta Q^c$. The uncompensated demand is linear $q_v^c = \frac{1}{\gamma}(\alpha - p_v - \eta Q^c)$. Integrating over the set of varieties V yields the household consumption of differentiated good $Q^c = (\alpha - \bar{p}) \frac{V}{\gamma+\eta V}$, where $\bar{p} = \frac{1}{V}\int_0^V p_v dv$ is the average price across consumed varieties. Substituting back in the demand for a given variety yields: $q_v^c = \frac{\alpha}{\gamma+\eta V} - \frac{1}{\gamma} p_v + \frac{\eta V}{\gamma+\eta V}\frac{1}{\gamma}\bar{p}$. The choke price that shuts down the demand of a given variety is $p^{max} = \frac{1}{\gamma+\eta V}(\gamma\alpha + \eta V \bar{p})$. The household demand for a given variety can be written in terms of the choke price: $q_v^c = \frac{1}{\gamma}(p^{max} - p_v)$. Aggregating over L households yields the aggregate demand for a consumed variety.

The expression for the demand function is sufficient to characterise the first and second moments of the price distribution. Let the variance of prices across varieties be $\sigma_p^2 = \frac{1}{V}\int_0^V (p_v - \bar{p})^2 dv$, then the income each household allocates to differentiated goods is $I_d^c = \bar{p} Q^c - \frac{V}{\gamma}\sigma_p^2$. Let I^c be the household's total income, then the expenditure on the outside homogeneous goods is given by $I_o^c = I^c - I_d^c > 0$. Goods q_l^c and q_k^c are perfect substitutes, they will be both consumed at the relative price $\frac{p_k}{p_l} = \theta$ and such that $I_o^c = p_l q_l^c + p_k q_k^c$.

The cutoff cost (15) is a sufficient statistic to determine the number of varieties V, the average price $\bar{p}$ and the variance in prices σ_p^2. Thus, welfare can be determined and it can be shown that it is a decreasing function of the cutoff cost c_D. The analysis is equivalent to the one in Mayer et al. (2014)[40] The inverse

[40]The two frameworks prescribe the same derivation for the expected profit before entry, with the difference that in our setup the flexibility of a firm is a random variable and the perspective entrants should average across its realisations. The deep difference between our

demand evaluated at the choke price $p^{max} = c_D$ determines the mass of varieties

$$V = \frac{\gamma}{\eta}\frac{\alpha - c_D}{c_D - \bar{p}}$$

as a function of the average price of a variety. For the sake of exposition, define the variable $\nu = x_i c$ which represents the marginal cost. The average price is a linear function $\bar{p} = \frac{1}{2}(c_D + \bar{\nu})$ of the average marginal cost across varieties $\bar{\nu}$. To compute the average marginal cost, define $H(\nu)$ as the measure of varieties produced at a marginal cost ν or lower normalised by the number of firm entrants M_E. Then $H(\nu) = \int_0^1 \left[\sum_{m=0}^{\infty} G(\omega^m \nu)\right] dF(\omega)$, where $H(\delta c_D) = V/M_E$. The average cost across varieties $\bar{\nu} = H(\delta c_D)^{-1} \int_0^{\delta c_D} \nu dH(\nu)$ is ultimately a function of c_D only, given the exogenous distributions of core marginal cost $G(c)$ and flexibility $F(\omega)$. Thus, the mass of varieties V and the mass of firm entrants $M_E = V/H(\delta c_D)$ are determined. Finally, only a share $G(\delta c_D)$ of firm entrants M_E actually enters and produce. Thus, the stable mass of incumbent firms is given by:

$$M = M_E G(\delta c_D)$$

Out of a population of L many agents, there are $V - M$ managers and M_E entrepreneurs, of which M become firm owners; thus, $L_w = L - (V + M_E - M)$ agents are workers. Because labor is the numeraire and each worker supplies one unit of labor, computing the average employment of labor across varieties $\bar{l}$ allows the aggregate mass of production workers $L_P = \bar{l}V$ to be determined. In addition, $L_E = f_E M_E$ workers are allocated to firm entry. The residual endowment of labor is allocated to the production of the labor–based outside good $Q_l = L_w - (L_P + L_E)$, which coincides with the expenditure in this good. Similarly, computing the average employment of capital across varieties $\bar{k}$ allows the aggregate mass of capital allocated to the differentiated sector $\bar{k}V$ to be determined. The residual units of capital are allocated to the production of the capital based outside good $Q_k = K - \bar{k}V$, whose sales are equal to θQ_k. We replace the marginal cost $x_i c \equiv \nu$ in the expressions for revenue and profit in (4a)-(4c). Computing the average revenue $\bar{r} = \int_0^{\delta c_D} r(\nu) dH(\nu)$ and profit $\bar{\pi} = \int_0^{\delta c_D} \pi(\nu) dH(\nu)$ across varieties allows the aggregate revenue $\bar{r}V$ and the aggregate profit $\bar{\pi}V$ to be determined. It can be verified that the aggregate budget constraint is satisfied

$$\bar{r}V + Q_l + \theta Q_k + L_E = L_w + \theta K + \bar{\pi}V$$

model and Mayer et al. (2014) is the uncertainty coming from the lack of knowledge of the owner on the technology of non-core products. But this uncertainty plays a role after entry and it does not affect the entry of a firm, which makes a successful entry whenever its core competence is profitable.

because it corresponds to $(\bar{r}-\bar{l}-\theta\bar{k})V=\bar{\pi}V$.

When the distribution of marginal cost is an inverse Pareto, several moments of these are two distribution can easily be taken to the data, as follows. Let ν be the marginal cost of a variety and let M_E be the mass of firm entrants. The function $H(\nu)=\int_0^1\left[\sum_{m=0}^{\infty}G\left(\omega^m\nu\right)\right]dF(\omega)$ yields the measure of varieties sold in the domestic market with marginal cost lower or equal to ν per unit mass of firm entrants; such that $H(\delta c_D)=V/M_E$ by construction.[41] When the distribution of core marginal cost is an inverse Pareto, then the measure of varieties per unit mass of entrant with marginal cost lower or equal to ν simplifies to $H(\nu)=\Omega G(\nu)$. The cumulative density $H(\nu)/H(\delta c_D)$ characterises the distribution of variable cost across the measure V of all varieties sold in the domestic markets. Let M be the mass of incumbent firms. This is a share of the mass of firm entrants $M=G(\delta c_D)M_E$. It follows that the average number of varieties per incumbent firm is given by $\Omega=\frac{V}{M}$.

For a given level of transport cost τ, a share $G(\delta c_D/\tau)$ of firm entrants become exporters (i.e. they export at least their core product). When the distribution of core marginal cost is an inverse Pareto, then the share of exporters over incumbent firms is $\tau^{-\rho}$.

9.2 Determination of the indirect utility function

All agents are remunerated with per capita income $I^c=\left(L+\theta K+\bar{\pi}V\right)/L$, where $\bar{\pi}$ is the average profit across varieties. Out of which, $I_d^c=\bar{r}V/L$ is the expenditure in differentiated goods, $I_o^c=\left(Q_l+\theta Q_k\right)/L$ is the expenditure in the outside goods, and the residual $\bar{\pi}V/L$ is allocated to financing the entry of new firms. Welfare can now be evaluated on the basis of the indirect utility function associated with the consumer's problem.

Substituting for the demand scaled by the mass of agents L, for $p^{max}=c_D$ and $Q_c=\int_0^V q_v^c(v)=(\alpha-\bar{p})\frac{V}{\gamma+\eta V}$ in the utility (1) yields:

$$W = q_l^c+\theta q_k^c+\alpha(\alpha-\bar{p})\frac{V}{\gamma+\eta V}-\frac{1}{2}\frac{V}{\gamma}[(c_D-\bar{p})^2+\sigma_p^2]-\frac{\eta}{2}(\alpha-\bar{p})^2\left(\frac{V}{\gamma+\eta V}\right)^2$$

where $\int_0^V\left[c_D-p(v)\right]dv=V(c_D-\bar{p})$ and $\int_0^V\left[c_D-p(v)\right]^2dv=V(c_D^2-2c_D\bar{p}+\bar{p^2})$ and $\sigma_p^2=\bar{p^2}-\bar{p}^2$. Substituting for $\nu\equiv x_ic=2p(\nu)-c_D$ in the expression of the revenue (4a)-(4c) and dividing by the mass of agents L allows the average individual expenditure in a given variety to be determined. Thus, the individual expenditure in differentiated goods is $I_d^c=\frac{V}{\gamma}[(c_D-\bar{p})\bar{p}-\sigma_p^2]$. The residual income constitutes the expenditure in non differentiated goods $q_l^c+\theta q_k^c=I^c-I_d^c$.

[41] We are following Mayer et al. (2014), with the only distinction that the level of flexibility is a firm's idiosyncratic random drawn from the distribution $F(\omega)$, which is independent from $G(c)$. Conditional on a level of flexibility ω, there are $G(\nu)$ core products such that $\nu\equiv c$, then $G(\omega\nu)$ first non-core products such that $\nu=\omega c$, $G(\omega^2\nu)$ second non-core products such that $\nu=\omega^2 c$, and so on.

Substituting in the expression of welfare yields:

$$\begin{aligned}
W &= I^c + \alpha(\alpha - \bar{p})\frac{V}{\gamma + \eta V} - \frac{1}{2}\frac{V}{\gamma}[(c_D - \bar{p})^2 + 2(c_D - \bar{p})\bar{p} - \sigma_p^2] - \frac{\eta}{2}(\alpha - \bar{p})^2\left(\frac{V}{\gamma + \eta V}\right)^2 \\
&= I^c + \frac{V}{\gamma}\frac{\gamma(\alpha - \bar{p})^2}{\gamma + \eta V} - \frac{1}{2}\frac{V}{\gamma}\left(\frac{\gamma(\alpha - \bar{p})}{\gamma + \eta V}\right)^2 - \frac{\eta}{2}\left(\frac{V}{\gamma}\right)^2\left(\frac{\gamma(\alpha - \bar{p})}{\gamma + \eta V}\right)^2 + \frac{\sigma_p^2}{2}\frac{V}{\gamma} \\
&= I^c + \frac{V}{\gamma}\left[2 - \frac{\gamma}{\gamma + \eta V} - \frac{\eta V}{\gamma + \eta V}\right]\left(\frac{1}{2}\frac{\gamma(\alpha - \bar{p})^2}{\gamma + \eta V}\right) + \frac{\sigma_p^2}{2}\frac{V}{\gamma} \\
&= I^c + \left(\frac{1}{2}\frac{V(\alpha - \bar{p})^2}{\gamma + \eta V}\right) + \frac{\sigma_p^2}{2}\frac{V}{\gamma}
\end{aligned}$$

where $c_D - \bar{p} \equiv \frac{\gamma}{\gamma + \eta V}(\alpha - \bar{p})$, given the expression for $p^{max} = \frac{1}{\gamma + \eta V}(\gamma\alpha + \eta V\bar{p})$.