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Abstract

This chapter takes stock of what has been learned from the recent micro-development literature about *wedges* — mechanisms generating dispersion in marginal revenue products of factors across firms, which are commonly interpreted as indicators of misallocation. We present a general theoretical framework that allows us to consider several different types of wedges simultaneously. We argue that it is important to distinguish between between *technological wedges*, which are present even in the efficient allocation that would be chosen by the social planner, and *distortionary wedges*, which are present in market equilibrium but not the social planner's allocation. Not all wedges, as we have defined them, are distortionary. We also argue that interactions among wedges are pervasive. We review empirical findings about different types of wedges — taxes, regulations, political connections, corruption, market power, contracting frictions, upgrading investments, and search — focusing on studies that present direct evidence on particular wedges and how they generate dispersion in marginal returns to factors. Throughout, we pay special attention to how wedges vary with firm size and whether the evidence supports the "large firms are constrained" view of development. We conclude with thoughts about promising directions for the misallocation literature.

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1 Introduction

It is widely agreed that one reason that poor countries are poor is that firms in them have low productivity. But in recent years, a separate, complementary idea has captured the attention of researchers across a range of fields, including in development: poor countries may be poor because resources do not flow to their most productive uses — in other words, that there is *misallocation* across firms, not just low productivity on average (Banerjee and Duflo, 2005; Hsieh and Klenow, 2009; Restuccia and Rogerson, 2008). This misallocation can reduce measured Total Factor Productivity (TFP) at the aggregate level, even for a given set of firm productivities.

The key idea of the misallocation literature is that, in an efficient allocation (in a model with many standard features), the marginal revenue products (MRPs) of factors and revenue-based TFP (TFPR) will be equalized across firms. From this perspective, if one observes that MRPs or TFPR are unequal, then one can infer that something or set of things is impeding the efficient allocation of factors. These things are commonly referred to as *wedges*. We will be more precise below, but broadly speaking our goal in this chapter is to take stock of what has been learned in the recent micro-development literature about these wedges.

The misallocation literature has been motivated by several empirical facts that appear to be robust. First, the prices paid to observably similar factors differ markedly across firms, even within narrowly defined industries. This heterogeneity is especially salient for capital (Banerjee, 2003; Banerjee and Duflo, 2005, 2010), but has been documented for other factors as well, as discussed below. Second, there is significant dispersion in measured TFPR across firms; although there is some contrasting evidence, this dispersion has generally been found to be greater in developing countries (Ayerst et al., 2024; Bils et al., 2021; Hsieh and Klenow, 2009; Rotemberg and White, 2017). Third, the average products of capital and labor and measured TFPR tend to be positively correlated with firm size, even within narrowly defined industries. Hsieh and Olken (2014) document this for India, Indonesia and Mexico, and Bartelsman et al. (2013) find similar patterns in eight countries, including three countries in Eastern Europe. Fourth, the size distributions of firms in developing countries tend to have more weight at small sizes than in developed countries (Bento and Restuccia, 2021; Hsieh and Olken, 2014). These basic patterns have been found to hold across a variety of settings. As we review studies of wedges, we will pay particular attention to the extent to which they can explain these key stylized facts.

Much of the misallocation literature has taken what Restuccia and Rogerson (2017) refer to as the *indirect* approach, which seeks to characterize the extent of misallocation without taking a stand on precisely what the wedges are. In the context of a fully specified model, this approach backs out the values of wedges that would rationalize the dispersion in TFPR or factor returns noted above. An advantage of this approach is that, if the model is correctly specified, the inferred wedges are informative about the overall extent of misallocation. But this approach also faces a number of challenges. An obvious one is that if the assumed model is not correct, the resulting inferences may be misleading. A second challenge is that, as we will argue below, there are wedges that generate dispersion in MRPs or TFPR that should not be considered sources of misallocation. Not all wedges, as we define them, are distortionary. A third challenge is that, in part because it does not take a stand on the microfoundations of wedges, the indirect approach provides little guidance about which specific policy levers are likely to reduce misallocation. This lack of specificity in policy recommendations is particularly salient given that, in a second-best environment, the effect of removing one wedge will depend on which other wedges are present, and overall efficiency may increase or decrease, a point cogently emphasized in a recent review by Ghatak and Mookherjee (2025).[1]

[1] Relatedly, Kehrig and Vincent (forthcoming) observe that dispersion in marginal products (in their

In this chapter, by contrast, we focus primarily on what Restuccia and Rogerson (2017) refer to as the *direct* approach, which looks for direct evidence that particular wedges are generating misallocation. In the spirit of much of the micro-development literature, we mainly consider studies that focus on experimental or quasi-experimental variation in the wedges. For a given wedge, we evaluate the evidence that the wedge is generating heterogeneity in marginal products of factors or TFPR across firms. This approach carries its own set of challenges. One is that many wedges are not directly observable, and the approaches that have been used to infer them have various shortcomings. Another is that it is often not clear how to draw broader conclusions about overall misallocation from micro-studies in particular contexts, which may not be representative of sectors or economies as a whole. But the direct approach also has a number of advantages. A key one, in our view, is credibility: this approach makes very clear what variation in the data is generating any parameter estimates. A second advantage is that the approach tends to generate more straightforward policy implications; once wedges that generate distortions are directly estimated, one can start to think about how to design policies to address them (although the problem remains difficult if wedges interact, as we will argue they generally do). Our focus on the direct approach is in the spirit of recent discussions by Atkin and Donaldson (2022) and Manelici et al. (2024), and also in line with Ghatak and Mookherjee (2025)'s call for more work investigating the microfoundations of misallocation.

To help organize the review, we begin (in Section 2) by developing a general theoretical framework that can accommodate many of the wedges that have been discussed in the literature. The framework incorporates microfoundations for several types of wedges, including market power, contracting frictions, innovative activities by firms, and search frictions, in addition to the exogenous taxes that are most commonly

case, of marginal products of capital across plants within firms) can raise output and welfare if it counters distortionary effects of financial frictions.

modeled in the literature. Moreover, it considers the wedges simultaneously, which helps us to think about interactions between them. In line with the literature, we think of an efficient allocation as the one that would be chosen by a social planner and define distortions as arising from a divergence in marginal products between the market equilibrium and the social planner's solution. At the same time, we argue that some dispersion in factor marginal products across firms may be driven by fundamentals or technology that constrain the social planner as well as firms and individuals. In this view, even the efficient allocation may feature dispersion in marginal products across firms. Given our definition of a wedge as any mechanism that generates dispersion in factor marginal products, our framework suggests a natural distinction between wedges that would be present even in the (constrained) social planner's solution, which we term "technological" wedges, and wedges in the market equilibrium that the social planner would not have chosen, which we refer to as "distortionary" wedges.[2] Reasonable people may disagree about whether a particular wedge should be classified as technological or distortionary — and the choice may depend on context — but we believe that in any given setting it is clear that some wedges are best characterized as technological and not distortionary.

With the theoretical framework in hand, we turn to a consideration of what has been learned empirically about different types of wedges. Motivated by the theory, we classify the wedges in five categories. The first (discussed in Section 3) is wedges that can be modeled reasonably well by exogenous taxes; in this category, we consider taxes, regulations, corruption, and political connections. From the perspective of misallocation, these are distortionary wedges, although in some cases they may interact to offset each other in ways that are beneficial for welfare. The second category we consider (in Section 4) is wedges arising from market power in product or input

[2]Our notion of technological wedges is related to Asker et al. (2014)'s discussion of capital adjustment costs and to the discussion of spillovers in Mookherjee and Munshi (2024) and Ghatak and Mookherjee (2025).

markets. Unlike taxes, these wedges are partially chosen by firms. Although such wedges create distortions in a similar way as exogenous taxes, they call not only for a different set of policy tools — e.g., antitrust or other pro-competitive policies, rather than tax or regulation reform — but also recognition that they will react endogenously to any policy intervention. The third category (in Section 5) is wedges arising from contracting frictions, including financial frictions, organizational frictions, and weakness of property rights. The last two types of wedges we discuss are those arising from innovative activities by firms, which we classify under the general heading of upgrading (Section 6), and from search (Section 7).

Throughout the empirical discussion, we pay particular attention to how wedges vary with firm size. Much of the misallocation literature has been motivated by what Hsieh and Olken (2014) describe as the "large firms are constrained" view of development. In this view, tax-like wedges impede the growth of larger firms in developing countries, explaining both the positive correlation of average products and firm size and the scarcity of larger firms in such countries relative to arguably less distorted economies like the U.S. As we review the evidence, we come back repeatedly to the question of whether this view is supported empirically. Perhaps not surprisingly for a review of the type, we find that the answer is mixed and depends on the particular wedge being considered.

Several themes emerge from the review. One is that many wedges that have been shown to affect firms differentially are reasonably well captured by the standard modeling of them as exogenous taxes on inputs or outputs. But a second theme is that wedges arising endogenously from strategic behavior by firms are less well represented by the standard modeling device and that it is important to take into account the endogenous responses of such wedges to policy and to other wedges. A third theme is that interactions among wedges are pervasive; in these cases, removing a particular wedge may have positive or negative consequences for misallocation. A fourth theme, already mentioned, is that many wedges are due to what we have called fundamentals or technology and should not be interpreted as contributing to misallocation. Indeed, in some circumstances, more dispersion in marginal products may be more conducive to growth than less dispersion (and hence would be chosen by the social planner). A fifth theme, related to the fourth, is that to the extent firms' investments have dynamic consequences (i.e., consequences beyond the next period), they will generally give rise to technological wedges — that is, to dispersion in static marginal returns even in the social planner's solution, which equates net present values (internalizing spillovers), not period-by-period returns. We focus on investments in capital, upgrading, and search, but the point would apply to any other dynamic input as well. We will highlight additional insights as we proceed.

Any review must make difficult choices about what to include and what to exclude. In this case, one complicating factor is that many studies that have sought to estimate the causes and consequences of what we are calling wedges have not self-consciously identified themselves as relating to misallocation. We still view such studies as highly relevant to the misallocation debate and have sought to include them in the review. At the same time, if we were to cast a net wide enough to capture all studies related in some way to wedges, the literature to be covered would be enormous, unmanageable in a single review. Our strategy in this chapter is to focus on studies that can be related in a fairly direct way to *heterogeneity* in wedges across firms within sectors, as it is this sort of dispersion in wedges that plays a key role in inferences about misallocation. Although we provide a theoretical framework to help organize our thinking about wedges, our review primarily focuses on insights from micro-data on firms, rather than on theoretical considerations or empirical conclusions drawn solely from data at a more aggregate level. We largely concentrate on studies that seek to measure a particular wedge or that focus on sources of exogenous variation in generating wedges, although we include some studies that do not fit either criterion if they seem particularly relevant.

Our focus on across-firm heterogeneity and micro-empirical work means that our coverage can make no claim to be exhaustive.

This chapter is related to a number of previous reviews. The misallocation literature has been previously reviewed by Hopenhayn (2014), Restuccia and Rogerson (2013, 2017), and Ghatak and Mookherjee (2025); the current chapter is more focused on the direct approach and on micro-empirical findings than any of these. The chapter is related to Buera et al. (2023)'s review of the recent macro-development literature, and to the more micro-oriented reviews of literature in the "firms and development" area by Tybout (2000) and Verhoogen (2023). The chapter has significant overlap with recent reviews in international trade that focus on how trade interacts with domestic distortions in developing countries by Atkin and Khandelwal (2020), Atkin and Donaldson (2022) and Khandelwal (2025).

2 Theory

In this section, we set up a general model that encompasses a range of wedges across several different margins of firm decisions. Our framework highlights the fact that some dispersion in the marginal products of different factors may be driven by fundamentals or technology, rather than policy or other distortions. We think of these "technological" constraints as also constraining the social planner; in their presence, even the efficient allocation may feature dispersion in marginal products across firms. In this context, distortions should be thought of as the degree to which equilibrium marginal products of different factors deviate from the efficient ones, rather than from an equalization benchmark. Although the model does not cover the set of all potential wedges studied in prior work, it accommodates key wedges such as market power, financial frictions, and spillovers, which may contribute to distortions in decisions about consumption, labor, capital, intermediate goods, innovation inputs, entrepreneurship, and search (for buyers and workers). All derivations are included in the theoretical appendix (Appendix A).

2.1 Environment

We assume a set of individuals $i \in \mathcal{I}$ with inter-temporal preferences given by:

$$U_{it} = \sum_{t'=t}^{\infty} \beta^{t'-t} \left(\frac{u_{it'}^{1-\vartheta} - 1}{1-\vartheta} - \frac{\xi}{1+\phi} \ell_{S,it'}^{1+\phi} + \nu_{it'}\, c_{G,t'} \right), \tag{1}$$

where per-period utility $u_{it} \equiv C(\boldsymbol{c}_{it})$ depends on the consumption vector $\boldsymbol{c}_{it}$ across all potential products and where β denotes the discount factor. Here $\ell_{S,it'}$ denotes the total labor supplied by individual i, ξ denotes a shifter of disutility of work, and ϕ characterizes the Frisch elasticity of labor supply. As we discuss below, individual i can potentially create and run a firm by directing labor to entrepreneurial activities. In addition, we assume that the individual receives a share ν_{it} of public goods generated by the government, $c_{G,t}$. Finally, individuals can accumulate a risk-free asset, starting period t with a stock $a_{it-1} \geq 0$ of this asset.

Each individual i can operate a single-product firm and the set $\mathcal{I}_t \subset \mathcal{I}$ denotes the set of all firms in operation at time t. If the firm is in operation, the firm starts period t with productivity $z_{it} > 0$ and a capital stock k_{it-1} determined in the previous period.[3] The production function is $y_{it} = z_{it} f(k_{it}, \ell_{it}, m_{it})$, where ℓ_{it} is the labor hired by the firm, k_{it} is the current stock of capital, determined as discussed below, and $m_{it} = M_i(\boldsymbol{m}_{it})$ is a constant-returns-to-scale (CRS) aggregator of the vector of intermediate products $\boldsymbol{m}_{it}$.

We impose few restrictions on the nature of market structure and competition, in order to be able to nest many potential alternatives. In final-product markets, we assume that firm i has access to set $\mathcal{I}_{C,it} \subset \mathcal{I}$ of potential customers at time t. Firm i sets the price of its product p_{it}. In the inter-firm trade market, firm i has access to a set $\mathcal{I}_{B,it} \subset \mathcal{I}$ of

[3] We assume that the current productivity is known. For a discussion of the consequences of uncertainty for misallocation, see for instance David et al. (2016) or FengREStatforthcoming.

potential downstream buyers. In each bilateral firm-to-firm relationship, we allow for the possibility that either the buyer or the seller can set the price. We also allow the possibility that firms may be price takers in the final-product and inter-firm markets.[4]

Similarly to the final-product and inter-firm markets, we assume that firm i has access to a set $\mathcal{I}_{H,it} \subset \mathcal{I}$ of potential employees. We consider the possibility that firm i may decide on its total hiring ℓ_{it} or wage rate w_{it} in the labor market, or take the latter as given.

Together with the productivity z_{it}, the above sets characterize the state of productive possibilities of the firm i at time t, which we denote by $s_{it} \equiv (z_{it}, \mathcal{I}_{C,it}, \mathcal{I}_{B,it}, \mathcal{I}_{H,it})$. As we will discuss next, firms can invest in "innovation" to upgrade their productivity and in "search" to expand their sets of potential customers and workers.

We model investments in upgrading as investments of labor by individual i to increase the productivity of her firm. We assume that the conditional distribution of the next-period productivity of the firm, z_{it+1}, is given by the cumulative distribution function $G(z_{it+1}|Z_{it})$, where $Z_{it} \equiv Z(z_{it}, \ell_{Z,it}, \overline{z}_t, e_{it})$ depends on current productivity z_{it},[5] the amount of labor $\ell_{Z,it}$ hired by the firm to invest in technological upgrading, an index $\overline{z}_t$ of the aggregate stock of knowledge that depends on the vector of all active productivities $(z_{it})_{i\in\mathcal{I}_t}$,[6] and the entrepreneurial inputs supplied by the individual i running the firm, denoted e_{it}. Letting θ_i be individual i's fixed entrepreneurial ability and $\ell_{E,it} \le \ell_{S,it}$ be the entrepreneurial labor supplied by individual i, we assume $e_{it} \equiv \theta_i \ell_{E,it}$.

[4]The extension to the case in which firms choose the quantity of their products (Cournot competition) in the final and/or firm-to-firm markets is straightforward. See footnote 9 below.

[5]More specifically, we assume the nesting structure $Z(z_{it}, \ell_{Z,it}, \overline{z}_t, e_{it}) \equiv \widetilde{Z}(Z_0(z_{it}, e_{it}), \ell_{Z,it}, \overline{z}_t)$ with $Z_0(0,0) = 0$, such that entrepreneurial inputs can substitute for being unproductive, $z_{it} = 0$, in the current period. We additionally impose the technical conditions that for all $Z_{it} > 0$, we have $\frac{\partial}{\partial \ell_{Z,it}} G(0|Z_{it}) = \lim_{z_{it+1}\to\infty} \frac{\partial}{\partial \ell_{Z,it}} G(z_{it+1}|Z_{it}) = 0$.

[6]This characterization for spillovers is common among many theories of firm dynamics (Luttmer, 2012; Sampson, 2016, see, e.g.,). An alternative approach is to characterize knowledge spillovers based on the diffusion of ideas from one firm to another (Klette and Kortum, 2004; Lucas and Moll, 2014, e.g.,). For a comparison of the differences in the nature of spillovers between the two specifications and the implications for the efficiency of allocations, see Lashkari (2018).

This set-up allows us to accommodate both the productivity dynamics of incumbent firms and the entry of new firms. We account for a firm that is not in operation by assuming that it is unproductive, i.e., $z_{it} = 0$, and assume that any firm will become unproductive in the absence of active entrepreneurial investment, i.e., $G(0|0) = 1$ and $Z(z_{it}, \ell_{Z,it}, \overline{z}_t, 0) = 0$. The individual can start up a firm by supplying entrepreneurial labor to make the firm productive in the next period, i.e., $\partial Z\left(z_{it}, \ell_{Z,it}, \overline{z}_t, e_{it}\right)/\partial e_{it} > 0$.[7]

Similar to the case of productivity, we assume distributions $\mathcal{G}_j\left(\mathcal{I}_{j,it+1}\,|\,\mathcal{I}_{j,it}, \ell_{N,it}\right)$ for $N \in \{C, B, H\}$ defined over the sets $\mathcal{I}_{j,it+1} \subset \mathcal{I}$, which depend on the current set $\mathcal{I}_{j,it}$ and the search investment $\ell_{N,it}$. We assume that, under these distributions, the expected size of the next-period set increases with the amount of the investment, i.e., $\partial \mathbb{E}\left[\,|\mathcal{I}_{j,it+1}|\,|\,\mathcal{I}_{j,it},\, \ell_{N,it}\right]/\partial \ell_{N,it} > 0$.

Together, firm productivities and buyer/worker sets characterize the economy's state of technology. We let $\boldsymbol{s}_t \equiv (\boldsymbol{z}_t, \mathcal{I}_t)$ denote the state of all firms in the economy in the beginning of period t, where $\boldsymbol{z}_t \equiv (z_{it})_{i\in\mathcal{I}}$ and $\mathcal{I}_t \equiv \left(\mathcal{I}_{C,it}, \mathcal{I}_{B,it}, \mathcal{I}_{H,it}\right)_{i\in\mathcal{I}}$ denote the vector of current productivity and the sets of customers, buyers, and potential employees, respectively, across all firms.

To increase the capital k_{it-1} inherited from the previous period to k_{it}, we assume that the firm needs to invest the amount $\iota_{it} \equiv k_{it} - (1-\delta_i)\, k_{it-1}$, where δ_i is a potentially firm-specific depreciation rate. To make this investment, the firm has to combine investment goods according to a firm-specific CRS aggregator of the vector of investment products $\boldsymbol{x}_{it}$ defined by $x_{it} = X_i\left(\boldsymbol{x}_{it}\right)$. Due to adjustment costs, the amount of investment goods needed to achieve investment ι_{it} is greater than the level of investment and is assumed to be given by $x_{it} = \iota_{it} + \frac{1}{2}\kappa_X \iota_{it}^2$, with the second term on the right-hand side capturing the adjustment costs. In the spirit of Buera et al. (2011) and Ghatak and Mookherjee

[7] Note that the entrepreneur may decide to specialize completely in running the firm, and not supply non-entrepreneurial labor on the market. Such full specialization in entrepreneurial decisions may be the case if we have $\partial Z_0\left(0, e_{it}\right)/\partial e_{it} < \infty$ at $e_{it} = 0$, so that a given wage rate, there are individuals for values θ_i below a cutoff θ_t^* who supply no entrepreneurial inputs $\ell_{E,it} = 0$.

(2025), we assume that firms are subject to a financial constraint arising from contracting frictions in the credit market. In particular, we assume that the total cost of capital and upgrading investments $\boldsymbol{p}'_{it}\boldsymbol{x}_{it} + w_{it}\sum_{N\in\{Z,C,B,H\}}\ell_{N,it}$ can be financed by debt under the constraint $CL\left(k_{it-1}, a_{it-1}\right)$, where CL is a credit limit that depends on the capital stock of the firm as well as the assets owned by the individual running the firm.

We assume that the government imposes a tax τ^{Y}_{jt} on each unit of product j in final good markets and a tax $\tau^{M}_{j,it}$ on each unit of that product sold to firm i. Similarly, the government imposes a vector of tax rates $\left(\tau^{L}_{it}, \tau^{L}_{z,it}\right)$ on the vector of labor inputs (for production and upgrading, respectively) hired by firm i at time t. We allow for the possibilities that tax revenues are returned to individuals in the form of public goods (with individual shares ν_{it} as in Equation (1)) or are used up in wasteful activities.

At time t, the consumption demand of the household is characterized by $\boldsymbol{d}_{C,it}\left(\boldsymbol{p}_t\right)$ as a function of all product prices. For a firm i that has pricing power in its final product market, let ε^{Y}_{it} denote the inverse (own) price elasticity of final demand $D_{C,it}\left(\boldsymbol{p}_t\right) \equiv \sum_{i'\in\mathcal{I}_{C,it}} d_{C,i,i't}\left(\boldsymbol{p}_t\right)$ for the product of firm i, if the firm has pricing power. Otherwise, we let $\varepsilon^{Y}_{it} = 0$. For the same firm, let $\varepsilon^{Y}_{i,jt}$ denote the inverse (own) price elasticity of downstream demand $d_{M,i,jt}$ of a firm $j \in \mathcal{I}_{B,it}$ within firm i's buyer set. Note that, again, $\varepsilon^{Y}_{i,jt} > 0$ if the upstream seller has the pricing power and $\varepsilon^{Y}_{i,jt} = 0$ if the downstream buyer has the pricing power.[8] In the latter case, in which the buyer has pricing power, we let $\varepsilon^{M}_{i,jt}$ denote the inverse (own) price elasticity of supply faced by the downstream firm i. In the former case, we define this inverse supply elasticity to be zero, $\varepsilon^{M}_{i,jt} = 0$. We define ε^{L}_{it} as the inverse labor supply elasticity faced by firm i among the workers it faces. Finally, we define an overall measure of the degree of seller market

[8]If neither side has market power, we have $\varepsilon^{Y}_{i,jt} = \varepsilon^{M}_{i,jt} = 0$.

power for firm i as $\overline{\varepsilon}_{it}^{Y}$ according to

$$\overline{\varepsilon}_{it}^{Y} \equiv 1 - \left(\frac{D_{C,it}}{y_{it}} \frac{1}{1-\varepsilon_{it}^{Y}} + \sum_{j \in \mathcal{I}_{it}^{S}} \frac{d_{M,i,jt}}{y_{it}} \frac{1}{1-\varepsilon_{i,jt}^{Y}} \right)^{-1} . \tag{2}$$

which we refer to as the inverse demand elasticity index for the firm.[9]

2.2 Wedges and Distortions

In order to define wedges, we first characterize the marginal revenue products of factors and investments under the optimal and the market allocations. We define wedges as mechanisms that generate dispersion in these marginal products. An important qualification to this definition is that not all sources of distortions are reflected in heterogeneity in marginal returns; we return to this issue below. In Subsection 2.2.1, we consider the optimal allocation. We characterize the potential heterogeneity in marginal revenue products of different factors (capital, labor, intermediates) and of investments in upgrading, entrepreneurship, and search under the optimal allocation, which give rise to what we define as technological wedges. In Subsection 2.2.2, we consider the market equilibrium. We characterize the potential drivers of heterogeneity in marginal revenue products under the market allocation and discuss how they give rise to distortionary wedges, above and beyond the technological wedges in the optimal allocation.

Two caveats about our approach to wedges and distortions are worth emphasizing. First, wedges and distortions can only be defined within the context of a particular model. Although our framework is arguably more flexible than many that have been used in the literature, it is not assumption-free. Second, like almost all of the misallocation literature, aggregate welfare (as defined in our framework) is the objective

[9] If we assume firms set quantities instead of prices (Cournot competition) in all markets, the definitions of the elasticities ε_{it}^{Y}, $\varepsilon_{i,jt}^{Y}$, and $\varepsilon_{i,jt}^{M}$ should be adjusted to the (own) price elasticities of "residual" demand or supply for the firm product, conditional on the quantities chosen by the other competitors.

against which we evaluate optimality. Some policies that appear to be distortionary under this perspective may be justified by other objectives that have been considered in the development literature (e.g., reducing inequality or increasing social harmony).[10]

2.2.1 Technological Wedges

Let the decentralized implementation of the optimal allocation be given by $\boldsymbol{A}^* \equiv (\boldsymbol{y}_t^*, \boldsymbol{x}_t^*, \boldsymbol{m}_t^*, \boldsymbol{\ell}_t^*, \boldsymbol{k}_t^*)_t$, corresponding to a collection $\boldsymbol{P}^* \equiv (\boldsymbol{p}_t^*, \boldsymbol{w}_t^*)$ of the vectors of prices $\boldsymbol{p}_t^*$ and wages $\boldsymbol{w}_t^*$ that implement the optimal allocations.

2.2.1.1 Capital

The marginal revenue product of capital for firm i at time t under the optimal allocation satisfies

$$MRPK_{it}^* = p_{it}^* z_{it} \frac{\partial f_{it}^*}{\partial k_{it}^*} = P_{X_i}(\boldsymbol{p}_t^*)\left(1 + \kappa_X \iota_{it}^*\right)\left(1 - \Psi_{K,it}^*\right), \tag{3}$$

where $P_{X_i}(\cdot)$ defines the unit cost function corresponding to the investment aggregator $X_i(\cdot)$. The first two terms on the right-hand side of the second equality are the (effective) current marginal cost of investment ι_{it}^*, as a product of the unit cost and the contribution of adjustment costs. The term $\Psi_{K,it}^*$ is the social marginal *expected continuation value* of capital, present when capital does not fully depreciate after the current period ($\delta_i < 1$), given by

$$\Psi_{K,it}^* \equiv \beta(1 - \delta_i)\,\mathbb{E}_t\left[\frac{P_{X_i}(\boldsymbol{p}_{t+1}^*)}{P_{X_i}(\boldsymbol{p}_t^*)}\frac{1+\kappa_X \iota_{it+1}^*}{1+\kappa_X \iota_{it}^*}\right]. \tag{4}$$

Equation (4) represents the marginal savings in next-period investments gained by investing today. In other words, this continuation value depends on the marginal rate of transformation between current and next-period investments.

Our core observation, building on the insights of Asker et al. (2014), is that marginal

[10] For more on the relationship between misallocation and inequality, see Boar and Midrigan (2024), Atkin et al. (2025) and Hsieh et al. (2025).

revenue product is a static concept applied here to a dynamic input. For the standard equalization benchmark to hold, we need to assume that the marginal continuation values are also equalized across firms. To the extent that different firms face different marginal rates of transformation, e.g., due to adjustment costs or heterogeneity in depreciation rates, this assumption is unlikely to hold.[11] We will see more examples of such considerations with dynamic decisions of upgrading investments and entrepreneurial inputs below.

Equations (3) and (4) show that the efficient distribution of MRPK across firms may be heterogeneous due to adjustment costs corresponding to the term $\kappa_X \iota_{it}^*$, to heterogeneity in the rates of capital depreciation δ_i, or to cross-sectional variation in the types of capital that firms use (captured by the aggregator $X_i(\cdot)$ of investment products).[12] Recognizing the fact that the discounted continuation value of capital may vary across firms, the social planner does not equalize MRPK across firms.

We define wedges for each factor under the optimal allocation as mechanisms that generate dispersion in the corresponding marginal revenue products. The wedges for capital in Equation (3) result from the assumptions that the social planner takes both the adjustment costs and the potential heterogeneity in firm-level investment aggregators $X_i(\cdot)$ as constraints in her allocation. They are forms of what we refer to as a *technological* wedges.

2.2.1.2 Intermediates and Labor

Next, we examine the revenue products of the static inputs in our environment. The marginal product of intermediates (MRPM) for input j in firm i under the optimal

[11] Although we model the choices of intermediates and labor as static, they are also often thought to have a dynamic component (e.g., because of adjustment costs). To the extent that they do, and to the extent that the marginal rates of transformation between current and next-period choices are heterogeneous across firms, the argument about the inappropriateness of the equalization benchmark applies to them as well.

[12] Here we do not focus on risk aversion of firms, but heterogeneity in risk-aversion across firms could also give rise to differences in efficient MRPKs across firms; see Killeen (2025).

allocation, for all products available to firm i is given by

$$MRPM^*_{j,it} \equiv p^*_{it} z_{it} f^*_{m,it} \frac{\partial M^*_{it}}{\partial m^*_{j,it}} = p^*_{jt}, \qquad i \in \mathcal{I}_{B,jt}, \tag{5}$$

where $f_{m,it}$ denotes the partial derivative of the production function with respect to the aggregate of intermediates, m_{it}, and where we have defined $MRPM^*_{j,it}$ as a function of the prices sustaining the optimal allocation. This implies that, under the optimal allocation, the MRPM of an intermediate j is equalized across all firms buying from the producer of the intermediate. For firms that do not have access to this product, $MRPM^*_{j,it}$ is given by the marginal product of that product at $m^*_{j,it} = 0$.

The efficient marginal revenue product of labor (MRPL) under the optimal allocation for an incumbent firm i that can hire a worker n ($n \in \mathcal{I}_{H,it}$) is

$$MRPL^*_{it} = p^*_{it} z_{it} \frac{\partial f^*_{it}}{\partial \ell^*_{it}} = w^*_{it} = \xi \, \ell^{\phi}_{S,nt}. \tag{6}$$

The $MRPL^*_{it}$ will be equalized if $\ell_{n,it} > 0$ and $\ell_{n',i't} > 0$ such that $n, n' \in \mathcal{I}_{H,it} \cap \mathcal{I}_{H,i't}$ across any pair of firms that employ workers who belong to the intersection of both firms' potential employee sets.

We find that, as with the case of capital, the optimal allocations of intermediate inputs and labor may also feature heterogeneity in the corresponding marginal products. Here, the technological constraints faced by the social planner stem from the segmentation in the intermediate input and labor markets, as characterized by the heterogeneity in sets of potential buyers $\mathcal{I}_{B,it}$ and employees $\mathcal{I}_{H,it}$. When firms face heterogeneous sets of potential inputs and workers, MRPMs and MRPLs are equalized only within each connected segment of the input and labor markets. In this sense, the segmentations in intermediate input and labor markets that may give rise to heterogeneity in marginal revenue products can be considered technological wedges.

Recall that in our environment, changing the sets of available buyers and workers requires active investment of productive resources. Firms may need to invest in marketing to reach to different types of final consumers or downstream buyers, or similarly to advertise their job opening across different local labor markets. Such costly investments loosen the constraints imposed by segmentation and weaken the technological wedges, moving the efficient marginal revenues toward equalization.

2.2.1.3 Upgrading, Entrepreneurship, and Search

Let us now consider the remaining dynamic investments that influence the future productive potential of the firm in our environment: investments in innovation and upgrading, $\ell_{Z,it}$; entrepreneurial investments, $\ell_{E,it}$; and investments in search for final customers $\ell_{C,it}$, for buyer firms $\ell_{B,it}$, and for potential employees $\ell_{H,it}$.

We can now define the social planner's net present value of the aggregate welfare at time t as $V_t^*\left(\boldsymbol{k}_{t-1}, \boldsymbol{s}_t\right)$ and the expected net present continuation value as:

$$\widetilde{V}_{t+1}^*\left(\boldsymbol{k}_t,\, \boldsymbol{s}_t,\, \boldsymbol{\ell}_t,\, \overline{z}_t\right) \equiv \mathbb{E}_{\boldsymbol{s}_{t+1}}\left[V_{t+1}^*\left(\boldsymbol{k}_t,\, \boldsymbol{s}_{t+1}\right) \mid \boldsymbol{s}_t,\, \boldsymbol{\ell}_t,\, \overline{z}_t\right],$$

where $\boldsymbol{k}_t$ is the vector of firm capital stocks at time t, where $\boldsymbol{s}_t$ is the state of firm productivities and buyer/worker sets; where $\boldsymbol{\ell}_t \equiv \left(\ell_{it}, \ell_{Z,it}, \ell_{C,it}, \ell_{B,it}, \ell_{H,it}, \ell_{E,it}\right)_{i\in\mathcal{I}}$ denotes the vector of all labor allocations; and where the expectation is over the next-period state $\boldsymbol{s}_{t+1}$. (See Appendix A.1 for a full characterization.) The social planner's first-order condition for the efficient levels of investment in upgrading, entrepreneurship, and search satisfies[13]

$$\beta\,\frac{\partial \widetilde{V}^*_{t+1}\left(\boldsymbol{k}_t,\,\boldsymbol{s}_t,\,\boldsymbol{\ell}_t,\,\overline{z}_t\right)}{\partial \ell_{N,it}} \leq w^*_{it}, \qquad\qquad N\in\{Z,E,C,B,H\}\,, \tag{7}$$

with equality being satisfied whenever there is non-zero investment, $\ell_{N,it}>0$. Note that, by construction, all of these investments expand the production possibilities frontier for the social planner, therefore yielding nonnegative marginal values on the left hand side.

Let us unpack this result for the case of upgrading and entrepreneurial investments. Define the marginal (next-period) revenue product of investment in upgrading and entrepreneurship under the optimal allocation as

$$MRPI^*_{N,it} \equiv \beta\,\mathbb{E}_t\left[p^*_{it+1}f^*_{it+1}\gamma_{it+1}\right]\,\frac{\partial Z_{it}}{\partial \ell_{N,it}} = w^*_{it}\left[1-\left(\Psi^*_{Z,it}+\overline{\Psi}^*_{Z,it}\right)\frac{\partial Z_{it}}{\partial \ell_{N,it}}\right], \qquad N\in\{Z,E\}\,, \tag{8}$$

where $\gamma_{it+1} \equiv -\frac{\partial G(z_{it+1}|Z_{it})}{\partial Z_{it}}/\frac{\partial G(z_{it+1}|Z_{it})}{\partial z_{it+1}}$ denotes the marginal effect of the current productivity index Z_{it} on shifting future productivity z_{it+1}, and where $\Psi^{Z,*}_{it}$ and $\overline{\Psi}^{Z,*}_{it}$ denote the marginal *expected net present continuation values of upgrading investment* of firm i on the same firm's outcomes and on all other firms (through spillovers), respectively. These terms are present since improved productivity in period $t+1$ persists in future periods and are given by

$$\Psi^*_{Z,it} = \beta\,\mathbb{E}_t\left[\frac{w^*_{it+1}}{w^*_{it}}\,\frac{\partial Z_{it+1}/\partial z_{it+1}}{\partial Z_{it+1}/\partial \ell_{Z,it+1}}\,\gamma_{it+1}\right], \tag{9}$$

$$\overline{\Psi}^*_{Z,it} = \beta\,\mathbb{E}_t\left[\frac{\beta}{w^*_{it}}\,\frac{\partial \widetilde{V}^*_{t+2}}{\partial \overline{z}_{t+1}}\,\frac{\partial \overline{z}_{t+1}}{\partial z_{it+1}}\,\gamma_{it+1}\right], \tag{10}$$

where the term $\frac{\partial Z_{it+1}/\partial z_{it+1}}{\partial Z_{it+1}/\partial \ell_{Z,it+1}}$ captures the rate of transformation between current

[13] To simplify the setting and unify the expressions, in characterizing entrepreneurial decisions in Equation (7) (and elsewhere in the main text) we only consider individuals who do *not* fully specialize in entrepreneurship. Such individuals supply some of their labor to their own firms, thus ensuring their marginal disutility of labor is equalized with the wage rate at their own firms. See the general characterization in Appendix A.1.

productivity and upgrading investments. The expressions above provide parallels to that of the expected continuation value of capital investment in Equation (4), capturing how the social planner evaluates the marginal effect of investment today beyond the outcomes in the next period. Here, it is evident that these continuation values generically vary across firms and we cannot expect an equalization of the marginal effect of current upgrading investments on revenues in the immediately ensuing period under the efficient allocation.

In the case of investments in customer or employee search $\ell_{N,it}$ with $N \in \{C, B, H\}$, we cannot generically express the marginal revenue products of investments in the next period as in Equation (8).[14] In principle, an extension in any of these sets will propagate to other firms through inter-firm linkages until it ultimately reaches final consumers. For instance, expanding the set of buyers for a given firm helps lower the production costs of the new downstream firms, which in turn reduce the production costs of their respective buyers, etc. The next-period returns to investments in search are the product of the marginal effect of additional investments on the size of the set of buyers/workers and the overall welfare effect of the expanded set on welfare in the next period. Similarly, the expected continuation value of search investments in period t captures the product of the rise in the costs of search (proxied by the growth in the wage rates w^*_{it+1}/w^*_{it}) and how the next-period search investment $\ell_{N,it}$ can substitute for the next-period set $\mathcal{I}_{j,it}$ in the search function $\mathcal{G}_j(\cdot; \mathcal{I}_{j,it}, \ell_{N,it})$ in that period.

2.2.2 Distortionary Wedges under the Market Equilibrium

Let us now turn our attention to the characterization of the marginal revenue products under market equilibrium. Consider a market allocation $\boldsymbol{A} \equiv (\boldsymbol{y}_t, \boldsymbol{x}_t, \boldsymbol{m}_t, \boldsymbol{\ell}_t, \boldsymbol{k}_t, \boldsymbol{a}_t)_t$ along with the corresponding equilibrium prices and wages $\boldsymbol{P} \equiv (\boldsymbol{p}_t, \boldsymbol{w}_t)_t$ in which firms follow

[14] Equation (8) relies on the differentiability of the value function with respect to the productivity state z_{it}, which is not the case for the discrete buyer and employee sets $\mathcal{I}_{j,it}$ for $N \in \{C, B, H\}$.

Markov-perfect strategies in their (potential) strategic interactions.

2.2.2.1 Intermediates, Capital, and Labor

In this subsection, we characterize the equilibrium marginal revenue products of the primary factors of production, capital, labor, and intermediates. Since in our environment the marginal revenue product of capital will depend on that of intermediates, we will begin with this factor. Under the market equilibrium, the marginal revenue product of intermediate j in firm i is given by

$$MRPM_{j,it} \equiv \overline{p}_{it} z_{it} f_{m,it} \frac{\partial M_{it}}{\partial m_{j,it}} = p_{jt} \frac{\left(1+\tau_{j,it}^{M}\right)\left(1+\varepsilon_{j,it}^{M}\right)}{\left(1-\tau_{it}^{Y}\right)\left(1-\overline{\varepsilon}_{it}^{Y}\right)}, \qquad i \in \mathcal{I}_{B,jt}, \tag{11}$$

where $\overline{p}_{it}$ denotes the average price of output of i, where $\tau_{j,it}^{M}$ and τ_{it}^{Y} are the taxes imposed on the inter-firm trade (between firms i and j) and on the sales of firm i, respectively, and where $\overline{\varepsilon}_{it}^{Y}$ is defined in Equation (2). Using our definition of a wedge for intermediate inputs as a mechanism that generates dispersion in $MRPM_{j,it}$ across firms that purchase from supplier j, we have four wedges here: (1) the tax τ_{it}^{Y} on the output of the firm; (2) the tax $\tau_{j,it}^{M}$ on input purchases; (3) the market power of firm i in its ability to charge markups on its buyers, reflected by the inverse demand elasticity index $\overline{\varepsilon}_{it}^{Y}$; and (4) the market power of firm i and in its ability to apply markdowns on its purchases from firm j, captured by the supply elasticity $\varepsilon_{j,it}^{M}$. An increase in any of these terms will increase $MRPM_{j,it}$ in the market equilibrium. These wedges appear in the equilibrium $MRPM_{j,it}$ in Equation (11) but not in the social planner's optimal $MRPM_{j,it}^{*}$ in Equation (5); they are thus examples of *distortionary* wedges.

We define the distortion for intermediate inputs as the ratio of the MRPM under the market allocation to that under the optimal allocation, given by

$$\mu_{j,it}^{M} \equiv \frac{MRPM_{j,it}}{MRPM_{j,it}^{*}} = \frac{p_{jt}}{p_{jt}^{*}} \frac{\left(1+\tau_{j,it}^{M}\right)\left(1+\varepsilon_{j,it}^{M}\right)}{\left(1-\tau_{it}^{Y}\right)\left(1-\overline{\varepsilon}_{it}^{Y}\right)}, \qquad i \in \mathcal{I}_{B,jt}, \tag{12}$$

Note that the distortion along this margin of firm choice depends on the interaction between all four wedges. Whether these different wedges reinforce each other's contribution to the distortion or compensate for them depends on their covariance structure across firms. For instance, if firms that have greater market power face lower taxes, the two wedges might undo one another. Note also that all four of the distortionary wedges in Equation (11) above enter into the expression for the distortion in Equation (12).[15]

We now define the MRPL under the market equilibrium, which we can show satisfies

$$MRPL_{it} \equiv \overline{p}_{it} z_{it} \frac{\partial f_{it}}{\partial \ell_{it}} = w_{it} \frac{\left(1+\tau_{it}^{L}\right)\left(1+\varepsilon_{it}^{L}\right)}{\left(1-\tau_{it}^{Y}\right)\left(1-\overline{\varepsilon}_{it}^{Y}\right)}, \tag{13}$$

As in the case of intermediates, output-side taxes and regulations τ_{it}^{Y} and market power $\overline{\varepsilon}_{it}^{Y}$ tend to raise the equilibrium MRPL. Labor market taxes and regulations τ_{it}^{L} and labor market monopsony ε_{it}^{L} wedges additionally tend to raise the MRPL. The overall distortions emerge as the result of the interactions among all these wedges. For instance, if labor market regulations are less stringent among firms that have greater labor market power, the two wedges may undo one another. Combining Equations (6) and (13), we can also define a measure of the labor market distortions as the ratio of the MRPL under the market equilibrium to that of the efficient MRPL, given by

$$\mu_{it}^{L} \equiv \frac{MRPL_{it}}{MRPL_{it}^{*}} = \frac{w_{it}}{w_{it}^{*}} \frac{\left(1+\tau_{it}^{L}\right)\left(1+\varepsilon_{it}^{L}\right)}{\left(1-\tau_{it}^{Y}\right)\left(1-\overline{\varepsilon}_{it}^{Y}\right)}. \tag{14}$$

In addition to showing how wedges may interact in generating the labor market distortion, this equation also helps to illustrate a point alluded to in the first paragraph of Section 2.2 above, namely that heterogeneity in marginal returns is not a necessary condition for a distortion to exist. Consider a case, for instance, in which taxes are equal

[15]Within the set of firms for which j is the supplier, these wedges are the only source of heterogeneity in $\mu_{j,it}^{M}$, as in the absence of these wedges, we would have $p_{jt} = p_{jt}^{*}$ and $\mu_{j,it}^{M} = 1$.

across firms, labor markets are competitive, and the market is characterized by monopolistic competition and constant elasticity of substitution (CES) demand (a workhorse model in international trade and the set-up assumed in Hsieh and Klenow (2009)). In this case, markups and MRPs will be equal across firms. But Equation (eq:distortion-L) shows that μ_{it}^{L} may still be non-zero in the presence of a divergence between w_{it} and w_{it}^{*}, which may arise if aggregate labor supply is elastic. Edmond et al. (2023) show that in the presence of elastic labor supply (parameter $\phi < \infty$ in our model) the average level of markup can play a major role in aggregate inefficiencies. Carrillo et al. (2023) also note this issue, and it motivates them to calculate separately two measures of misallocation, one conditional on aggregate factor supply and one arising from a divergence between aggregate input supply in market equilibrium and the optimal level. Although we use Equation (14) to highlight the issue, the point applies more broadly to all elastically supplied inputs.

We now turn to distortionary wedges for capital. Let $\boldsymbol{\mu}_{it}^{M} \equiv \left(\mu_{j,it}^{M}\right)$ denote the vector of all intermediate distortions from Equation (12), and $\mu_{it}^{Y} \equiv \eta_{it}\left(1-\tau_{it}^{Y}\right)\left(1-\overline{\varepsilon}_{it}^{Y}\right)$ denote a measure of output distortions of firm i (the product of distortions due to incomplete markets, output taxes, and product market power), where η_{it} is the marginal utility of financial resources for the individual running firm i at time t. Then the market-equilibrium level of MRPK for firm i at time t is given by

$$MRPK_{it} \equiv \overline{p}_{it} z_{it} \frac{\partial f_{it}}{\partial k_{it}} = P_{X_i}\left(\boldsymbol{p}_t^{*}\cdot\boldsymbol{\mu}_t^{M}\right)\left(1+\kappa_X \iota_{it}\right)\left(1+\zeta_{it}\right)\left(1-\Psi_{K,it}\right) - \frac{\beta}{\mu_{it}^{Y}}\mathbb{E}_{t+1}\left[\zeta_{it+1}\frac{\partial CL_{it+1}}{\partial k_{it}}\right], \tag{15}$$

where ι_{it} is the equilibrium investment and where we have now defined the private marginal discounted continuation value of capital as

$$\Psi_{K,it} \equiv \beta\left(1-\delta_i\right)\mathbb{E}_{t+1}\left[\frac{P_{X_i}\left(\boldsymbol{p}_{t+1}^{*}\cdot\boldsymbol{\mu}_{t+1}^{M}\cdot\left(1+\boldsymbol{\tau}_{it+1}^{M}\right)\cdot\left(1+\boldsymbol{\varepsilon}_{it+1}^{M}\right)\right)}{P_{X_i}\left(\boldsymbol{p}_t^{*}\cdot\boldsymbol{\mu}_t^{M}\right)}\frac{1+\kappa_X\iota_{t+1}}{1+\kappa_X\iota_{it}}\frac{1+\zeta_{it+1}}{1+\zeta_{it}}\right]. \tag{16}$$

As before, the dot notation stands for element-wise multiplication of vectors and we have used the definition of intermediate distortions from Equation (12). Importantly, the term ζ_{it} stands for the Lagrange multiplier in the entrepreneur's problem on the credit constraint $CL\left(k_{it-1}, a_{t-1}^{i}\right) \geq \sum_{i' \in \mathcal{I}_{it}^{S}} \left(1 + \tau_{i',it}^{M}\right) p_{i',it} x_{i',it} + \left(1 + \tau_{it}^{L}\right) w_{it} \sum_{N \in \{Z,C,B,H\}} \ell_{N,it}$, where $p_{i',it}$ is the price in the transactions between the firm and the investment product seller i' and w_{it} is the wage rate of innovation workers of the firm.

We can accordingly define a measure of capital distortion as the ratio of the value of the MRPK under the market equilibrium in Equation (15) to the one under the optimal MRPK function defined in Equation (3) as

$$\mu_{it}^{K} \equiv \frac{MRPK_{it}}{MRPK_{it}^{*}}. \tag{17}$$

This allows us to see how capital distortions emerge as the result of the interaction among a number of different wedges: in addition to the financial frictions captured by the measure of binding constraints, ζ_{it}, we see in Equation (15) that all factors that affect the distortions of intermediates indirectly impact the distortion of capital through their effects on investment decisions. Importantly, we note that seemingly "static" distortions in intermediate investment-good markets can translate into "dynamic" distortions in capital accumulation. Moreover, in the absence of full depreciation and/or in the presence of adjustment costs, the interactions of these wedges with heterogeneity in depreciation rates and investment aggregators all make additional contributions to capital distortions.

2.2.2.2 Upgrading, Entrepreneurship, and Search

Under the market equilibrium allocation, individual i evaluates the private expected net present value $v_{it}\left(\boldsymbol{k}_{t-1}, \boldsymbol{s}_{t}, a_{it-1}\right)$ of being in a state with vectors of capital stock $\boldsymbol{k}_{t-1}$

and in states $\boldsymbol{s}_{t-1}$ with assets a_{it-1}. (See Appendix A.2 for the complete characterization.) We can define the expected net present continuation value of accumulating capital k_{it} and assets a_{it} and allocating labor allocations $(\ell_{it}, \ell_{Z,it}, \ell_{C,it}, \ell_{B,it}, \ell_{H,it})$ given the labor and capital allocations other firms as

$$\widetilde{v}_{it+1}\left(\boldsymbol{k}_t, \boldsymbol{\ell}_t, a_{it}; \boldsymbol{s}_t, \overline{z}_t\right) \equiv \mathbb{E}_{\boldsymbol{s}_{t+1}}\left[v_{it+1}\left(\boldsymbol{k}_t, \boldsymbol{s}_{t+1}, a_{it}\right) | \boldsymbol{s}_t, \boldsymbol{\ell}_t, \overline{z}_t\right]. \tag{18}$$

We can then show that investments in upgrading, entrepreneurship, and search satisfy[16]

$$\beta \frac{\partial \widetilde{v}_{it+1}\left(\boldsymbol{k}_t, \boldsymbol{\ell}_t, a_{it}; \boldsymbol{s}_t, \overline{z}_t\right)}{\partial \ell_{N,it}} = w_{it}^{*} \mu_{it}^{L} \mu_{it}^{Y} \left(1 + \zeta_{it}\right), \qquad N \in \{Z, E, C, B, H\}. \tag{19}$$

Comparing this case with the first order condition of the social planner, we find two important differences: on the right hand side, the additional terms involving the labor and output distortions and, on the left hand side, that the social planner's expected continuation value is replaced by the private one. Once again, we note that seemingly "static" distortions in labor and product markets can translate into "dynamic" distortions in upgrading, entrepreneurial, and search investments.

As with the case of the optimal allocations, we can define a next-period measure of MRP of upgrading and entrepreneurial investments of firm i at time t under the market equilibrium as

$$MRPI_{N,it} \equiv \beta\, \mathbb{E}_t\left[\overline{p}_{it+1} f_{it+1} \gamma_{it+1}\right] \frac{\partial Z_{it}}{\partial \ell_{N,it}} = w_{it}^{*} \mu_{it}^{L} \left(1 + \zeta_{it}\right) \mathbb{E}_t\left[\frac{\mu_{it}^{Y}}{\mu_{it+1}^{Y}}\right] \left(1 - \Psi_{Z,it} \frac{\partial Z_{it}}{\partial \ell_{N,it}}\right), \qquad N \in \{Z, E\}, \tag{20}$$

where, as before, $\mu_{it}^{Y} \equiv \left(1 - \tau_{it}^{Y}\right)\left(1 - \overline{\varepsilon}_{it}^{Y}\right) \eta_{it}$ is a measure of output distortion and μ_{it}^{L} is the labor distortion defined by Equation (14), and where the expected continuation value of

[16] As before, to simplify the first order condition here we assume that individual i is not fully specializing in entrepreneurial labor ($\ell_{E,it} < \ell_{S,it}$) and uses some of their labor supply for production in their own firm. See Appendix A.2 for the characterization in the general case.

upgrading is given by

$$\Psi_{Z,it} = \beta\,\mathbb{E}_t\left[\frac{w^*_{it+1}}{w^*_{it}}\,\frac{\mu^Y_{it+1}}{\mu^Y_{it}}\,\frac{1+\zeta_{it+1}}{1+\zeta_{it}}\,\frac{\partial Z_{it+1}/\partial z_{it+1}}{\partial Z_{it+1}/\partial \ell_{Z,it+1}}\,\gamma_{it+1}\right] - \frac{\beta}{\mu^L_{it}\,(1+\zeta_{it})\,w^*_{it}}\,\mathbb{C}_t\left(\frac{\mu^Y_{it}/\mu^Y_{it+1}}{\mathbb{E}_t[\mu^Y_{it}/\mu^Y_{it+1}]},\,\frac{\overline{p}_{it+1}f_{it+1}}{\mu^Y_{it}/\mu^Y_{it+1}}\gamma_{it+1}\right). \tag{21}$$

Combining this result with the optimal MRP from Equation (8), we can write our measure of distortions for upgrading and entrepreneurial investments as

$$\mu^N_{it} \equiv \mu^L_{it}\,(1+\zeta_{it})\,\mathbb{E}_t\left[\frac{\mu^Y_{it}}{\mu^Y_{it+1}}\right]\frac{1-\Psi_{Z,it}\,\frac{\partial Z_{it}}{\partial \ell_{N,it}}}{1-\left(\Psi^*_{Z,it}+\overline{\Psi}^*_{Z,it}\right)\frac{\partial Z_{it}}{\partial \ell_{N,it}}}, \qquad N \in \{Z, E\}. \tag{22}$$

The presence of labor market distortions μ^L_{it} and binding financial frictions ζ_{it} both undermine the incentives to upgrade or enter. Growth in the two wedges, however, tends to raise current incentives to innovation since the firm internalizes the fact that future investments in upgrading will be more costly than those of today. Crucially, another important wedge that emerges here is due to the fact that the discounted marginal continuation value of knowledge spillovers $\overline{\Psi}^*_{Z,it}$ does not appear in Equation (20). When this spillover is positive, this wedge undermines the equilibrium incentives to upgrade relative to the social planner's ideal level.

As with the case of the optimal allocation, we are not able to derive a general expression for the revenue product of search investments. However, we can rely on the analysis in the case of upgrading investments to draw intuitions about the potential market distortions in search investments. As with the case of upgrading, labor market distortions, financial constraints, and market power will interact in shaping the search distortions. The distortions here closely parallel those of the innovation and upgrading. For instance, to the extent that the social surplus created by a firm investing in search for buyers or workers is not fully appropriated by the original firm (as it is accrued by the buyer or the worker), there will be underinvestment in search. On the other hand, to the extent that by entering the new product and labor markets the searching firm displaces the rents that previously accrued to some existing sellers or employers, the firm's private incentives to invest in search exceeds that of the social planner.

2.3 Relationship to Hsieh and Klenow (2009)

In this section, we briefly discuss how our framework relates to the seminal approach of Hsieh and Klenow (2009). Our theory nests their model if we assume that all firms can hire all workers, that all firms have access to all products, that investment does not feature adjustment costs, that capital depreciates uniformly across firms, and that firm-level production functions are Cobb-Douglas with identical output elasticities (i.e., $\alpha_{it}^K \equiv k_{it} f_{k,it}/f_{it} = \alpha_K$, $\alpha_{it}^L \equiv \ell_{it} f_{\ell,it}/f_{it} = \alpha_L$, and $\alpha_{it}^M \equiv m_{it} f_{m,it}/f_{it} = \alpha_M$). Under their assumptions, Equations (3), (11), and (6) show that efficient marginal revenue products of all factors are equated across firms. In this context, observed heterogeneity in marginal revenue products would imply the presence of distortionary wedges.

In Hsieh and Klenow (2009), dispersion of TFPR is a key measure of distortions. How does TFPR vary across firms in our more general environment? Letting $P_{M_i}(\cdot)$ denote the unit cost function corresponding to the aggregator $M_i(\cdot)$, extended such that the prices of all products unavailable to the firm are set to infinity ($p_{jt} = \infty$ for firm i if $i \notin \mathcal{I}_{B,jt}$), we find that the efficient marginal revenue product of the bundle of all intermediate inputs satisfies $MRPM_{it}^* \equiv p_{it}^* z_{it} f_{m,it}^* = P_{M_i}(\boldsymbol{p}_t^*)$. Now, we can write the market MRP of the bundle of inputs as $MRPM_{it} \equiv p_{it} z_{it} f_{m,it} = P_{M_i}\left(\boldsymbol{p}_t^* \cdot \boldsymbol{\mu}_{it}^M\right)$, where the dot notation stands for element-wise multiplication of vectors. The corresponding firm-level measure of intermediate distortions is given by

$$\mu_{it}^M \equiv \frac{MRPM_{it}}{MRPM_{it}^*} = \frac{P_{M_i}\left(\boldsymbol{p}_t^* \cdot \boldsymbol{\mu}_{it}^M\right)}{P_{M_i}(\boldsymbol{p}_t^*)}, \tag{23}$$

Now, combining the marginal revenue products of capital, labor, and intermediates, we find that the firm-optimal and equilibrium revenue-based total factor productivity

(TFPR) satisfy

$$TFPR^*_{it} \equiv p^*_{it} z_{it} = P_f \left(\boldsymbol{MRP}^*_{it} \right), \qquad TFPR_{it} \equiv p_{it} z_{it} = P_f \left(\boldsymbol{MRP}^*_{it} \cdot \boldsymbol{\mu}_{it} \right), \tag{24}$$

where $P_f(\cdot)$ is the unit cost function associated with the production function f; $\boldsymbol{MRP}^*_{it} \equiv (MRPK^*_{it}, MRPL^*_{it}, MRPM^*_{it})$ is the vector of optimal marginal factor productivities of different factors for firm i at time t, defined in Section 2.2.1, and $\boldsymbol{\mu}_{it} \equiv \left(\mu^K_{it}, \mu^L_{it}, \mu^M_{it}\right)$ is the vector of distortions in intermediates, labor, and capital, defined in Section 2.2.2 and in Equation (23).

Equation (24) shows that the optimal distribution of TFPR is equalized across firms if the form of the production function $f(\cdot)$ is identical across all firms, and if all conditions for the equalization of the factor-specific marginal revenue products stated above are met. The distortions in TFPR across firms are then given by

$$\mu^{TFPR}_{it} \equiv \frac{TFPR_{it}}{TFPR^*_{it}} = \frac{P_f \left(\boldsymbol{MRP}^*_{it} \cdot \boldsymbol{\mu}_{it} \right)}{P_f \left(\boldsymbol{MRP}^*_{it} \right)}. \tag{25}$$

If we assume away technological wedges (that is, if $\boldsymbol{MRP}^*_{it} \equiv \boldsymbol{MRP}^*_{t}$ is constant across firms) then equilibrium variation in $TFPR_{it}$ will uncover the vector of factor distortions $\boldsymbol{\mu}_{it}$. At the same time, if any of these assumptions do not hold, then dispersion in $TFPR_{it}$ will not in general be a sufficient statistic for these distortions.

3 Taxes, Regulations, Corruption and Political Connections

With the theoretical framework in hand, we now turn to our review of what has been learned from direct, micro studies of the various wedges that may contribute to overall misallocation. We begin with studies that examine taxes, regulations, and the ways firms try to avoid or work around them, including through informality of different types or through bribes and political connections. This category of wedges is perhaps the most straightforward to analyze of all the categories we consider, and maps most closely into the wedges modeled as exogenous taxes in the canonical models.

3.1 Taxes

From the perspective of the misallocation debate, the key question about taxes is whether they have heterogeneous impacts on firms, in particular on firms of different sizes within industries. Such heterogeneous impacts may arise for a couple of different reasons. One is that the taxes are de jure heterogeneous; another is that they are homogeneous in law but heterogeneous in effective application, because of differences in enforcement and/or compliance (Bachas et al., 2024; Slemrod, 2019). We consider each possibility in turn.

With respect to the first reason, it is common for developing countries to have different tax regimes for small firms, with taxes often based on turnover (i.e. sales) rather than profits (Best et al., 2015; Slemrod, 2019). The main motivation — in a context of limited enforcement capability and widespread evasion — is that turnover taxes are more difficult for firms to evade than taxes on profits.[17] In Pakistan, Best et al. (2015) show that turnover taxes significantly reduced evasion. In this setting, firms had to pay a minimum tax given by either a profit tax or a turnover tax, whichever was greater. This generated a kink in the tax schedule. The authors show significant bunching at the kink, which moved around as the kink moved, suggesting strategic reporting by firms. There was less misreporting of turnover and the turnover tax reduced evasion by 60-70% by the authors' estimate.

Many countries impose lower statutory corporate tax rates on small firms; in addition, many provide explicit subsidies for small firms, which generate similar

[17] Even in cases where governments have third-party information on revenues, they often lack information on firms' costs, and firms can manipulate reported costs in order to reduce their tax burden (Carrillo et al., 2017).

implications for misallocation as lower statutory taxes on such firms.[18] Drawing on administrative tax records from 16 counties, mostly in Africa and Latin America, Bachas et al. (2025) observe that effective tax rates — calculated as tax liability (taking into account tax credits, preferential tax rates, and special deductions) divided by profits — increase through almost all of the firm size distribution, up to the ninth decile. At the same time, the very largest firms often benefit from significant tax breaks, with effective tax rates declining in the top decile.

Even when tax burdens are legally the same across firms, de facto burdens may vary because of variation in enforcement. Many countries explicitly target large taxpayers for stronger enforcement; Basri et al. (2021) report that at least 62 countries have such policies. Studying the creation of "medium size taxpayer offices" in Indonesia, which aimed to increase both enforcement and customer service for larger firms (below the very top tier of 200 taxpayers nationwide), Basri et al. (2021) find that the offices were extraordinarily effective: tax revenues from affected firms more than doubled over the following six years.[19] Even when there are not separate offices for large firms, inspection rates vary across types of firms, in particular by firm size. Using the World Bank Enterprise Surveys, Bachas et al. (2019) show that industries in developing countries with larger firms tend to have higher inspection rates. Consistent with this observation, Samaniego de la Parra and Fernández Bujanda (2024) report that the Mexican social security agency uses firm size as one variable when deciding which firms to target for inspections. Focusing on inspections by a different agency, which were randomized, they also find that inspections increased compliance.

Even in the absence of differences in enforcement, tax burdens may vary because firms differ in their compliance decisions. One possible explanation, advanced by

[18]See e.g., Rotemberg (2019) on the general-equilibrium consequences of small-firm subsidies in India.

[19]Interestingly, the intensity of enforcement did not vary by size once firms were moved to medium size taxpayer offices, which arguably reduced the wedge due to differential tax enforcement among this subset of firms. In related work, Almunia and Lopez-Rodriguez (2018) also find positive impacts of increasing enforcement for large firms on tax compliance in Spain.

Kleven et al. (2016), Naritomi (2019) and others, is that non-compliance requires collusion with employees or customers and collusion is harder to sustain in larger firms. The larger a firm, the greater is the probably that a disgruntled worker or customer will become a whistle-blower. Whatever the underlying mechanism, there is fairly clear evidence that tax compliance is greater in larger firms. Using the World Bank Enterprise Surveys, Bachas et al. (2019) show that industries with larger firms on average are more likely to be compliant. In Mexico, Kumler et al. (2020) estimate evasion of payroll taxes by comparing firms' payroll reports to responses of employees to a household survey and find that larger firms display systematically greater compliance with payroll taxes than smaller firms. Considering a set of Latin American countries, Perry et al. (2007) show that the share of unreported sales (which may be because of not reporting transactions at all or reporting less than their true value) is high (20-40% for most countries) and declining in firm size. The latter fact is consistent with the finding of Naritomi (2019) that small firms were more likely than large firms to increase sales in response to a program giving consumers an incentive to report transactions in Brazil, suggesting that they had higher rates of non-compliance initially.

Overall, the evidence seems fairly incontrovertible that the burden of taxation tends to fall more heavily on larger firms, consistent with the "large firms are constrained" view of development discussed in the introduction. The thornier question, from the perspective of the misallocation debate, is whether the differential effective tax rates by size are welfare-reducing. Given the limited enforcement capacity of many developing countries, if governments are going to raise revenue, the greater reliance on larger firms may be unavoidable. Although we do not explicitly model enforcement capacity in our theoretical framework, it is clear that any welfare calculation would need to weigh the distortion generated by size-dependent tax wedges against the benefits of government-supplied public goods and other services.[20] While we do not conduct such

[20] An early attempt to quantify the welfare impacts of size-dependent government policies is provided by

a welfare analysis here, we note that more work along these lines would be welcome.

3.2 Regulations

Like taxes, regulations may apply heterogeneously across firms de jure or de facto. As Hallward-Driemeier and Pritchett (2015) point out, the gap between regulations as they are written and as they are implemented in practice is often very large.

Some countries have policies that explicitly favor small firms in product markets. For example, for many years India reserved certain products for production by small and medium enterprises. Martin et al. (2017) examine the consequences of the gradual removal of these restrictions. They find that districts more exposed to de-reservation (in the sense of having previously had a larger share of small-scale firms producing the reserved products) saw greater employment and output growth than less exposed districts, which suggests that the size-based restrictions were impeding economic performance at the district level.

Many countries have labor regulations that apply only above certain employment levels. Amirapu and Gechter (2020) study a suite of Indian labor regulations, including workplace safety regulations and social security taxes, that apply to firms with 10 or more employees. Augmenting a strategy first developed by Garicano et al. (2016) in France, Amirapu and Gechter find lower density of firms just above 10 workers, suggesting that the regulations bind, and estimate that the suite of regulations increases labor costs by about 35%.[21] On the other hand, when they use their methodology to look at the consequences of India's Industrial Disputes Act (IDA), which is famously restrictive — it requires firms with employment of 100 or more workers to receive state government permission before laying off workers — they find little evidence that the

Guner et al. (2008).

[21]An important caveat to this result, from Figueiredo Walter and Moneke (2024), is that the bunching at the 10-worker cutoff may in part have been due to enumerator incentives: the workload for enumerators in the Indian Economic Census of 2005 increased discontinuously at 10 workers. In other years, there was no such discontinuity at 10 employees, and no bunching observed at that level.

regulation affects labor costs. This latter result is consistent with Hsieh and Olken (2014), who do not find bunching around the 100-worker cutoff.

Part of the reason for the lack of bunching observed in some contexts is that firms may find various ways to work around size-dependent regulations. One such workaround is hiring temporary or casual workers. Chaurey (2015) shows that firms in Indian states with more restrictive labor laws (using a categorization from Besley and Burgess (2004)) were more likely to respond to positive rainfall shocks by hiring contract workers (not covered by the IDA), echoing a sector-level finding by Adhvaryu et al. (2013). In related work, Bertrand et al. (forthcoming) explore the consequences of a 2001 Indian Supreme Court decision that reduced the costs to firms of hiring contract workers. After this ruling, the contract share of employment rose overall, but especially for firms with 100 or more workers. In panel data, controlling for establishment fixed effects, the rising contract share was associated with increased employment and a decline in MRPL. Fitting a model of endogenous innovation with size-dependent firing costs to the data, the authors estimate that all of the decline in the gap in value-added per worker between large and small plants could be explained by the increased adoption of contract labor. The use of contract labor may be part of the explanation for the (otherwise puzzling) lack of bunching at the 100-worker cutoff.

Heterogeneity in the impacts of regulation can also arise from demand-side pressures in product markets. For instance, even in settings where government enforcement is weak or non-existent, multinational corporations may require that their suppliers comply with local labor law, in part to avoid bad publicity if violations were to come to light. In an RCT conducted in collaboration with 29 multinational apparel buyers in Bangladesh, Boudreau (2024) finds that buyer pressure to form occupational health and safety committees was effective, in the sense of both improving compliance with the law and improving objective safety outcomes. This sort of pressure tends to be stronger on larger firms, given that it is typically the larger and more productive suppliers in an industry that sell to multinational buyers. These findings are consistent with earlier work by Harrison and Scorse (2010), who argue that anti-sweatshop campaigns against Nike, Reebok, and Adidas in Indonesia in the 1990s led to wage increases in the textile, footwear, and apparel sector overall and especially in districts with suppliers for the three targeted companies.

Although the preponderance of evidence suggests that regulations tend to bind more on larger firms, one contrasting piece of evidence comes from Atkin and Donaldson (2022), who report estimates from the World Bank Enterprise Surveys of costs of dealing with regulations as a share of total sales, derived from questions about bribe payments by typical firms and the amount of time senior management spends dealing with regulations. In low-income countries, this share is higher for smaller firms. This finding is suggestive that there are fixed costs to complying with regulations, which represent a larger share of sales for smaller firms. We return to the issue of bribes below.

3.3 Informality

Up to this point, we have discussed taxes and regulations separately, but in fact the two dimensions are intertwined in firms' decisions about how much of their activity to declare to governments. There are several distinct margins of such decisions. One is whether to register with the government at all (the extensive margin of informality). Another is whether to report a particular employee to the government (an intensive margin of informality). A third is whether to declare a particular transaction to the government (another intensive margin of informality). All of these margins are important in developing countries. Schneider and Enste (2000) and La Porta and Shleifer (2008, 2014) estimate that the informal economy represents over half of GDP in many developing countries. Even in middle-income countries such as Mexico or Brazil, about half of the labor force is employed informally (Levy, 2008; Perry et al., 2007).

To be clear, informality does not represent a wedge in itself, but firms' decisions on these margins influence the "bite" of the wedges generated by taxes and regulations. From the perspective of the misallocation debate, the key question is how such decisions affect heterogeneity in this bite across firms. On all three margins, informality tends to decline in firm size. Using a survey of formal and informal firms in Brazil, Ulyssea (2018) shows that both the share of informal firms and the share of informal workers within firms was declining in firm size (measured by employment). Perry et al. (2007) show that these patterns held generally across Latin American economies.[22]

The most commonly cited explanation for the positive correlation of formality and firm size is simply that the cost of being caught is increasing in size (Slemrod, 2019; Ulyssea, 2018). It may also be that formalizing carries fixed costs that are more easily borne by larger firms. The seminal argument of De Soto (1989), for instance, emphasized the number of days required to register a firm initially. It is also possible that the value of some benefits of formalization — for instance, access to courts or financial markets — increase in firm size.

Much of the micro-development work on informality has focused on the impact of formalizing on firms, using exogenous variation in the costs of formalizing (Benhassine et al., 2018; De Andrade et al., 2014; De Mel et al., 2013; Fajnzylber et al., 2011; McKenzie and Sakho, 2010; Rocha et al., 2018). The evidence is mixed, both on how responsive firms are to the costs of formalizing and on the effects on firm growth and profits; Ulyssea (2020) and Jayachandran (2021) provide reviews. A valuable insight is that the possibility of non-compliance on the employee or transaction margins may influence firms' decisions on the extensive margin of formality. Ulyssea (2018) estimates an equilibrium model in which lower costs of formalizing may induce firms to register, but firms still under-report their employees or transactions. His estimates suggest that reductions in the cost of formalizing would tend to have little effect on the overall extent

[22] In related work, Henning and Okello Ayo (2025) find that smaller firms were more likely to exit the formal sector (on the extensive margin) in response to audits.

of informal employment in Brazil for this reason. Relatedly, Chaurey et al. (forthcoming) study the effects of an increase in fines for hiring contract workers in the Indian state of Andhra Pradesh, and find less hiring of such workers but a greater rate of firm informality, as firms sought to avoid the tighter regulation.

In the context of our theoretical model, the intensive margins of informality, for employees and transactions, can be thought of as simply generating differences in the exogenous taxes for labor and inputs, τ^{Y}_{jt} and $\tau^{M}_{j,it}$. The extensive margin of informality requires a bit more discussion. Although in our framework we only consider one entry decision, about whether to start a firm or not, it would be straightforward to extend the framework to consider an additional decision, about whether to pay a fixed cost of registering to become a formal firm. If the benefits of formality are increasing in firm productivity, as the evidence cited about suggests, then the firms that remain fully informal tend to be lower-productivity, smaller firms. In this context, greater enforcement of formalization rules (which typically impinge more on smaller firms, since such firms are less likely to be in compliance) may tend to reduce heterogeneity in the bite of taxes and regulations across firms and hence reduce misallocation (Meghir et al., 2015). Along related lines, Dix-Carneiro et al. (forthcoming) argue that trade liberalization may interact with such size-dependent wedges to amplify the gains from trade (by shifting resources to larger firms).

Together, low fixed costs of starting an informal firm, high fixed costs of formalizing, and the large number of individuals with relatively poor labor-market prospects (which may itself be a symptom of misallocation), provide a natural explanation for the preponderance of very small, unproductive firms in the firm-size distributions of many developing countries, noted by Hsieh and Olken (2014) and others. This discussion warrants caution in drawing conclusions about misallocation from the overall shape of the firm-size distribution. If the informal sector is primarily populated by low-ability entrepreneurs because their options are constrained in the labor market, it may not contribute much one way or the other to aggregate output. Instead, the contribution of misallocation to aggregate output may hinge more on the extent of misallocation among formal firms. This is an empirical question on which we need more evidence.

3.4 Corruption

Corruption — from petty roadside bribes paid by small-scale traders to government procurement auctions that award contracts to prominent, politically connected firms — can shape the returns experienced by firms in developing countries in a variety of ways. Moreover, because corruption often entails informal extortion, skirting of standardized rules, or achieving unfair advantage, its impacts are often felt heterogeneously across firms.

Many forms of corruption can be viewed as mechanisms that move de facto taxes away from their de jure rates. Identifying the sign of these corruption-driven wedges is the topic of long-standing debate: does corruption shackle firms with higher marginal costs (Kaufmann and Wei, 1999; Shleifer and Vishny, 1993), or does it "grease the wheels" of bureaucracy (Huntington, 1968; Leff, 1964), as bribed officials turn a blind-eye towards compliance with taxes or regulation? Moreover, these wedges may vary across firms. For example, government officials may be able to extort larger bribes from larger firms that have a higher "ability to pay" or from firms with greater sunk capital which have lower "refusal power" (Svensson, 2003). Alternatively, to the extent that corruption "greases the wheels," firms that are more subjected to regulation — e.g., larger firms, in the case of size-dependent regulation — may also pay greater bribes. Note this does not necessarily mean that larger firms face higher "taxes" due to corruption: despite paying larger bribes on net, larger firms may enjoy lower effective taxes due to the weaker enforcement purchased with their bribes. We discuss below to the empirical challenge of estimating this net effect, especially when it may be easier to measure the costs of corruption (e.g., bribes paid) than benefits (e.g., weakened regulatory enforcement). Moreover, the impact of corruption on misallocation depends on the baseline distribution of de jure taxes and regulations, not just how corruption alters their de facto rate. Under the "grease the wheels" hypothesis, greater bribes and lower enforcement for larger firms may mitigate misallocation driven by size-dependent regulation.

Empirical measurement of bribe payments is a challenge, due to their illicit nature. However, there have been recent improvements in measurement, moving beyond the traditional focus on perceptions of corruption to direct measurement through surveys and observation (Olken and Pande, 2012). The new work reveals a mixed picture of how the burden of bribes is distributed across firms. Echoing the findings of Svensson (2003) mentioned above, Olken and Barron (2009) find through direct enumerator observation that truckers in Indonesia who drove visibly newer trucks or carried more valuable cargo paid higher bribes at weigh stations along major highways. The authors' granular data also allows them to identify non-linearities in the bribe schedules, which displayed a complex two-part tariff in which higher-quantity firms could opt into a higher-fixed-cost, lower-marginal-cost pricing scheme. Sequeira and Djankov (2014) collected measures of bribes reported by clearing-agents-turned-enumerators for import shipments into two ports in South Africa and Mozambique, finding that larger firms tended to pay relatively higher bribes. While these studies suggest that larger firms pay higher bribes in absolute terms, several studies suggest that as a *as a percent of sales or revenues*, smaller firms tend to pay more — that is, they face a higher "tax rate" due to bribes. For example, Manelici et al. (2024) find that informal firms in Mexico tend to report losing 7% of sales to crime and bribes, while formal firms lose only 3% on average. This pattern is confirmed in a geographically comprehensive picture by Bai et al. (2019), who show that larger firms tend to pay lower bribes as a percent of revenue in both cross-country and within-country data from the World Bank Enterprise Surveys. Using more detailed data on Vietnamese firms, Bai et al. (2019) also provide causally identified evidence consistent with this pattern, instrumenting for firm growth using growth in the corresponding industry in other provinces in Vietnam and in China. They attribute the lower bribes as a share of revenues to the fact that large firms were more mobile, which they hypothesize deterred local officials from extracting large bribes for fear of firms leaving. Taken together, these results suggest that although larger firms may pay greater bribes in absolute terms in some settings, across a variety of settings they tend to pay less in percentage terms — i.e., a lower tax rate due to bribes — because of higher refusal power and, in some cases, sophisticated pricing schemes that effectively offer quantity discounts.

But this is only part of the story. The "grease the wheels" hypothesis would suggest that while firms may pay bribes, they also get benefits in return, such as lower taxes or regulation, which may on net lower their operating costs. What is the heterogeneity in impacts across firms, once these benefits are factored in? Sequeira and Djankov (2014) find that firms were willing to pay substantially higher transport costs to avoid the more corrupt port in Mozambique, suggesting that much of the corruption in their setting was "coercive" (cost-increasing) rather than "collusive" (cost-decreasing, through evasion of import tariffs). This is consistent with evidence from Fisman and Svensson (2007), who, in a follow-up to Svensson (2003), find that a one percentage point increase in bribes was associated with three percentage points lower firm growth, instrumenting for bribe rates using industry-location averages.

In sum, the empirical evidence on bribe payments — though limited due to measurement challenges and somewhat mixed across settings — is on the whole inconsistent with a "grease the wheels" story in which larger firms pay bribes to reduce size-based regulatory burdens. Rather, smaller firms seem to average pay larger bribes (in percentage terms) and, on net, corruption seems to raise costs and reduce their growth.

3.5 Political Connections

Political connections (which are not necessarily illegal) may enable preferential access to capital or government procurement contracts. Like corruption, the influence of such connections seems reasonably modeled by exogenous taxes.

The accumulated empirical evidence on the role of political connections in generating misallocation is clear. Across several settings, larger and more politically connected firms have been shown to enjoy greater access and lower returns to capital. Khwaja and Mian (2005) use panel data on the universe of corporate lending in Pakistan to show that firms with a director participating in an election borrowed 45% more, especially from government-owned banks. Politically connected borrowers were of worse "firm quality," being less likely to export, and their loans had worse performance, with 50% higher default rates. Similarly, Claessens et al. (2008) find that firms in Brazil that donated to elected government officials received more bank financing after their candidate won (relative to firms who made contributions to losing candidates) and saw lower returns on their assets. These results are also echoed by Li et al. (2008), who find that affiliation with the Communist Party had a positive effect on loan access in China, controlling for other factors that affected credit access.

Politically connected firms may also have differential access to government contracts. Colonnelli and Prem (2022) study a randomized anti-corruption campaign in Brazil and find that politically connected firms — those that made political donations or had a manager who holds elected office — shrank after the crackdown, while unconnected firms grew. Moreover, the overall number of firms in treated municipalities increased. Schoenherr (2019) finds that private firms in Korea with CEOs from the same network as a newly elected president were awarded more government contracts, but performed systematically worse, with more frequent cost overruns. Colonnelli et al. (2024) show that a randomized outreach campaign by the Ugandan

National Procurement Agency to reduce small and young firms' perceptions of corruption increased their participation in procurement auctions.

Several papers look at the value of political connections on overall firm valuation. In a seminal paper, Fisman (2001) documents that firms that were closely tied to Indonesian President Suharto experienced strong declines in their stock value during periods of rumors about Suharto's health, suggesting that part of their valuation was based on their connection to the regime. Faccio (2006) documents similar results in a dataset of over 20,000 publicly traded firms across 47 countries, finding that when one of a firm's shareholders or top executives entered political office, the firm enjoyed a large increase in corporate value. Chiang and Qin (2025) find that an anti-corruption campaign run by the Chinese government decreased the value of politically connected firms by 7.5%.

In summary, there is strong evidence that political connections advantage connected firms, often to the detriment of more-productive, less-connected firms. Although few studies look explicitly at heterogeneity in political connections by firm size, it is natural to expect political connections to be stronger at large firms. Indeed, many of the empirical tests for political connections, including those that identify political connections through board of directors membership or those that measure impacts through stock returns, are only relevant for larger companies.

3.6 Discussion

The wedges we have discussed in this section — taxes, regulations, corruption, political connections — have in common that it seems reasonable to model them as exogenous taxes that affect firms differentially. In this sense, they do not raise severe concerns about misspecification in the standard models used in the misallocation literature. At the same time, our review points to differences in how the various types of wedges vary with firm size. On the whole, the preponderance of evidence supports the view that taxes and regulation tend to impinge more on larger firms than smaller, in line with the "large firms are constrained" view. In the case of corruption and political connections, by contrast, the somewhat limited evidence suggests that small firms are the more constrained ones. Officials extort higher bribes from smaller firms (as a percentage of their income), while large firms seem more likely to have political connections that can facilitate access to credit and government contracts, although there is clearly variation in connections within firm-size categories.

4 Market Power

Market power is a potentially important source of distortionary wedges in developing countries. Market power can drive firms to constrict output below socially optimal levels to attain higher prices or to constrict purchases to depress wages or other input prices. As we saw in Section 2.2, markup wedges, like taxes and regulations, may contribute to distortions in the marginal revenue products of all factors.[23] However, unlike taxes and regulations, markups are not fully exogenous. While they may be shaped by external forces such as entry barriers, patent laws, or other policies, markups are ultimately endogenous objects, reflecting optimizing behavior by firms.[24] This matters for optimal policy responses in two ways. First, in calibrating policies to correct these wedges, one must account for firms' endogenous responses to the policy: subsidizing firms that are viewed as too small (or taxing firms that are viewed as too large) will produce different aggregate impacts in an environment in which these wedges respond endogenously (Gupta, 2024; Haltiwanger et al., 2018). Second, the policy levers that are appropriate for addressing market power, such as antitrust or

[23] For the sake of brevity, when referring to market power in its general form, we will use the terminology of seller market power (markups, oligopoly, demand elasticities, etc.); we leave to the reader to fill in the equivalence for buyer market power. In the subsections below, when we address the location of market power, we will be more specific in our language.

[24] Markups are an example of what Ghatak and Mookherjee (2025) refer to as a market friction; a key point in both their and our discussion is that these may respond endogenously to market conditions.

other pro-competitive policies, differ from those to address, for instance, exogenous taxes and regulations.

In this section, we review the empirical evidence on the extent to which market power is a source of variation in marginal products of different factors across firms. We organize the section around the main markets in which firms may have market power: product market power (appearing in our theory as a non-zero inverse elasticity of firm-level final demand ε_{it}^{Y}), intermediary or firm-to-firm market power (appearing in our theory as a non-zero inverse elasticity of firm-to-firm demand $\varepsilon_{j,it}^{Y}$ or supply $\varepsilon_{j,it}^{M}$), and input market power (with a focus on labor markets, appearing in our theory as a non-zero inverse elasticity of labor supply ε_{it}^{L}).

The methodological approaches in this literature span a wide range. Some directly measure markups in survey or accounting data, an approach that has the benefit of being clear and relatively assumption-free, but which is susceptible to mismeasurement (and which, especially in accounting data, often struggles to estimate marginal rather than average returns). Others estimate markups using the production-function approach pioneered by Hall (1986) and De Loecker and Warzynski (2012), which, under the assumption of cost minimization, requires estimates of a firm's output elasticity with respect to a flexible input and its expenditure share on that input, but imposes no assumptions on conduct or demand. Others take a demand-side approach, using demand estimates along with assumptions on conduct to infer markdowns, trading off greater assumptions for the ability to run counterfactuals (e.g., Berry et al. (1995)). Within these approaches, many papers use instruments, natural experiments, or randomized variation to estimate key parameters, such as output or demand elasticities. Others use similar sources of exogenous variation to explore the impact of policy shocks to competition and/or entry. We do not attempt to review here the methodological issues that arise in estimation (for reviews, see e.g., Berry et al. (2019) and De Loecker and Eeckhout (forthcoming)); instead, we focus on the literature's substantive findings on the drivers of markup heterogeneity across firms in developing countries.

4.1 Product Market Power

The classic form of market power studied in the literature is the power to charge markups on the products a firm sells. What might drive variation in this power across firms?

Firm size may directly shape the level of markups, if for instance more productive firms have greater market shares and therefore face less elastic residual demand, as in the model of Atkeson and Burstein (2008). Much of the empirical literature is consistent with this prediction, finding that larger firms tend to charge larger markups. For example, De Loecker et al. (2016) use a production-function approach adapted to a multi-product setting to estimate markups among Indian manufacturing firms. They find that, on average, larger firms tend to have lower marginal costs and higher markups in the cross-section. In response to an exogenous reduction in marginal costs induced by India's 1991 trade liberalization, they find that more-exposed firm-product pairs saw substantial reductions in marginal costs; however, pass-through to factory-gate prices was incomplete, since markups rose.

Greater markups among large firms could also be reflective of factors on the demand side if, for example, larger firms are more likely to serve wealthy, quality-sensitive customers. Gupta (2024) uses detailed firm-product data from India in a cost-minimization approach to estimate markups (and marginal costs). In contrast to De Loecker et al. (2016), he finds that larger firms have *higher* marginal costs, perhaps as a result of large firms producing higher quality and requiring better quality inputs (Kugler and Verhoogen, 2012). He also finds that larger firms have larger markups, perhaps because they sell to richer customers, who appear to be less price-sensitive. He also uses a rainfall instrument as a shock to demand from poor consumers, showing that this led to lower markups among firms as their demand composition shifted towards more price-sensitive poor consumers.[25] Relatedly, Atkin et al. (2015) find in direct surveys that larger producers of soccer balls in Pakistan have both higher markups and higher costs, which they attribute to similar forces. Geography can also segment demand. Atkin and Donaldson (2015) develop an approach using pass-through of price shocks to correct for spatially varying markups in (effectively barcode-level) data on imported products Ethiopia and Nigeria. They find that markups are lower in rural areas, which they attribute to demand being more elastic at higher prices.

The degree of competition and the nature of strategic interactions may be an important driver of variation in firm markups. In some cases, this is the result of government regulation, such as in Busso and Galiani (2019), which studies random variation in how many retail stores are licensed as eligible shopping locations for participants in a conditional cash transfer program. They find that markets with a greater number of licensed firms have lower prices. Jensen and Miller (2018) find that the roll-out of cell phone towers in Kerala, India enabled boatbuilders to enter each others' markets, resulting in high-quality boatbuilders expanding their business, while low-quality businesses shrank or even exited. As a result, quality-adjusted consumer prices declined (though raw prices rose). Finally, low demand itself may constrain the number of firms that a market can support. This point is highlighted in Leone et al. (2025), which develops an empirical model of the global cement industry, estimated under a variety of assumptions about conduct and using variation in prices driven by neighboring countries' exports to the rest of the world to estimate demand. The authors find that the high prices for cement observed in many African countries are in part the result of low demand constricting the number of firms, leading to lower competition

[25] Gupta also estimates the impact of a counterfactual policy that subsidizes firms with high markups and taxes firms with low markups to correct for these wedges, with the size of the subsidy/tax set to equalize marginal revenue product (MRP) of inputs across firms under the erroneous assumption that MRP variation arises from exogenous policy-driven distortions. But because in his model this variation in fact arises from endogenous markups, reflecting not just firm conduct but also demand, the efficiency gains from this counterfactual are 30% lower than under standard models of policy-driven misallocation.

and higher markups. Beirne and Kirchberger (2021) also find that oligopoly power lead to significantly higher cement prices, especially in poorer countries, which they argue results in substantial global misallocation.

In summary, we see that productivity or cost heterogeneity, demand segmentation, and variation in the strategic environment can all drive heterogeneity in firm markups in developing countries. On the whole, the empirical literature suggests that product markups are larger among larger firms. In our theory, this appears as these firms facing a larger inverse elasticity of firm-level final demand, ε_{it}^{Y}. This wedge is expected to create distortions in all firm-level decisions — capital, labor, intermediates, and upgrading and search decisions — and to result in more-productive firms being smaller than optimal.

4.2 Intermediary and Firm-to-Firm Market Power

There has been longstanding speculation that intermediaries may hold market power. In our theory, this would appear as a non-zero inverse elasticity of firm-to-firm demand, $\varepsilon_{i,j,t}^{Y}$, or supply, $\varepsilon_{i,jt}^{M}$. As with product market power, heterogeneity can arise from variation in firm costs, demand or supply segmentation, and the strategic environment. Studying maize traders in Kenya, Bergquist and Dinerstein (2020) take an experimental approach to identifying conduct and markups. They show that the price pass-through of a marginal-cost subsidy offered to traders in randomly selected markets was low. Combining this with a second experiment that randomized prices to estimate demand, they find that traders appear to have colluded in their setting. Moreover, they find evidence of large heterogeneity in markups across traders. Other evidence on firm-to-firm market power suggests that there may be heterogeneity in markups even *within* the selling firm, across buyers. For example, Burstein et al. (2024) find that Chilean firms selling manufacturing intermediate goods charge different markups to buyers of the same product, with an average price range across buyers of 46%.

Segmentation of demand (or supply), modeled in our framework through heterogeneity in the sets $\mathcal{I}_{B,it}$, is one natural driver of heterogeneity in intermediary markups. Transport or search costs may restrict intermediaries to activity in specific villages or regions, which may feature different demand (or supply) elasticities — and therefore different optimal markups (or markdowns). Heterogeneity in markups and markdowns can also arise if firms have limited ability to substitute between buyers or suppliers and this ability varies across producers. For example, Zavala (2024) develops and estimates a model in which Ecuadorian exporters of agricultural products are oligopolistic and farmers vary in land suitability for particular crops, which limits their ability to switch between buyers. His results suggest that exporters passed on to farmers only a quarter of every dollar they earned in international markets, a share that was lower in crops with greater exporter concentration.

Variation in the strategic environment can also drive heterogeneity in intermediary markups. Conduct itself can vary across markets. For example, in addition to the two experiments mentioned above, Bergquist and Dinerstein (2020) ran a third experiment to randomly subsidize trader entry into new markets; they find that entry can break up collusion, but only when the entrant does not know the incumbents. Entry can also vary across markets, perhaps limited by search costs. In an RCT in Uganda, Bergquist et al. (2024) find that agricultural traders were more likely to enter markets when they were connected to sellers or buyers there via a mobile-phone-based matching platform. Wedges due to market power may interact with wedges due to search: if search is characterized by increasing returns such that larger intermediaries search more, those intermediaries may find themselves in markets with fewer competitors and be able to charge larger markups. Credit constraints may also limit entry; this is another form of potential interactions of wedges. For example, Bartkus et al. (2022) find that an initiative to purchase large transport boats for Amazonian fishermen — who are typically too credit-constrained to do so on their own — allowed them to cut out transport intermediaries and earn higher revenues. Policy can generate heterogeneity in entry.

Using a spatial regression discontinuity design, Chatterjee (2023) finds that a law in India forcing farmers to sell to intermediaries in their own state limited spatial competition among traders and reduced the prices that farmers receive. Rubens (2023) studies a reform in China that forced the exit of small tobacco manufacturers and encouraged consolidation among those who remained. Although it was intended to support economies of scale, Rubens finds in a difference-in-difference analysis that the regulation had the unintended consequence of increasing input-price markdowns and driving misallocation of inputs within affected provinces, which saw aggregate productivity fall.

Several theoretical challenges arise when studying market power among intermediaries. One is separating markups from the costs of additional — and often less visible — services that intermediaries may offer, such as supply or demand assurances, credit, or the resolution of contracting frictions. Such non-price components of transactions are often needed to achieve second-best resolutions to market failures. However, these non-price amenities can tie suppliers or buyers to a particular intermediary, generating a source of market power.[26] Heterogeneity in either intermediaries' ability to offer these non-price amenities or in buyers' (or suppliers') valuations of them can generate heterogeneity across firms in markups (or markdowns). For example, Cajal-Grossi et al. (2023) use transaction-level data to show that garment exporters in Bangladesh earn larger markups from "relational" buyers, even after controlling for seller-product-time fixed effects. Echoing these findings in the agricultural sector, Leone et al. (2025) use transaction-level data along the full supply chain of Costa Rican coffee and variation in farmer price driven by regulatory shifts to estimate a structural model in which farmers supply oligopsonistic mills differentiated by price and non-price amenities. Their estimates suggest that non-price amenities are

[26] Conversely, market power may *enable* firms to offer these amenities, as relational contracts are easier to sustain when parties have fewer outside options (Macchiavello and Morjaria, 2021).

paramount in farmers' decisions, with mill fixed effects explaining a large portion of the variation in farmer supply. Original survey data shows that these fixed effects are correlated with services such as advanced payments, loans, and training programs. Emran et al. (2021) show that a natural experiment in Bangladesh banning financial intermediaries from the edible oils supply chain, which was intended to reduce intermediaries' market power, actually raised consumer prices, by restricting access to credit along the supply chains serving them.

Another challenge when studying market power among intermediaries is defining the "market." This is critical to estimating the number of entrants active in the market, but when traders are physically mobile, defining a market's boundaries is not straightforward. Casaburi and Reed (2022) develop an approach for estimating market size, using the difference in prices offered by traders whom they randomly treated with a marginal-cost subsidy and by those in a control group. This difference yields an estimate of a "differentiation rate," which in their context was low, suggesting that traders were fairly homogeneous. They find high pass-through of a quasi-experimental international price shock, which suggests (through the lens of a model of Cournot competition) that markets were connected across villages.

Lastly, the length of the supply chain itself may be endogenous. Grant and Startz (2025) develop a model in which multi-layer supply chains arise as a response to economies of scale in trade costs, as downstream agents trade off higher marginal costs for lower fixed costs when sourcing from intermediaries upstream. Original data collected among wholesale and retail traders in Nigeria confirm the model's predictions: smaller traders are more likely to buy in resale markets and to pay higher unit prices, but enjoy lower fixed trade costs. Counterfactuals using their quantitative model suggest that shortening the chain, through policies that "cut out the middleman," would lower marginal costs but also induce exit of sellers, with ambiguous net effects for consumer welfare.

While there is empirical evidence that intermediaries tend to charge markups or markdowns, the frontier of the literature suggests that understanding how these wedges interact with other features of the market, such as credit constraints, contractual risk, and fixed costs is key to understanding the aggregate welfare impacts of removing this wedge alone. More research in this space, including on understanding how policies to address these other features may indirectly affect intermediary market power, is needed.

4.3 Labor Market Power

Firms may also possess buying market power for labor and other inputs. The monopsony power that employers may exert when hiring labor appears in our theory as a non-zero inverse elasticity of labor supply, ε^L_{it}. In this subsection, we discuss the empirical evidence on labor market power in developing countries and its role in generating heterogeneity in markdowns charged by firms.[27]

There is substantial evidence that larger employers impose larger markdowns on wages. Drawing on industrial surveys in China and India, Brooks et al. (2021b) estimate markdowns among manufacturing firms, using a modification of the De Loecker and Warzynski (2012) approach. The key idea is that as long as the firm does not have buying market power in at least one input (in their context, materials), the standard approach can be used to identify markups using that input; then for other goods, the total price-cost margin can be divided by the markup for the exogenous input to yield markdowns.[28] They find that monopsony power lowered wages for the average worker by 18% in China and 16% in India — effects that are most pronounced among the largest firms. Amodio and De Roux (2024) similarly find greater markdowns among larger employers in Colombia. Using exogenous demand shocks (from variation in

[27] We focus on labor market power among employers on the buying side. There could in theory also be market power among employees on the selling side. For example, Breza et al. (2019) study a setting in India in which labor supply is coordinated by social norms, even in a decentralized spot market.

[28] Rubens (2023) shows how to modify this approach when inputs are not substitutable.

baseline export destination shares across firms and changes in exchange rates over time), they estimate firm-level labor supply elasticities which suggest that workers' MRPL was 40% higher than wages on average, and more so among firms with greater shares of employment in their local labor market. Finally, Amodio et al. (2025b) provide global evidence, applying the cost minimization approach to panel data on more than 13,000 manufacturing firms across 82 low and middle-income countries around the world. They, too, find that larger and more productive firms impose larger markdowns.

Markdowns may also vary across firms if they are located in different industries and locations — in the context of our model, if they face different sets of potential employees, $\mathcal{I}_{H,it}$. For example, Felix (2022) develops a model of monopsony power in the Brazilian labor market in which labor supply is characterized by a nested CES structure across firms, with workers choosing among labor markets (defined by microregion × occupation) and then, within labor markets, across firms.[29] Using shocks to import competition from Brazil's tariff liberation of the 1990s — variation across firms but within labor markets to estimate the lower nest elasticity and variation across labor markets to estimate the upper nest elasticity — Felix estimates average wage markdowns of 50%, with larger markdowns for firms with greater market shares. Geography can also drive segmentation of the labor market; for example, Brooks et al. (2021a) find that construction of the national highway system in India reduced employer markdowns substantially. Lastly, worker demographics, such as gender, can segment labor markets. Sharma (2023) finds that female workers in Brazil were substantially less likely to separate from their employer following an exogenous wage reduction driven by the end of the Multi-Fiber Arrangement. She estimates a discrete-choice model in which workers have nested CES preferences over job's

[29]This model is based on the framework developed by Berger et al. (2022), which can be microfounded in a setting in which individual workers have idiosyncratic taste preferences across different firms. In our framework, this could be accommodated by incorporating an additional taste shock of the form $\xi_{i',it}$ for individual i for a firm i' at time t, as in Card et al. (2018). The implication is that, within the same labor market, firms can offer different wages to workers and face imperfectly elastic labor supplies.

location, industry, and specific employers, and finds that estimated elasticities are lower for women, suggesting that they face larger markdown.[30]

Variation in the strategic environment can also generate heterogeneity in markdowns. For example, Sharma (2025) finds evidence that industry associations facilitate collusion among Indian garment producers. She studies the impact of firm-specific demand shocks driven by a sudden influx of demand from specific brands on exposed firms' unshocked competitors, showing that while unshocked competitors on average raised their wages in response, those outside industry associations lowered employment, while those inside *raised* employment. These patterns are consistent with the hypothesis that collusive agreements within the industry associations fell apart in reaction to the shock.

In addition to the factors shaping conduct and number of entrants, a recent set of papers has highlighted the role of competition from outside the formal, private sector in disciplining markdowns. In the context of Peru, Amodio et al. (2025c) develop a general-equilibrium model in which the possibility of self-employment tends to raise the supply elasticity of wage labor to the oligopsonistic formal sector and to reduce markdowns. Because the rate of self-employment in an industry is negatively correlated with its capital intensity, their results suggest that the mitigating role of self-employment may be stronger in less capital-intensive industries. Public sector employment can also serve as a disciplining threat to keep markdowns low in the private sector. Muralidharan et al. (2023) find that a randomized, large-scale increase in the reach of India's National Rural Employment Guarantee Scheme increased market (non-program) earnings of low-skilled workers, without reductions in employment, suggesting a possible reduction in markdowns in the private sector.

Other government policies and regulation can shape the strategic environment. For

[30] Sharma also finds lower labor-supply elasticities, and correspondingly larger markdowns, for larger employers.

example, Naidu et al. (2016) show that a reform in the United Arab Emirates that relaxed restrictions on migrant workers' ability to shift to new employers increased migrants' earnings, consistent with a model in which employers had monopsony power prior to the reform. Estefan et al. (2024) find that a ban on outsourcing in Mexico reduced markdowns, especially among the largest firms among whom markdowns were greatest at baseline. On the other hand, Felix and Wong (2025), who study a reform in Brazil in which outsourcing was legalized, find that the reform did not lower overall employment or reduce wages. Finally, the ability of workers to unionize may affect the markdowns employers can extract from them. Lagos (2024) shows that a reform in Brazil preventing the expiration of collective bargaining agreements increased wages (and amenities), without reducing employment. Using a strategy similar to Amodio and De Roux (2024) across sixteen Latin American countries, Amodio et al. (2025a) find that wage-setting power was significantly higher among firms in countries with lower union density, limited collective bargaining, and no unemployment protection.

In sum, the empirical literature provides substantial evidence that larger employers tend to charge larger markdowns, face higher inverse elasticities of labor supply, ε_{it}^{L}, and employ too few workers relative to the social optimum. However, their labor market power also appears to be somewhat constrained by the large share of employment outside of the formal sector in many countries, including in the informal and public sectors.

Similar to our discussion in Section 4.2, there may also be interactions between labor market power and other wedges, such as contracting frictions. For example, a long-standing literature suggests that monopsony power may enable employers to offer workers more general training (Acemoglu and Pischke, 1999; Azar and Marinescu, 2024). Though most of the evidence on this is from high-income countries, newer evidence is emerging from low-income countries. For example, Cefalà et al. (2024) show that agricultural employers in Burundi are more likely to train workers when they are randomly offered a guarantee that the worker will return to the employer in future periods. More research in this area would be welcome.

4.4 Summary

Across many empirical settings, researchers have found larger firms to have both greater markups and greater markdowns. There are some potentially offsetting forces: for example, small firms may be more likely to be in rural or isolated markets in which they face few competitors. But on net, the former forces appear to dominate empirically. This observation carries similar implications for misallocation as the observation from Section 3 that the burden of taxes and regulations tends to fall more heavily on large firms. In particular, both observations suggest that larger firms are too small relative to what would be the case under the optimal allocation. (Recall from our framework that output taxes and inverse demand elasticities tend to enter into our expressions for distortions in a similar way and hence can be expected to have similar implications for misallocation. A similar point applies to input taxes and inverse supply elasticities. See Equations (12) and (14).) At the same time, we note again that markups and markdowns are chosen by firms; in this sense, the findings in this section cannot be taken as support for the "large firms are constrained" view. We also note again that the optimal policy interventions will differ depending on whether distortions are due to taxes/regulations or to market power. A promising topic for future research is to quantify the relative importance of taxes/regulations and market power in generating distortions in a framework such as ours.

5 Contracting Frictions

Another potentially important source of wedges is contracting frictions of various types. Such frictions are commonly thought to be more severe in developing countries, in part because of weaker enforcement institutions. In this section, we briefly examine the micro evidence on the extent to which contracting frictions give rise to the heterogeneity in marginal returns noted above. (Ghatak and Mookherjee (2025) discuss how market frictions such as financial frictions give rise to misallocation more extensively and readers are referred there for a more detailed discussion.) In our framework, in the interest of simplicity, we have modeled only one contracting friction, a credit limit, but the conceptual points we make apply to other types of contracting frictions as well. Financial frictions are the type of contracting friction for which the literature is most developed and we start with these in Subsection 5.1. We discuss "agency" frictions within organizations in Subsection 5.2. In Subsections 5.3-5.5, we then turn to other mechanisms that influence the strength of wedges due to contracting frictions: courts, relational contracts, and property rights.

5.1 Financial Frictions

In our theoretical framework, we model a financial constraint as the limit $CL(k_{it-1}, a_{it-1})$ on the amount that a firm can borrow to finance capital and upgrading investments. This limit rises with the firm's capital stock and the entrepreneur's level of assets — a simple way to capture a collateral constraint. The Lagrange multiplier ζ_{it} corresponding to this constraint constitutes a wedge in the expression for capital distortions in Equation (17). There are two primary channels through which the credit limit impacts the efficiency of capital accumulation. First, a binding credit constraint today ($\zeta_{it} > 0$) translates to an effectively higher price of investment, pushing up the MRPK by a factor of $1 + \zeta_{it}$ today and lowering capital investment. Second, a future binding credit constraint ($\zeta_{it+1} > 0$) incentivizes the firm to accumulate capital beyond its productive return in order to ease its future constraints, as captured by the last term in Equation (15).

How do we expect this wedge to impact different firms across the size distribution? On one hand, the credit constraint may be more binding for smaller firms as they may have lower levels of collateral. In this case, we would expect the wedge ζ_{it} to be higher for smaller firms.[31] On the other hand, larger firms may have more need for finance, e.g., because they use more capital-intensive technologies or procure their inputs from (or sell to) more distant markets.[32] In this case, we may expect the wedge ζ_{it} to be higher for larger firms. Theoretically, it is not a priori clear which of these channels will dominate. Hsieh and Olken (2014) document that average returns to capital, calculated as the ratio of value-added to capital stock at the firm level, increase with firm size in India and Mexico. Interpreted through the indirect approach, this might lead us to infer that financial constraints are more binding for larger firms. However, as we have already seen in our theory, such cross-sectional variation may stem from many causes beyond financial-friction wedges, e.g., differences in technology or capital-adjustment costs. To shed more light on the underlying mechanisms, we turn to the micro-empirical literature.

One approach to uncovering evidence for financial frictions is to experimentally manipulate the capital stock of firms. This approach has only been implemented among microenterprises, given the challenges in carrying out such interventions among larger firms. In an important contribution, De Mel et al. (2008) randomly allocated capital, either cash or in-kind, to Sri Lankan micro-enterprises. In a regression with profits on the left-hand side, instrumenting capital stock with the randomized capital drops, the authors estimate a marginal return to capital of about 60% per year on average in their sample, well above going market interest rates of 12-18% per year, suggesting that entrepreneurs had limited access to formal credit. The authors also find significant variance in returns; notably, female entrepreneurs had returns that were statistically indistinguishable from zero, a result further explored in De Mel et al. (2009)

[31] Lumpiness in required capital investments could also disfavor small firms (if for instance the machines available for a given task have a capacity greater than needed by small firms). At the same time, there is evidence that small firms are able to share capital to work around such constraints (Bassi et al., 2022).

[32] Differences in employment of modern technologies and the scale of operations may also play a role in shaping needs for external financing (Buera et al., 2011; Midrigan and Xu, 2014).

and corroborated in Uganda by Fiala (2018).

Heterogeneity in the returns to capital has been a salient finding in the broader literature on small firms. In the microfinance literature, a robust finding is that microcredit has positive impacts for better or more experienced entrepreneurs (e.g., those with pre-existing businesses) but often zero or even negative effects on those with less ability or experience (Banerjee et al., 2019; Crépon et al., 2024; Meager, 2022). In our framework, such an effect could emerge for instance because of a covariance between the financial constraints ζ_{it} and entrepreneurial ability θ_i. There is a small literature using new sources of information to identify entrepreneurs who are likely to have high returns. Bryan et al. (2024) show that machine-learning methods applied to psychometric test scores can predict success in using microfinance in Egypt. Hussam et al. (2022) show that communities in Maharashtra, India, possess useful information about who is likely to be successful as an entrepreneur. McKenzie (2017) finds that a business-plan competition in Nigeria was successful in identifying entrepreneurs whose businesses grew upon receiving cash grants. Notably, this study finds similar effects for slightly larger firms (i.e. among existing firms, which had pre-program employment of 7-8 workers on average) as for microenterprises, suggesting that firms of this size were also credit-constrained. Among smallholder farm households in Mali, Beaman et al. (2023) find heterogeneity in returns that is correlated with engagement in credit markets: capital infusions (implemented via cash grants) had positive effects on average on land under cultivation, fertilizer use, and overall input expenditures for the overall population, but zero effects among households that declined to apply for a previously offered loan.

The literature on returns to capital among larger firms is less developed. Given the difficulties of directly manipulating the capital stock of larger firms, the inferences in this stream of literature are necessarily more indirect. Banerjee and Duflo (2014) exploit changes in the definition of "priority sector" in India — to which banks were required to target 40% of their loan portfolios — as a source of exogenous variation in the supply of credit. Conceptually, they argue that non-credit-constrained firms will simply substitute subsidized credit for market credit, without changing output, until the market credit has been fully replaced. Empirically, when the priority-sector size cutoff was increased, the newly eligible firms not only accepted more credit but also expanded sales, even if they still had market credit, suggesting they were previously credit-constrained. The authors estimate very high returns to capital acquired through loans, on the order of 89% per year after interest. Finlay (2025) finds that the effects of the priority-sector expansion are driven by exporting firms (which are larger) rather than purely domestically oriented firms. Although primarily focused on the issue of strategic default, Blouin and Macchiavello (2019) also provide evidence on credit constraints among larger firms — in this case, coffee mills in 24 countries. Using confidential records from a large lender and a regression-discontinuity design based on credit scores, the authors find that mills that exogenously received a larger loan tend to expanded input purchases and sales without fully substituting for other loans.

In related work, Bau and Matray (2023) study the heterogeneous effects of a liberalization of foreign investment rules in India. In response to the staggered relaxation of limits on foreign ownership across sectors over the 2000s, firms with initially high average product of capital (which under Cobb-Douglas production functions coincides with the marginal product of capital) saw increases in revenues, capital stock, and wage bills, and reductions in average returns to capital. This evidence is consistent with the hypothesis that higher-MRPK firms, which tended to be larger in employment terms,[33] were initially more financially constrained.

Financial constraints may manifest themselves not only in heterogeneity in borrowing constraints, but also in differences in interest rates across firms. It has long been recognized in the development literature that interest rates vary greatly across

[33]Source: personal communication with the authors.

borrowers and that richer people tend to pay lower interest rates (Banerjee, 2003; Banerjee and Duflo, 2005, 2010). Using credit-registry information from Brazil, Cavalcanti et al. (2024) show both that dispersion in interest rates (or in spreads between interest rates and deposit rates) is high and that smaller and younger firms pay higher rates, even controlling for default risk and other loan characteristics.[34] Although the possibilities of market imperfections and greater servicing costs for smaller borrowers mean that we cannot map the higher observed interest rates directly to MRPKs, we view the fact that smaller firms are willing to pay higher interest rates as suggestive that they are more credit-constrained (and have higher marginal returns) than larger firms in the Brazilian context.

Considering the literature on heterogeneity in the returns to capital overall, we find it difficult to draw strong conclusions about whether large firms or small firms are more constrained. The literature remains thin and, as we have discussed, the evidence is mixed. There is a clear need for more research to estimate MRPKs and how they vary across firms, especially among larger firms.

Beyond the question of how marginal returns to capital vary across firms of different sizes, an important question that arises in this context is how financial frictions interact with other wedges.[35] One important interaction is with entrepreneurs' entry decisions. Midrigan and Xu (2014) argue that the detrimental welfare effects of financial frictions are much stronger along this margin, since misallocations of capital among incumbent firms tend to be corrected over time as high-return firms accumulate capital. (See also Moll (2014).) One possible reason is because, as the last term of Equation (15) shows, constrained firms have an additional incentive to accumulate capital, since they internalize the effects of their future capital constraints. Potential entrants, in contrast,

[34] In related work using U.S. credit registry data, Faria-e-Castro et al. (2025) develop a methodology for calculating firm-specific costs of capital and also find significant heterogeneity across firms, although the implied misallocation is much smaller than Cavalcanti et al. (2024) find in Brazil.

[35] As noted above, the idea that financial frictions may interact with size-dependent frictions is present in Ghatak and Mookherjee (2025) and Kehrig and Vincent (forthcoming); see also Qian and Vereshchagina (2024).

may not be able to generate sufficient income if employed in a low-wage labor market, preventing them from entry. In our theory, this effect emerges, for instance, if entrepreneurs, in addition to supplying their own labor, also need to hire workers $\ell_{Z,it}$ in the period before entry. In this case, Equation (20) shows that the financial-constraint wedge, ζ_{it}, could be particularly strong due to the fact that entrepreneurs have no accumulated capital in the current period ($k_{it-1} = 0$ and therefore lower CL_{it}). With the same reasoning, the wedge might be weaker for richer individuals (higher a_{it-1} and therefore higher CL_{it}), even if these individuals have lower entrepreneurial ability θ_i. A couple of recent micro-empirical studies have found the entry margin to be important. Bazzi et al. (2024) study a Brazilian program that extended credit access to firms (particularly small- and medium-size) and find effects on entry of more-productive firms that grow more and survive over longer horizons. Fonseca and Matray (2024) show that a program expanding access to banking across Brazilian localities with initially low bank access led to a rise in entrepreneurial activity.

Financial constraints also potentially interact with market power. A recent study by Li et al. (2025) in the US context finds that two wedges corresponding to a financial constraint and product market power vary in opposite directions across firms (partly explained by the fact that the former decreases and the latter increases in size). Crucially, the interaction between the two wedges implies that the overall capital distortions are substantially lower than what we may expect by considering each in isolation.

A promising approach to studying interactions of financial constraints with other wedges has recently been laid out by David and Venkateswaran (2019), who study the drivers of capital misallocation in a calibration exercise in Chinese firm-level data, using a model that accounts for multiple wedges such as adjustment costs and information frictions, as well as additional residual output and capital wedges. They conclude that a residual, size-dependent wedge (accounting for the combined effect of financial constraints, taxes, and regulations) makes the largest contribution to capital misallocation in China.[36] Although this paper primarily takes a more "macro," indirect approach, it is notable for the way it considers multiple wedges simultaneously and carefully calibrates the model to several different micro-level moments from Chinese manufacturing firms.

5.2 Organizational Frictions

Principal-agent relationships within firms involve moral hazard problems similar to those that may lead lenders to require the posting of collateral, and may constrain the size of firms or increase costs in a similar way. Although in the interest of keeping the model as simple as possible, we have not modeled such frictions explicitly, they can be thought of as analogous to financial frictions in our model. They would impose additional incentive or participation constraints on the equilibrium allocations, with corresponding Lagrange multipliers that generate wedges similar to that of the Lagrange multiplier of the collateral constraint, ζ_{it}. As a result, such frictions would generally have similar implications for misallocation. A key question for our purposes is whether these agency issues within firms are more severe for larger or smaller firms. We begin by considering direct estimates of MRPLs and how wages vary across firms for similar workers and then turn to recent evidence on agency issues.

There is a small literature that has sought to estimate MRPL directly using randomly generated variation in the amount of labor used by firms. In Sri Lankan microenterprises, De Mel et al. (2019) randomly provided a short-term (8-month) wage subsidy to firms with two or fewer workers and find a significant short-term impact on employment that dissipated in the longer term. Using the subsidy as an instrument for labor usage, they estimate a modest MRPL that was smaller than the wage that the firm

[36] David et al. (2021) find similar results in an extension of this analysis across several developed and developing countries.

would have needed to be pay in the absence of the subsidy.[37] In contrast, among small Ghanaian firms in which apprentices typically pay an entrance fee for jobs, Hardy and McCasland (2023) find that a randomized government program that provided recruitment services to firms generated significant positive effects on both employment and profits, suggesting an average MRPL of more than double the average apprentice wage. The experimental approach to estimating MRPLs seems promising, but to date there has been little direct evidence of heterogeneity in MPRLs by firm size[38] and, as for capital, it may be prohibitively expensive to conduct such experiments among larger firms. In Section 4.3 above, we discussed some recent attempts to estimate MRPLs more indirectly; more research is needed to reconcile those indirect methods with the more direct methods discussed in the previous paragraph, and more generally to characterize MRPLs across entire firm-size distributions.

Just as interest rates have been observed to vary across firms, there is extensive evidence that wages vary systematically across firms for similar workers. Following Abowd et al. (1999), many papers have estimated models with both firm and worker fixed effects and have generally found that the firm effects explain a substantial share of wage variation; Card et al. (2018) and Kline (2024) provide reviews. For the middle-income countries where it has been possible to estimate such models (e.g., Mexico, Brazil, South Africa, China) the dispersion in firm effects has generally been found to be larger than in rich countries (Alvarez et al., 2018; Bassier, 2023; Engbom and Moser, 2022; Frías et al., 2024; Gerard et al., 2021; Guo et al., 2025). The firm effects have typically been found to be positively correlated with firm size, in both developing and developed countries (Alvarez et al., 2018; Bloom et al., 2018; Card et al., 2013; Frías et al., 2024). Caution is warranted in interpreting these patterns, since many mechanisms can

[37] The authors note that the low MRPL on average may have been due to a financial wedge that prevented firms from accumulating capital to combine with labor.

[38] De Mel et al. (2019) look at how the MRPL varies by capital stock of firms, within their sample of small firms, but do not find significant heterogeneity.

lead to a divergence of wages and MRPLs, but we view them as suggestive that MRPLs may not be equalized across firms and may be higher among larger firms.

One piece of evidence that agency issues within firms generate potentially important wedges comes from the prevalence of family firms. Family-run firms are a pervasive phenomenon in developing countries and family business groups are a common source of financing for individual firms (Bertrand and Schoar, 2006; Khanna and Yafeh, 2007). The prevalence of family control may seem surprising in light of a growing literature showing that inherited family control is associated with weaker performance (Bertrand et al., 2008; Pérez-González, 2006) and lower scores on the World Management Survey of management practices (Bandiera et al., 2017; Bloom and Van Reenen, 2007, 2010).[39] If family control is associated with worse firm performance, why is it so prevalent in developing countries? One possible answer is that firm owners value working with, or being able to offer employment to, their family members (Burkart et al., 2003; Kotia, 2025; Swanson, 2025). While certainly plausible, this explanation begs the question of why family control is especially prevalent in developing countries. It seems likely that at least part of the explanation is difficulties in contracting with professional managers in weaker institutional environments: owners commonly use family members to manage the firm as a means to guard against manager malfeasance (Bertrand and Schoar, 2006).

Such contracting difficulties can be understood as increasing the costs of delegation and exacerbating span-of-control issues that may constrain firm size. One suggestive piece of evidence is provided by Ilias (2006): in the surgical-goods industry in Sialkot, Pakistan, the size of firms is strongly positively correlated with the number of brothers of the firm founder. An alternative, more structural approach is taken by Akcigit et al. (2021), who embed delegation costs in a model of firm dynamics and fit the model to

[39] A particularly well-identified study by Bennedsen et al. (2007) uses the gender of a departing CEO's first-born child as an instrument for whether control was retained within the family and finds a large negative effect of family succession on firm profitability in Denmark. Lemos and Scur (2019) find corroborating evidence from 13 countries.

various moments, including results from a management-consulting experiment by Bloom et al. (2013); their estimates suggest that the efficiency of delegation is significantly lower in India than in the U.S. The costs of delegation and the limits on the availability of family members to manage firms could be thought of as simply a source of decreasing returns to scale at the firm level, but a distinctive feature of family control is that the long-run effects may differ from the short-run effects on firms. While reliance on family members may be an effective way to solve agency problems in the short term, the practice may prove costly in the long run. The use of family members as managers may lead to pressures to keep the firm under family control once the founder steps down, with the negative effects on performance mentioned above. In this sense, the prevalence of family firms may help to explain the observation of Hsieh and Klenow (2014) that firms appear to grow less as they get older in India and Mexico than in the U.S. The downside of family control may reveal itself only as firms get older and founders retire.

A small but growing literature has used experiments to examine agency issues within firms. Atkin et al. (2017b) randomly allocated a surplus-enhancing, waste-reducing technology among Pakistani soccer-ball producers and find that a misalignment of incentives under the existing pay scheme limited adoption. Kelley et al. (2024) randomly allocated GPS trackers on Kenyan minibuses and find effects in line with what one would expect in classic labor-discipline models (e.g., Shapiro and Stiglitz (1984)): vehicle owners modified contract terms to induce higher effort and less risky driving from their drivers.[40] Houeix (2025) examines adoption of digital payment systems among taxicabs in Dakar, Senegal, and finds (echoing Atkin et al. (2017b)) that a conflict of interest within the firm constrained adoption: drivers were less willing to adopt if the platform shared information on their revenues with vehicle owners. In a Chinese auto

[40]See also De Rochambeau (2021), who randomly allocated GPS trackers on long-distance trucks in Liberia, and also finds that driver effort increased, but additionally finds that owners were reluctant to impose the more stringent monitoring on drivers with whom they had the closest social relationships.

firm, Cai et al. (2025) conducted two experiments, one offering a signing bonus and another increasing monitoring. They find that, in line with gift-exchange theories (Akerlof, 1982, 1984), the signing bonuses increased work hours, and, in line with labor-discipline theories, the increased monitoring improved performance but also increased the quit rate.

Taking stock of the literature on organizational frictions overall, our reading is that there is now reasonably strong evidence that agency issues matter for firm decisions, but there is limited evidence to date on the heterogeneity in organizational frictions across firms, and hence it is too early to draw strong conclusions about how such frictions influence misallocation. More research on such heterogeneity is needed.

5.3 Courts

The sorts of contracting frictions we have highlighted above are present in developed countries as well, but they are widely perceived to be more severe — and hence to be more likely to generate misallocation — in developing countries. The most common explanation for this is weakness of legal institutions, especially courts. There is a growing body of well-identified evidence that performance of courts indeed matters for firm outcomes and the strength of wedges brought about by contractual frictions.

A key aspect of court performance is how long it takes to get contractual disputes resolved. Since the extent of court delays is often correlated with other determinants of firm outcomes, researchers have had to be creative in finding sources of exogenous variation in delays. Ponticelli and Alencar (2016) exploit features of Brazilian geography and rules about how large a municipality needs to be before a court is created in it. The number of municipalities nearby without their own courts can then be used as an instrument for court congestion in existing courts. Using this strategy, the authors find that areas with less-congested courts experienced a greater increase in the use of secured loans, in investment, and in output in response to a reform of Brazilian bankruptcy law (which required well-functioning courts to be effective). Visaria (2009) focuses on the roll-out in India of a new type of court designed to reduce delays for bankruptcies. Using loan records from a large private bank, she finds that in areas where the new tribunals were established borrowers were less likely to be delinquent in paying back loans and interest rates subsequently declined, suggesting that the new courts improved the functioning of financial markets.

When courts perform poorly, because of delays, ineffective enforcement, or other issues, firms need to find alternative ways to mitigate contracting frictions (Johnson et al., 2002). One way that they may do so is by integrating vertically. Boehm and Oberfield (2020) examine the idea that input transactions requiring relationship-specific investment are vulnerable to hold-up and particularly reliant on the quality of courts. They use the age of Indian states' High Courts, which depend in part on when the states were created, as an instrument for the courts' backlogs of cases and show that firms in industries that rely more on relationship-specific inputs are more likely to bring the processing of inputs inside the firm in states with higher backlogs. The authors also develop and estimate a model of vertical integration decisions and use it to analyze counterfactual reductions in court congestion. A valuable feature of their framework is that it accommodates heterogeneity across firms (because of productivity draws) and across input suppliers within firms (because of random supplier-firm-specific match terms) as well as across states with courts of different quality.

5.4 Relational Contracts and Networks

When court enforcement is weak or non-existent, firms often seek to work around contracting problems through relational contracts — informal arrangements in repeated interactions sustained by the threat of future non-cooperation (Baker et al., 2002; MacLeod and Malcomson, 1989). The literature on relational contracts is growing fast and has recently been reviewed by Macchiavello (2022), Boudreau et al. (2023), and

Macchiavello and Morjaria (2023); here we focus on a few key contributions that are especially relevant to our themes. The early studies by McMillan and Woodruff (1999) and Banerjee and Duflo (2000) present some of the first evidence, based on tailored surveys, on relational contracts among firms in developing countries. Among Vietnamese firms, McMillan and Woodruff (1999) show that suppliers are more likely to "trust" a buyer, in the sense of extending trade credit (allowing the buyer to delay payment), if the buyer has fewer options for switching suppliers and evading future sanctions for non-payment. Among Indian software firms, Banerjee and Duflo (2000) show that characteristics that are plausibly associated with having a good reputation — in particular, having ISO 9001 certification, having previously done business with a foreign client, and having an older founding date — are correlated with the contract terms that foreign clients offer the firms. In particular, Indian firms with these characteristics are more likely to be offered time-and-materials contracts, in which the foreign client pays for overruns, as opposed to fixed-price contracts, in which the firm is responsible for overruns.

While these early studies are correlational, more recent work has made progress in using exogenous variation to shed light on the factors that shape relational contracts. In the international coffee market, Blouin and Macchiavello (2019) note that some contracts are indexed to the international spot-market price and some are not and find that firms were especially likely to default on the non-indexed contracts when the spot price rose; about half of observed defaults were strategic by their estimates. In related work in the Kenyan cut flower industry, which experienced a major supply disruption due to ethnic violence in early 2008, Macchiavello and Morjaria (2015) find an inverted-U relationship between relationship age and rose producers' compliance with agreements to provide flowers during the violence. This finding is consistent with a model in which the value of a relationship increases with age, but once a relationship is sufficiently mature and a producers' reputations are sufficiently well established, the reputational damage from non-compliance may be limited. Among Senegalese garment firms, Wiles and Houeix (2025) randomly allocated Whatsapp contacts with suppliers in Turkiye as well as other interventions that manipulated the level of "trust" with suppliers.[41] They find that the initial contacts led to increased transactions (suggesting that search frictions were important) and also that the trust treatments increased the likelihood of established longer-term relationships (suggesting that contracting frictions were also important).

Datasets from value-added-tax systems with firm-to-firm transaction information are increasingly available and are opening up new research possibilities in this area. One promising effort in this direction is by Brugues (2025), who develops a dynamic model of the evolution of firm-to-firm relationships in a setting of limited enforcement and seller market power and estimates it in firm-to-firm transaction records from Ecuador. The key insight, borne out empirically, is that in order to incentivize compliance with a relational contract much of the surplus is backloaded and both quantities and values transacted grow over time within a relationship (in the spirit of previous work by, for instance, Rauch and Watson (2003)).

Apart from repeated interactions within a relationship, another way that firms seek to mitigate contracting frictions, highlighted by McMillan and Woodruff (1999) and others, is by relying on networks to help sanction counterparties if they default. The repetition of interactions can occur at the community level rather than between individual firms. Perhaps the best-documented example of network effects both mitigating contracting problems and generating misallocation is from Banerjee and Munshi (2004)'s study of the garment sector of Tirupur, India. The authors show that firms led by Gounders, the dominant caste group in the industry, started with more capital and continued to have more capital at all levels of experience, even though firms

[41] In particular, one intervention put firms in a Whatsapp group with other firms connected to the same suppliers and another intervention let firms know that their ratings of suppliers will be used to sanction the suppliers.

led by non-Gounders grew more quickly in terms of output, overtaking Gounder firms by 5 years after founding, suggesting that they had higher entrepreneurial ability. The Gounder network appears to have helped members overcome credit constraints, but with the consequence that capital was allocated to less productive entrepreneurs. Munshi (2014) provides a review of evidence showing that such network effects are widespread in developing countries and that while communities can help solve contracting problems they are often accompanied by economic costs from excluding non-members.

5.5 Property Rights

Reallocation of property rights is another mechanism through which contracting frictions can be mitigated. In principal-agent frameworks, making the agent (the party taking a non-contractible action) the residual claimant will generally lead to more efficient outcomes. But there may be barriers to such reallocations. In this subsection, we briefly review studies that speak to these issues, most of which are from the agricultural sector.

Under sharecropping contracts, tenant farmers are less-than-full residual claimants on their land's output, thereby diminishing their optimal investment. In the context of our model, a sharecropping rule in which tenant i retains $(1 - \pi_{it})$ of her land's revenue would be equivalent to an effective tax, π_{it}, on the output of the production unit. Banerjee et al. (2002) develop a model that endogenizes π_{it} and highlights an interaction with credit constraints. A fixed-rent contract, which would resolve the contracting friction, is unavailable to poorer farmers, as the fixed rental rate is bounded above by their baseline wealth in the event of crop failure, making the contract unappealing to the landlord. This provides a theoretical explanation for why poorer farmers (who tend to have smaller farms) may face weakened incentives for investment. Applying this theory to a natural experiment that increased tenant land security among sharecroppers in West Bengal, India, Banerjee et al. (2002) find that the strengthening of property rights increased agricultural productivity. A randomized control trail (RCT) that randomly increased the share of output retained by sharecroppers in Uganda finds similar gains: tenants responded by increasing investment in inputs, driving up output (Burchardi et al., 2019).[42]

Another mechanism through which limited property rights may drive misallocation is the inability to transfer assets to those with the greatest productive use. This source of misallocation has been the subject of extensive study in the indirect-approach literature, to which we do not attempt to do justice here. Gollin and Udry (2021) present a helpful summary of this literature, as well as a critique, noting that measurement error and unobserved land heterogeneity can generate what appears to be large misallocation. They present a theoretical framework for separating these features from genuine misallocation using plot-level data from Tanzania and Uganda. The key insight is that misallocation should not occur across plots managed by the same farmer in the same season; within-farmer-season variation across plots is therefore informative about mismeasurement and unobserved heterogeneity. They show that adjusting for these features reduces the variance of estimated productivity by as much as 70%.[43]

Several studies have combined model-based approaches with direct measurement of distortions. For example, Adamopoulos and Restuccia (2014) use the gap between farm-gate prices and international prices (after controlling for transportation costs) as proxies for farm-size distortions in 17 countries, finding that poorer countries tax crops that are produced at a larger scale at higher rates. Embedding these size-dependent distortions in a Lucas (1978) span-of-control model with farmers of heterogeneous productivity, they estimate that farm-size distortions drive about half of the differences

[42] Quantile treatment effect regressions suggest that the impacts on output were concentrated at the top of the size distribution, although Burchardi et al. (2019) interpret this as a return to risk-averse farmers switching into riskier crops.

[43] Subsequent indirect approaches have incorporated similar household-fixed-effects methods. For example, Chen et al. (2023) use rich panel data in Malawi, also including data on land quality and weather data, to address unobserved heterogeneity.

in agricultural productivity across rich and poor countries.[44]

A recent set of papers uses natural or randomized experiments to estimate the role of such frictions. Chari et al. (2021) show that a natural experiment in China that allowed farmers to rent out their land led to a reallocation of land from less to more productive farmers, increasing aggregate productivity by 10%.[45] In a novel experiment, Acampora et al. (2025) subsidized randomly selected Kenyan landowners to rent out their land. Landowners with relatively high land-to-household-size were more likely to take up the offer, perhaps because they were more labor constrained, while renters were on average younger, more educated, and better financially resourced farmers, who may have been more productive than the landowner (although most were from a small circle of his relatives or acquaintances). Consistent with this, they find that estimated TFP and harvest values increased on the land rented out. However, the increase in revenue observed in the experiment was substantially less than the gains a standard indirect approach would suggest under a full reallocation. This is partially because the induced rentals were not those with the largest predicted gains, based on the baseline estimated productivity of the owners and renters. The results point to the need to be attentive not just to the distribution of gains from removing misallocation, but also to the distribution of frictions, such as those arising from search and learning.[46]

6 Upgrading

We now turn to a consideration of wedges related to firms' investments in upgrading. In our model, such investments are modeled as investments of labor, $\ell_{Z,it}$, that a firm

[44]In related work, Adamopoulos and Restuccia (2020) and Chen et al. (2023) exploit changes in land-market institutions and find that they can have substantial effects on agricultural productivity.

[45]The authors benchmark this against a standard indirect approach, which they use to estimate the gains that might emerge in their setting from *full* reallocation — distinct from the partial reallocation induced by the policy they study — and find that the efficiency gains would be 73%.

[46]This is echoed by Bryan et al. (2024), who use lab-in-the-field games in Uganda and Kenya to demonstrate that risk and coordination frictions limited potentially productive land trades. Their results suggest that improved contract enforcement and mechanisms for search and coordination can facilitate trade that improves allocative efficiency.

dedicates to increasing its future productivity. Productivity next period, z_{it+1}, depends on own productivity this period, z_{it}, an index of the aggregate stock of knowledge this period, $\bar{z}_t$ — a simple way of capturing spillovers — and an individual's entrepreneurial ability and entrepreneurial labor, captured in $e_{it} = \theta_i \ell_{E,it}$. As we saw in Sections 2.2.1.3 and 2.2.2.2, there is a close parallel between upgrading and capital investments in that they involve similar dynamic considerations. The returns on these investments unfold over several periods and, due to likely cross-firm heterogeneity in the continuation values of the investments, the efficient marginal revenue products of these investments may vary across firms. In particular, Equation (8) shows that the optimal marginal revenue product of upgrading investments is lower for those firms whose upgrading investments generate larger continuation values beyond the next period, either for themselves or in the knowledge spillovers they generate for others. Put another way, the social planner would have such firms invest more in upgrading than would be the case under the equalization of the MRPs of upgrading investments. Since firms do not internalize knowledge spillovers in the market equilibrium, the market-equilibrium MRPs of upgrading will in general differ from those of the social planner. Moreover, the wedges in upgrading may interact with the other wedges we have considered — including market power, financial frictions, and tax wedges — to further contribute to distortions.

In reviewing the empirical literature that sheds light on these issues, we organize our discussion in four subsections. In Subsection 6.1, we consider studies that focus on directly observable investments in productivity, in particular R&D spending and expenditures on management consulting and training. We also note that standard measures of productivity have various shortcomings, especially in the context of upgrading in developing counties. This motivates us to consider, in Subsection 6.2, other dimensions of upgrading, in particular quality improvements, product innovation, and technology adoption. In Subsection 6.3, we consider recent work on spillovers and how they may shape marginal returns to upgrading investments. Finally, in Subsection 6.4 we briefly consider studies that have examined interactions of wedges from upgrading investments and other types of wedges.

6.1 Investments in Productivity

The available research from developing countries suggests that larger firms tend to do more R&D than smaller firms within the same industry. This positive correlation holds for instance in China (König et al., 2022; Wei et al., 2017) and several Latin American countries (Paus and Robinson, 2022). One view about why smaller firms engage less in R&D is because they are more credit constrained (see e.g., Guariglia et al. (2011)); this points to a possible interaction of upgrading investments with the financial frictions highlighted in Section 5 above. Another view is that R&D can be viewed as a fixed (and subsequently sunk) cost, which larger firms can spread over more units and hence have a stronger incentive to pay (Cohen and Klepper, 1996; Sutton, 1991). Both views seem likely to be part of the explanation.

The fact that size and R&D intensity are positively correlated is consistent with the idea that higher current productivity z_{it} tends to raise the payoff to investments in productivity improvements, other things equal, but this correlation does not necessarily imply a similar correlation between size and the marginal return to upgrading investments in equilibrium. Evidence on how the returns to R&D vary with firm size in developing countries is thin. In an influential contribution, Aw et al. (2011) estimate a structural model of R&D and exporting decisions by Taiwanese firms and infer that the net benefits of R&D investment are increasing in firm productivity.[47] Another noteworthy piece of evidence is provided by Wei et al. (2017), who find a negative relationship between number of patents per million yuan of R&D investment and decile

[47] In related work, König et al. (2022) model firms' decisions to innovate or to imitate other firms, in a setting in which "innovation wedges" make the returns to such investment heterogeneous, similar to how wedges influence upgrading investments in our framework.

of firm sales in China; they suggest that this may be because larger firms tend to invest more in R&D and there are diminishing returns to R&D. de Souza and Garber (2025) estimate the impact of R&D subsidies in Brazil using a regression-discontinuity design based on a cutoff in eligibility scores. They find impacts on firm output and product innovation; the effects are greater for firms initially facing higher interest rates (which tend to be smaller (Cavalcanti et al., 2024)), pointing to a possible interaction between upgrading investments and credit constraints. There is a small literature examining the effects of tax changes on R&D expenditures and patenting behavior, including studies in China (Cai et al., 2018), India (Ivus et al., 2021), and Argentina (Crespi et al., 2016), with somewhat mixed results. Overall, we feel that it is difficult to draw conclusions about the returns to R&D and how they differ across the firm size distribution in developing countries from the currently somewhat underdeveloped literature.

While R&D spending has the advantage that it can be directly observed and is clearly aimed at improving productivity (and hence in principle corresponds to the upgrading investments $\ell_{Z,it}$ in our model), it also has shortcomings. In developing-country settings, firms mainly aim to catch up to the world frontier, rather than push it forward, and much of the investment that firms make in learning is not classified as R&D. Moreover, R&D expenditures may be subject to misreporting. Studying a Chinese program that offered lower corporate tax rates to firms that reported R&D expenditures above a given cutoff, Chen et al. (2021) find that firms "bunched" at levels of R&D expenditures just above the cutoff. When the schedule of corporate tax rates changed, the location of bunching also changed, which the authors suggest was partly due to strategic mislabeling of other expenses as R&D (as evidenced by drops in non-R&D spending at the tax cutoffs); they estimate that about 24% of R&D expenditures were misreported. The authors argue that it is still possible to estimate the productivity impact of true R&D in their setting; estimating a model with strategic mislabeling, subject to a mislabeling cost, they find that doubling true R&D spending would increase productivity by about 9%, a magnitude that is consistent with rates of return to R&D found in developed countries (Hall et al., 2010). But in our view, the finding of extensive strategic misreporting, coupled with the fact that R&D spending often does not capture investments aiming at catch-up, means that analyses using R&D expenditures in developing-country contexts need to be interpreted with caution. A related concern can be raised about studies that focus on patents as an outcome. Patents are a staple of the empirical literature on innovation in developed countries (see e.g., the review by Bryan and Williams (2021)), but in contexts where firms mainly seek to catch up to the world frontier, patents are less useful as a measure of upgrading.

Although they may not describe themselves as estimating the impact of upgrading investments or as speaking to the misallocation debate, a number of recent experiments among firms can be interpreted as shedding light on the returns to such investments. Spending on management consultants, for instance, can be considered an investment in upgrading and has been experimentally manipulated in several recent studies. In an influential experiment among Indian textile firms, Bloom et al. (2013) randomized consulting services from an international consulting firm and find significant effects on management practices, defect rates, output, and profits. A follow-up study to examine long-term effects finds that many of the effects persisted: treated firms had higher labor productivity, were more likely to export, and retained more of the recommended management practices than control firms eight years later (Bloom et al., 2020). These long-term results underline the importance of considering the dynamic effect of upgrading investments, as we do in our framework (captured in the continuation values of such investments, in Equation (9)). In an experiment in Colombian auto parts firms, Iacovone et al. (2022) compare the effects of one-on-one consulting (which is expensive) and group consulting, and find impacts of similar magnitudes, which points to the cost-effectiveness of group consulting. In this setting also, the positive effects persisted over many years (Iacovone et al., 2025), pointing again to the importance of dynamic considerations. Another influential study by Bruhn et al. (2018) finds that consulting services had persistent positive effects on the performance of small and medium enterprises in Mexico. Although the results in the literature on entrepreneurial training (as opposed to consulting), reviewed by McKenzie and Woodruff (2014) and McKenzie (2021), are somewhat mixed, there is growing evidence that tailored, "high-touch" training can be effective.

While these studies of consulting and training can be interpreted as providing evidence of positive returns on average, there is less evidence on the extent of dispersion in these returns, and in particular how the returns vary with firm size. More evidence on this dispersion, and on the persistent effects of such investments, would be very valuable.[48]

6.2 Other Dimensions of Upgrading

TFP measures are widely used to measure firm performance but they also have important shortcomings. Revenue-based TFP measures may reflect markups and markdowns as well as technical efficiency (De Loecker and Goldberg, 2014). This has led many researchers to focus on quantity-based TFP (also known as TFPQ) when quantity information is available. But Katayama et al. (2009), De Roux et al. (2023) and others point out that when quality and variety vary at the firm level, TFPQ measures can be misleading. Verhoogen (2023) advocates for considering a broader set of outcomes to characterize the upgrading process — in particular, quality improvements, product innovation, and technology adoption — and here we briefly take up this suggestion. Investments that target these outcomes can be interpreted as similar to the investments in improving productivity that we model in our framework, with similar dynamic consequences. Investments in upgrading today are expected to pay off over a longer

[48]Given the dynamic nature of these investments, it will be important to study the returns over longer time horizons.

period than what is considered when calculating short-term returns. As above, we first consider cross-sectional variation between the upgrading outcomes and firm size and then briefly consider the small literature trying to estimate the returns to such investments and their dispersion.

There is now quite strong evidence that, within sectors, larger firms tend to produce higher-quality goods. One type of evidence is direct survey responses. For instance, Atkin et al. (2015) asked Pakistani soccer-ball producers directly about the quality of balls produced, and find that quality and marginal cost increase with firm size. Another source of evidence is quality ratings, available for some products such as wine. Crozet et al. (2012) find that French producers of higher-rated champagnes export more overall and export to more destinations than producers of lower-rated ones.[49] A third source of evidence is firm-product-level prices and quantities, from which indirect inferences about product quality can be drawn. In Colombian data, Kugler and Verhoogen (2012) show that larger plants charge higher output prices and pay higher input prices, and that these relationships are steeper in sectors with greater scope for quality differentiation (as proxied by R&D and advertising intensity, following Sutton (1998)); these patterns are consistent with a model in which larger firms produce higher-quality outputs using higher-quality inputs.[50] Perhaps the strongest evidence is from Faber and Fally (2022), who show in U.S. scanner data that the products of larger firms tend to be purchased by higher-income consumers, consistent with extensive evidence that richer consumers tend to be more willing to pay for product quality (see e.g., Gupta (2024)).[51] Conceptually, the correlation between firm size and product quality may arise from a complementarity between entrepreneurial ability and input quality in producing output quality or from a fixed cost of producing high quality, among other reasons

[49] See also the discussion of Chilean wine quality in Cusolito and Maloney (2018).

[50] Manova and Zhang (2012) present consistent patterns in Chinese trade data.

[51] Using a more theory-reliant approach to estimate production functions and demand simultaneously, Eslava et al. (2023) also find strong positive relationships between firm size, product quality, and markups.

(Kugler and Verhoogen, 2012). More research on the underlying mechanisms would be welcome, and the increasing availability of data linking consumers to firm-product-level data in developing countries (see, e.g., Atkin et al. (2025)) is expanding the analytical possibilities in this area.

The cross-sectional patterns for product innovation and technology adoption are similar to those for quality choices. For instance, in Indian data, Goldberg et al. (2010b) show that larger Indian firms tend to sell in more distinct product categories within sectors, and Braguinsky et al. (2021) document a similar pattern for Meiji-era Japan. Drawing on an extensive set of technology-adoption surveys conducted by the World Bank, Cirera et al. (forthcoming) document that larger establishments tend to use more advanced technologies, measured either as the highest-sophistication technology used in the firm or the technology most used within the establishment, controlling for business function. Bustos (2011) presents evidence that exporters in Argentina, which tend to be larger than non-exporters within sectors, spend more on technology per worker.

As in the case of R&D spending, the fact that quality, product variety, and technology adoption are positively correlated with firm size is consistent with the idea in our model that current productivity, z_i, tends to increase the return to investments in these other dimensions of upgrading, other things equal. But this fact does not imply that in equilibrium there is a positive correlation of the *returns* to such investments and firm size. The empirical literature aiming to estimate returns to upgrading is even thinner than the literature for R&D discussed above. At this point, the most that can be said is that several studies using quasi-experimental or experimental variation in the incentive to upgrade find evidence consistent with the idea that such upgrading investments have positive marginal returns. For instance, there is growing evidence that demand-side shocks to the incentive to export (generally to richer countries) are associated with improvements in output quality, input quality, and firm performance (Atkin et al., 2017a; Demir et al., 2024; Hansman et al., 2020; Verhoogen, 2008), as well as technology adoption (see, e.g., Bustos (2011)). Increases in the availability of imported inputs (or reductions in their costs) have also been found to increase output variety (Goldberg et al., 2010a) and output quality (Bas and Strauss-Kahn, 2015; Fan et al., 2015b). There is also evidence that greater competition from imports of final goods can lead developing-country firms to upgrade in order to escape competition (Amiti and Khandelwal, 2013; Fieler and Harrison, 2023; Medina, 2024), although such pro-upgrading effects of import competition may be limited to the most-productive firms (Cusolito et al., 2023). In data from Meiji-era Japan, Braguinsky et al. (2021) find that when the main industry association periodically limited the output of low-quality cloth by association members, firms experimented with higher-quality products; this appears to have induced learning and improved performance.

While these studies have yielded valuable insights about the drivers of upgrading at the firm level, they have not explicitly measured the returns to upgrading, nor do they present evidence on how these returns vary across the firm-size distribution within sectors. This question remains wide open for research and is key to evaluating the extent of misallocation in upgrading investments.

6.3 Spillovers

In our terminology, spillovers represent both a technological and a distortionary wedge. They represent a technological wedge in that they may lead the social planner not to equalize the private returns to upgrading investments across firms; instead, the social planner's allocation involves lower private returns for firms that generate more spillovers (more precisely, a greater expected net present continuation value of spillovers, $\overline{\Psi}^*_{Z,it}$ in Equation (10)). They represent a distortionary wedge in that, although they influence the social planner's optimal allocation, they are not taken into account by individual firms in the market equilibrium; the stronger are spillovers, the greater is the divergence between the optimal allocation and the market equilibrium and the larger the distortion.

Spillovers have long played a central role in economists' thinking about agglomeration and growth, going back at least to Marshall (1890). Learning spillovers among agricultural producers are the subject of a substantial body of work in development economics, reviewed by, for instance, Munshi (2007), Foster and Rosenzweig (2010), and Magruder (2018). Early experimental work estimating spillovers, including in other contexts, is reviewed by Duflo et al. (2008).

There is comparatively less empirical work on spillovers between firms in non-agricultural settings in developing countries, but two recent studies provide particularly clean evidence. Cai and Szeidl (2018) randomly assigned managers from 2,820 Chinese firms into groups that met monthly for one year and find large effects on firm revenues, profits and a management practices; they also seeded information about a government business grant and a private savings opportunity and find that managers were more likely to share information about the savings opportunity, which was less "rival" in the sense that other firms making use of it was less likely to reduce a firm's own payoff.[52] Rather than seeking to manipulate firms' networks, Chaurey et al. (2025) randomly allocated a relatively new technology — energy-efficient motors for stitching machines — among leather-goods producers in Bangladesh. Exploiting differences in exposure driven by the randomization, they find robust evidence of positive spillovers within very local geographic areas.

Overall, the evidence seems reasonably compelling that there are learning spillovers between firms, including among larger firms outside of agriculture. It is less clear how much the distortions that arise from such externalities contribute to misallocation. Empirically, this question is relatively unexplored. Brooks et al. (2024) provide a promising attempt to draw out the aggregate implications of learning between

[52] Fafchamps and Quinn (2018) and Brooks et al. (2018) also conducted experiments that created network links between more senior and less senior entrepreneurs, with some evidence of positive impacts on the performance of the firms of the less senior entrepreneurs.

entrepreneurs, building on a mentorship experiment in Kenya analyzed in Brooks et al. (2018). But much work in this broad direction remains to be done.

6.4 Interactions with Other Wedges

So far in this discussion of upgrading, we have focused on one wedge at a time. But as we have shown in our framework (see in particular Equation (22)), the distortion in upgrading investments is a complex interaction of wedges in such investments with distortions in labor markets, credit constraints, and output markets. In this subsection, we briefly consider some recent empirical studies that shed light on such interactions.

One type of interaction that appears to be important empirically is between wedges arising from upgrading investments and those arising from market power. In cross-section, within sectors, it has generally been found (and mentioned above) that larger firms, which produce higher-quality products, also charge higher markups (Atkin et al., 2015; Gupta, 2024). Given that the number of distinct products sold also tends to rise with firm size, similar correlations hold between numbers of products and markups. A question that remains open is whether these positive correlations are due to stable, long-term relationships, for instance because larger firms tend to sell to higher-income consumers who are less price-sensitive, or to shorter-term dynamics. Peters (2020) presents a dynamic model in which firms invest in innovation precisely in order to be able to charge high markups on their products until other firms catch up, and finds that the model plausibly matches patterns in Indonesian micro-data on firms, notably the fact that markups increase with firm age. The dynamic consequences of upgrading for markups is a potentially rich topic, well deserving of further micro-empirical study.

Another type of interaction that appears to be important is between credit constraints and upgrading investments. A common feature of the upgrading investments we consider is that they require up-front investments that pay off over time. As with capital investments, since the returns are not fully reflected in current cash flows, the presence of financial frictions may drive heterogeneity in firms' investments. Interactions of this type are stressed by Ghatak and Mookherjee (2025), who note that in the presence of such interactions, distortionary wedges may have positive consequences for aggregate welfare if they tend to counteract other distortionary wedges. There is a large literature in developed countries on financial constraints and corporate investments (see, e.g., Fazzari et al. (1988) and the subsequent literature) but there are relatively few papers in developing countries focused on upgrading investments in particular and the results have been somewhat mixed. One example is Fan et al. (2015a), who exploit variation in province-level credit availability in China to examine the effects of financial constraints on firms' quality choices. Another example is George et al. (2025), who examine the expansion of the priority sector for loans in India (discussed in the context of Banerjee and Duflo (2014) above) and find little impact on firms' product offerings, possibly because of other constraints faced by firms in the Indian context. More research on the interactions between financial constraints (and other types of contracting frictions) and upgrading investments in developing countries, and how the relationship may differ from the corresponding relationship in developed countries, would be valuable.

7 Search Costs

Search costs are often thought to be high in developing countries. On the output side, firms may lack knowledge of where prices are highest or where eager consumers await; on the input side, they may face costs to identifying and connecting with good suppliers or employees. Can these search costs generate dispersion in marginal revenue products of different factors? And is this dispersion a sign of misallocation?

In our theoretical framework, we have allowed the sets of potential consumers, $\mathcal{I}_{C,it}$, downstream firm buyers, $\mathcal{I}_{B,it}$, and workers, $\mathcal{I}_{H,it}$, to vary across firms. Firms can invest in expanding these sets, but doing so is costly: firms must visit new markets, pay for advertisements, or spend time getting referrals. We model these investments in search as investments of labor. We interpret these costs as real costs, which the social planner would also have to pay. In this sense, we interpret any differences in the marginal revenue products of capital, labor, and intermediates caused by segmentation in the sets $\mathcal{I}_{C,it}$, $\mathcal{I}_{B,it}$, and $\mathcal{I}_{H,it}$ as technological wedges. As we also saw in Section 2.2.2, these technological wedges may interact with distortionary wedges to amplify or ameliorate the effects of the latter. For instance, under oligopolistic market structures, more market segmentation (smaller buyer sets) may be associated with lower competition and higher market power.

The natural question that emerges is the efficiency of the allocation of investments that firms make in search to expand their sets of buyers and workers across firms. As we saw in Section 2.2.1.3, these investments have a dynamic nature and we can characterize them similarly to investments that firms make in upgrading their productivity. As with the latter, search may also be accompanied by market failures such as the lack of appropriability (where the social surplus from new economic relationships is not fully accrued by the searching firm) and business stealing (where the private return to the searching firm comes at the expense of other firms/individuals).

In this section, we review recent empirical evidence on search among firms in developing countries. First, we ask (in Subsection 7.1) how much heterogeneity has been observed in search decisions across firms cross-sectionally. Second, we examine (in Subsection 7.2) the evidence on the types of firms that are most affected by exogenous reductions in search costs. Lastly, we look (in Subsection 7.3) at the evidence on how market segmentation caused by barriers to search shape market power and other distortions.

7.1 Which Firms Search Most?

Why might search behavior differ by firm size? If many of the investments firms make to find a new market or trading partner (such as physically visiting the market, advertising, making phone calls, etc.) are fixed with respect to quantity sold, then larger firms will be more likely to search, as they are more willing to pay a given fixed cost in exchange for lower per-unit costs or higher per-unit output prices. In many models, this generates a threshold size (or productivity level) above which the firm will search (Allen, 2014; Bergquist et al., 2024; Jensen, 2007; Startz, 2024).

In our framework there are several other mechanisms that may lead to a "scale bias" in search behavior, including the fact that larger firms typically charge larger markups, which may make additional search more valuable (see Section 4), or that larger firms engage in greater upgrading, which increases their need to search for specialized suppliers or buyers (see Section 6). Of course, opposite forces are possible: for example, if small firms are typically owned by poorer individuals with lower opportunity costs of time, they may be more willing to pay the search costs in labor time. What does the empirical evidence show?

The early empirical work on search in developing countries, including seminal studies of the introduction of cell phones in India and Niger (Aker, 2010; Jensen, 2007), primarily used market-level data on prices to document that reductions in search costs reduced price dispersion. However, recent advances in firm-level data have shed light on search behavior by individual firms. For example, Startz (2024) uses transaction-level data from wholesale and retail importers in Nigeria to show that larger transactions are more likely to involve traveling to international source locations. Travel allows these importers to learn about new product varieties more quickly through in-person search (as well as paying 32% lower unit costs by making spot transactions that avoid a contract enforcement problem). Bergquist et al. (2024) document that wholesale traders in

Uganda often sell their goods across localities, whereas smallholder farmers sell almost exclusively within their local market. Similarly, Allen (2014) finds that larger farmers in the Philippines are more likely to sell in non-local destinations. The limited existing empirical evidence is consistent with the idea that larger firms are more willing to pay search costs, but more work here is needed.

7.2 Which Firms Benefit More from Policies to Reduce Search Costs?

We now turn to the empirical evidence on the effect of policies aimed at reducing search costs. Given that small firms appear to be less likely to search in the cross-section, one might assume that a reduction in search costs might benefit them most. However, this is not always the case.

In some contexts, the impacts of these policies are indeed greatest for smaller firms. For example, Allen (2014) finds that the roll-out of mobile phones in the Philippines disproportionally induced smaller farmers into trading across the countries' islands. Using a similar difference-in-difference approach, Carballo et al. (2022) find in Peru that participation in an online platform offering a centralized location to gather and share firm information increased the value of exports more for smaller firms. In a randomized evaluation, Wiseman (2023) shows that an intervention to offer market price and tariff cost information specifically to small-scale, informal traders in Kenya significantly increased their profits.

However, in other contexts, the effects appear to be greater for larger firms. In an RCT in Uganda, Bergquist et al. (2024) find that a platform to connect buyers and suppliers of agricultural products was mostly used by wholesale traders; take-up was negligible among smallholder farmers, who were on average 50 times smaller in scale. Using a structural model in which search is modeled as a fixed cost, they estimate the threshold needed to induce agents into cross-market trade and find that, despite the intervention meaningfully reducing this threshold, it remains too high for the majority of farmers to engage directly in trade. In the RCT putting Senegalese garment traders in Whatsapp groups described above, Wiles and Houeix (2025) find treatment effects for initial contacts that were greatest above 75th percentile of firms (by sales or profitability). Dillon et al. (2025) run an RCT of a telephone directory for agricultural SMEs in Tanzania and find that increases in business calls and profits were concentrated among above-median productivity firms. Cai et al. (2024) randomly matched and subsidized the first transaction between suppliers and buyers of Chinese paintbrush parts and find that treatment effects were greatest among "growth-oriented buyers." Finally, consistent with weaker effects among smaller firms, a wide set of RCTs offering market price information via mobile phones specifically to smallholder farmers have found muted impacts (Fafchamps and Minten, 2012; Mitra et al., 2018; Soldani et al., 2023; Svensson and Yanagizawa, 2009; Svensson and Yanagizawa-Drott, 2012).

One way to rationalize these disparate findings is to again invoke potential fixed costs of search. If the model has this property, which firms enjoy the greatest benefits from search cost interventions will depend on where along the distribution of firm size lies the marginal firm finding it worthwhile to search and on the magnitude by which the intervention reduces this threshold. To see this more clearly, note that we can use Equation (19) to write the market investment $\ell_{N,it}$ of firm i in search as

$$\ell_{N,it} = \left(\frac{\partial \widetilde{v}_{it+1}}{\partial \ell_{N,it}}\right)^{-1} \left(\tfrac{1}{\beta} w_t^* \, \mu_{it}^L \, \mu_{it}^Y \, \left(1 + \zeta_{it}\right)\right), \qquad N \in \{C, B, H\},$$

where we have inverted the function $\partial \widetilde{v}_{it+1} / \partial \ell_{N,it}$ (the partial derivative of the expected continuation value $\widetilde{v}_{it+1}\left(k_{it}, a_{it}, \boldsymbol{\ell}_t; \boldsymbol{k}_{t-1}, \boldsymbol{s}_t, \overline{z}_t\right)$ as a function of the investment $\ell_{N,it}$),[53] and where we have considered a setting with no labor market segmentation such that $w_{it}^* = w_t^*$. The $\mu_{it}^L \, \mu_{it}^Y \left(1 + \zeta_{it}\right)$ terms show how wedges in labor, output and capital markets can influence search investments. Thinking about a shift in the cost of search

[53] In deriving this equation, we have assumed that $\widetilde{v}_{it+1}\left(k_{it}, a_{it}, \boldsymbol{\ell}_t; \boldsymbol{k}_{t-1}, \boldsymbol{s}_t, \overline{z}_t\right)$ is a monotonic function of $\ell_{N,it}$.

as a shift in w_t^*, the response of search investments is given by $\Delta \log \ell_{N,it} \approx \varepsilon_{it} \Delta \log w_t^*$ where ε_{it} is the elasticity of function $(\partial \widetilde{v}_{it+1}/\partial \ell_{N,it})^{-1}$ with respect to its argument. Here, cross-firm variation in the response of search investments to reductions in search costs could be driven by two different margins. First, it could arise because the relative returns are different between firms even if all firms face identical distortions to their search investments, i.e., $\mu_{it}^L \mu_{it}^Y (1 + \zeta_{it}) = \mu_{it}^N$, for instance due to the presence of fixed search costs. Second, even if the expected continuation function is similar between firms, cross-firm variation in distortions in search investments $\mu_{it}^L \mu_{it}^Y (1 + \zeta_{it})$ can lead to heterogeneous responses.

7.3 Effect of Search on Competition

Many papers document that reductions in search costs, for example, through the roll-out of cell phones or the introduction of online marketplaces, increase firm entry into new markets (Allen, 2014; Bergquist et al., 2024; Jensen, 2007), which in our framework corresponds to firms expanding their sets of buyers. The expansion in these sets may have effects on the degree of competition among firms.[54] For example, Jensen and Miller (2018) exploit the roll-out of cell phone towers across Kerala, India (the same shock explored in Jensen (2007)), which they show enabled fishermen to learn about boatmakers in villages beyond their own. Boatmakers in previously near-autarkic markets were then able to enter into each other's territory, increasing competition among them. This led to a radical reconfiguration of the market, in which high-quality boat-builders expanded and low-quality boat-builders contracted (and, in some cases, even exited). Cai et al. (2024), discussed above, also finds evidence of business stealing as a result of reducing search costs. When one firm in a pre-existing linkage was

[54] Papers featuring bargaining models, rather than market-clearing prices determined in spot markets, also feature impacts on competition. For example, Mitra et al. (2018) find evidence that the randomized provision of price information to potato farmers in West Bengal, India, via mobile phones affected ex post bargaining between farmers and village intermediaries, as the platform informed farmers about their outside options.

connected to a new trading partner, the pre-existing link was 20 percentage points less likely to continue.

In a more structural approach, Vitali (2024) studies how search costs affect firm location and competition among garment firms in Kampala, Uganda. Using a quantitative spatial model, estimated on original survey and mystery shopper data, she explores how firms decide whether to co-locate, trading off an improved ability to attract customers against increased spatial competition. Policy counterfactuals that discourage co-location, such as capping the number of firms that can operate in the central business district, disproportionally harm high-quality firms, in a channel akin to Jensen and Miller (2008) in reverse. An issue closely related to search is congestion. In an RCT that placed orders and left reviews for firms on a large e-commerce platform in China, Bai et al. (2023) show that congestion slowed consumer learning about quality. As in Jensen and Miller (2018), these forces hurt high-quality sellers the most.

Overall, while there is ample evidence on differences in search behavior across firms, evidence linking search behavior to market power is still relatively nascent. Additional research in this space would be welcome, especially as this represents an obvious channel through which search can lead to or ameliorate misallocation.

8 Conclusion

Much of the existing literature on misallocation has taken an indirect approach, inferring the presence of wedges from the fact that marginal revenue products of factors (MRPs) or revenue-based productivity (TFPR) vary across firms. In this chapter, by contrast, we have focused on studies that take a more direct approach, seeking to measure wedges directly and to use exogenous variation to understand how they shape firm decisions. Two points in particular have been central to our discussion. First, not all wedges should be considered distortionary. There are technological wedges as well:

these should be thought of as constraining the social planner and giving rise to MRP dispersion even in the social planner's optimal allocation. Of course, there may be reasonable disagreement about where to draw the boundary between technological and distortionary wedges. For example, we have modeled firms as having access to different sets of consumers or workers, which they can expand through investment. Because we think of these investments as real costs, we assume the social planner is also subject to them. This classification may be uncontroversial for investments such as the time and money firms must pay to search for new markets, but less so for others, such as the utility cost of violating social norms, gender roles, or other barriers that may prevent firms from connecting with a wider range of workers (Oh, 2003). Still, it seems clear to us that at least some of the MRP dispersion observed in real data should be attributed to technological wedges as we have defined them. Second, wedges interact. Given the complications of such interactions, researchers have typically (and understandably) found it necessary to focus on just one wedge at a time, but we have argued that interactions among wedges are pervasive. Future research would do well to consider such interactions more fully.

The literature that takes a direct approach to misallocation is still at an early stage. Many studies touch on issues that are relevant to this research agenda, but relatively few self-consciously try to relate careful causal identification of a particular wedge to the broader question of the extent of misallocation and its aggregate consequences. Much work remains to be done. In the course of the review, we have tried to point to areas where we think more research would be particularly valuable. In this concluding section, we emphasize two additional areas for research going forward.

A first broad topic, unglamorous but crucial, is measurement. There are several related challenges here. In the cases of capital, labor, and material inputs, a key challenge is to estimate marginal revenue products in a way that does not require strong assumptions about functional forms. Under Cobb-Douglas production functions, marginal products coincide with average products, which are observable, but this will not in general be true. Two recent studies, by Carrillo et al. (2023) and Hughes and Majerovitz (2025) demonstrate ways to exploit experimental variation in order to estimate marginal products in a way that does not require strong functional form assumptions, using variation from government procurement contracts for construction services in Ecuador and from microenterprises in Sri Lanka (reanalyzing data from De Mel et al. (2008)), respectively. More research along these lines, from a wider range of contexts, would be extremely valuable.

In the cases of investments in upgrading and search, just measuring the magnitude of such investments, much less estimating their marginal products, is often difficult and should be the focus of research. As we argued above, R&D spending is not entirely satisfactory as a proxy for investment in upgrading in a developing countries, where much of the investment that firms make in catch-up learning is not classified as R&D. Search investments are also difficult to measure directly, for instance in surveys, as they often take the form of labor time and travel that are difficult to separate from other business activities of firm. Another frontier for research is to characterize how MRPs vary across firms, in particular how they vary with firm size. As we have argued above, the correlation of MRPs and firm size is potentially crucial for inferences about misallocation, but we have few direct estimates of this correlation, even for the marginal return to capital, the MRP that has been most extensively studied.

A related measurement challenge is to separate the roles of measurement error and true dispersion of marginal returns in explaining observed dispersion in estimated MRPs or TFPR. Several notable recent studies suggest that the role of measurement error may be substantial. Using farm data from Tanzania and Uganda, Gollin and Udry (2021) find that there is significant dispersion in TFPR (which is the same as TFPQ in their setting) even when comparing across plots owned by a particular farmer, which they argue should not be interpreted as due to misallocation; they attribute it instead to measurement error and unobserved land quality differences. Rotemberg and White (2017) make the practical but important point that the cleaning procedures that statistical agencies employ for firm data are not innocuous and can make a big difference for observed TFP dispersion. Other recent papers highlighting the role of measurement error include Haltiwanger et al. (2018) and Bils et al. (2021). Apart from simple measurement error, TFPR estimates are subject to the potential biases discussed for instance in De Loecker and Goldberg (2014), De Loecker and Syverson (2021), and Verhoogen (2023), which may also create problems for inferences about misallocation.

A second broad topic for future work is to try to bring together, more closely than we have done here, the direct estimates of wedges and those that emerge from the indirect approaches that have been more common in the misallocation literature. Wedges estimated under the indirect approach in principle capture the full extent of misallocation (under the maintained assumptions of the model being used for inference). When summing up various direct estimates of particular wedges, and allowing for interactions between them, do we arrive at something close to the overall wedge from standard indirect approaches? This would be in the spirit of the exercise that Atkin and Donaldson (2022) conduct, in a model without dynamics, as well as with the call by Buera et al. (2023) for a synthesis of macro and micro approaches. A reconciliation in the context of a framework like ours is beyond the scope of the current chapter, but we believe that it would be a useful exercise, one that would allow researchers to begin to quantify the relative importance of what we have called distortionary and technological wedges in explaining overall dispersion in MRPs and TFPR. Such a decomposition might also point to policies that would be effective in reducing distortions, taking into account the sorts of dynamics and interactions of wedges we have tried to highlight here.

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A Theory Appendix

A.1 Social Planner's Problem and the Efficient MRPs

Let $\boldsymbol{s}_t \equiv (\boldsymbol{z}_t, \mathcal{I}_t)$ denote the state of the firms in the economy in the beginning of period t, where $\boldsymbol{z}_t \equiv (z_{it})_{i\in\mathcal{I}}$ and $\mathcal{I}_t \equiv \left(\mathcal{I}_{C,it}, \mathcal{I}_{B,it}, \mathcal{I}_{H,it}\right)_{i\in\mathcal{I}}$ denote the vector of current productivity and the sets of customers, buyers, and potential employees, respectively, across all firms. Let us begin with setting up the social planner's problem abstracting away from all but strictly technological constraints.

A.1.1 First-Order Conditions

We can state the social planner's problem as follows

$$\begin{aligned} V_t^*\left(\boldsymbol{k}_{t-1}, \boldsymbol{s}_t\right) = \max \sum_i \nu_{it} & \left(\frac{C\left(\boldsymbol{c}_{it}\right)^{1-\vartheta}}{1-\vartheta} - \frac{\xi}{1+\phi}\left(\sum_{i\in\mathcal{I}_{H,i't}} \ell_{i,i't} + \ell_{E,it}\right)^{1+\phi} + G_t\left(\boldsymbol{c}_{G,t}\right)\right) + \beta\, \widetilde{V}_{t+1}^*\left(\boldsymbol{k}_t,\, \boldsymbol{s}_t,\, \boldsymbol{\ell}_t,\, \overline{z}_t\right) \\ & + \sum_{i\in\mathcal{I}} \lambda_{it}^* \left(z_{it} f\left(k_{it}, \ell_{it}, M_i\left(\boldsymbol{m}_{it}\right)\right) - \sum_{i'\in\mathcal{I}_{B,it}} m_{i,i't} - \sum_{i\in\mathcal{I}_{B,i't}} x_{i,i't} - \sum_{i'\in\mathcal{I}_{C,it}} c_{i,i't} - c_{G,it}\right) \\ & + \sum_{i\in\mathcal{I}} \chi_{it}^* \left(X_i\left(\boldsymbol{x}_{it}\right) - k_{it} + \left(1-\delta_i\right) k_{it-1} - \tfrac{1}{2}\kappa_X \left(k_{it} - \left(1-\delta_i\right) k_{it-1}\right)^2 \right) \\ & + \sum_{i\in\mathcal{I}} \omega_{it}^* \left(\sum_{i'\in\mathcal{I}_{it}^L} \ell_{i',it} - \ell_{it} - \sum_{N\in\{Z,C,B,H\}} \ell_{N,it} \right), \end{aligned} \tag{A1}$$

where $\boldsymbol{k}_{t-1} \equiv (k_{it-1})_{i\in\mathcal{I}}$ stands for the set of the initial stocks of capital, where $\ell_{i,i't}$ denotes the labor supply by individual i to firm i', where $\boldsymbol{\ell}_t \equiv (\ell_{it}, \ell_{Z,it}, \ell_{C,it}, \ell_{E,it})$ is the allocation of different types of labor in firm i, and where $\beta \widetilde{V}_{t+1}^*\left(\boldsymbol{s}_t,\, \boldsymbol{\ell}_t\right)$ is the expected net present continuation value defined by

$$\widetilde{V}_{t+1}^*\left(\boldsymbol{k}_t,\, \boldsymbol{s}_t,\, \boldsymbol{\ell}_t,\, \overline{z}_t\right) \equiv \mathbb{E}_{\boldsymbol{s}_{t+1}}\left[V_{t+1}^*\left(\boldsymbol{k}_t,\, \boldsymbol{s}_{t+1}\right) \mid \boldsymbol{s}_t,\, \boldsymbol{\ell}_t,\, \overline{z}_t\right],$$

with the expectation defined over the next-period state $\boldsymbol{s}_{t+1}$ under the distribution

$$\prod_i G\left(z_{it+1}|z_{it}, \overline{z}_t, \ell_{Z,it}, \theta_i\, \ell_{E,it}\right) \mathcal{G}_C\left(\mathcal{I}_{C,it+1}|\mathcal{I}_{C,it}, \ell_{C,it}\right) \mathcal{G}_B\left(\mathcal{I}_{B,it+1}|\mathcal{I}_{B,it}, \ell_{B,it}\right) \mathcal{G}_E\left(\mathcal{I}_{E,it+1}|\mathcal{I}_{E,it}, \ell_{E,it}\right). \tag{A2}$$

The consumption and labor supply decisions (assuming the workers enters the labor market) are characterized by the following first order conditions

$$\lambda_{jt}^* = \nu_{it}\, u_{it}^{-\vartheta}\, \frac{\partial u}{\partial c_{j,it}}, \qquad \text{if } i \in \mathcal{I}_{C,jt}, \tag{A3}$$

$$\omega_{jt}^* \leq \nu_{it}\, \xi\, \ell_{S,it}^{\phi}, \qquad \text{if } i \in \mathcal{I}_{H,jt}, \tag{A4}$$

$$\beta\, \frac{\partial \widetilde{V}_{t+1}^*\left(\boldsymbol{k}_t,\, \boldsymbol{s}_t,\, \boldsymbol{\ell}_t,\, \overline{z}_t\right)}{\partial \ell_{E,it}} \leq \nu_{it}\, \xi\, \ell_{S,it}^{\phi}, \tag{A5}$$

where we have defined the labor supply of individual i as $\ell_{S,it} \equiv \sum_{i\in\mathcal{I}_{i't}} \ell_{i,i't} + \ell_{E,it}$ and where equality in condition (A4) holds when $\ell_{i,i't} > 0$.

Assuming the firm is in operation and we have $z_{it} > 0$, we find the following first order conditions for capital, production labor, intermediates, and investments in firm i at time t is given by

$$\chi_{it}^{*}\left(1+\kappa_X \iota_{it}\right) = \lambda_{it}^{*}\, z_{it}\, f_{k,it} + \beta\, \frac{\partial \widetilde{V}_{t+1}^{*}\left(\boldsymbol{k}_t,\, \boldsymbol{s}_t,\, \boldsymbol{\ell}_t,\, \overline{z}_t\right)}{\partial k_{it}}, \tag{A6}$$

$$\omega_{it}^{*} = \lambda_{it}^{*}\, z_{it}\, f_{\ell,it}, \tag{A7}$$

$$\lambda_{jt}^{*} = \lambda_{it}^{*}\, z_{it}\, f_{m,it}\, \frac{\partial M_{it}}{\partial m_{j,it}}, \qquad i \in \mathcal{I}_{B,jt}, \tag{A8}$$

$$\lambda_{jt}^{*} = \chi_{it}^{*}\, \frac{\partial X_{it}}{\partial x_{j,it}}, \qquad i \in \mathcal{I}_{B,jt}, \tag{A9}$$

where f_k,f_ℓ, and f_m denote the partial derivatives of the production function with respect to capital, labor, and intermediates, respectively, and where we have defined the investment ι_{it} defined $\iota_{it} \equiv k_{it} - (1-\delta_i)\, k_{it-1}$.

A.1.2 Efficient Prices

We would like to compare the market equilibrium of the model against a market-based implementation of the optimal allocation. In such an implementation, we will have that the marginal utility of income for each household would have a one-to-one relation to their corresponding weight in the social welfare function, given by $\nu_{it} = 1/\eta_{it}^{*}$. We can choose the numeraire such that the mean of these weights across all individuals is unity. Accordingly, from Equations (A3) and (A18), we find that in the optimal market-based implementation, each product i has the same price in all transactions (final product markets or inter-firm transactions) with an optimal price satisfying $p_{it}^{*} = \lambda_{it}^{*}$.

A.1.3 Capital

Using the envelope condition

$$\begin{aligned}
\frac{\partial \widetilde{V}_{t+1}^{*}\left(\boldsymbol{k}_t,\, \boldsymbol{s}_t,\, \boldsymbol{\ell}_t,\, \overline{z}_t\right)}{\partial k_{it}} &= \mathbb{E}_{\boldsymbol{s}_{t+1}}\left[\frac{\partial V_{t+1}^{*}\left(\boldsymbol{k}_t,\, \boldsymbol{s}_{t+1}\right)}{\partial k_{it}}\,\middle|\, \boldsymbol{s}_t,\, \boldsymbol{\ell}_t\right], \\
&= (1-\delta_i)\; \mathbb{E}_{\boldsymbol{s}_{t+1}}\left[\chi_{it+1}^{*}\left(1+\kappa_X \iota_{t+1}\right) \,|\, \boldsymbol{s}_t,\, \boldsymbol{\ell}_t\right], \\
&= (1-\delta_i)\; \mathbb{E}_t\left[\chi_{it+1}^{*}\left(1+\kappa_X \iota_{t+1}\right)\right],
\end{aligned} \tag{A10}$$

where the last line defines $\mathbb{E}_t[\cdot] \equiv \mathbb{E}_{\boldsymbol{s}_{t+1}}[\cdot \,|\, \boldsymbol{s}_t,\, \boldsymbol{\ell}_t]$. Next, from Equation (A9), we find[55] $\chi_{it}^{*} \equiv P_{X_i}(\boldsymbol{p}_t^{*})$ where P_{X_i} is the unit cost function corresponding to the aggregator $X_i(\cdot)$. Combining this result with (A6) and (A10) leads to Equation (3).

[55] Multiply both sides by $x_{j,it}$ and sum over $x_{j,it}$ and use the CRS property of X_i to find: $\sum_j p_{jt}^{*} x_{j,it} = \chi_{it}^{*} X_{it}$.

A.1.4 Intermediates and Labor

Next, let us consider the marginal product of intermediates (MRPM). Equation (A8) implies[56]

$$MRPM^*_{j,it}\left(p^*_{j,t}\right) = p^*_{it} z_{it} f_{m,it} \frac{\partial M_{it}}{\partial m_{j,it}} = p^*_{j,t}, \qquad i \in \mathcal{I}_{B,jt},$$

which implies that under the optimal allocation the MRPM of a product j is equalized across all firms buying from the firm that produces this product.

As for labor, from Equations (A4) and (A19), we know that the market-based implementation of the socially optimal allocation involves $w^*_{it} \equiv \omega_{it}$. Next, Equation (A7) suggests that if $\ell^j_{i,t} > 0$ then Equation (6) holds.

A.1.5 Upgrading, Entrepreneurial, and Search Investments

For an incumbent firm i with $z_{it} > 0$, the optimal innovation and search investments is characterized by the first order condition

$$\beta \frac{\partial \widetilde{V}^*_{t+1}\left(\boldsymbol{k}_t,\, \boldsymbol{s}_t,\, \boldsymbol{\ell}_t,\, \overline{z}_t\right)}{\partial \ell_{N,it}} \le \omega^*_{it}, \qquad N \in \{Z, E, C, B, H\}. \tag{A11}$$

For the innovation investments, we have

$$\begin{aligned}
\frac{\partial \widetilde{V}^*_{t+1}\left(\boldsymbol{k}_t,\, \boldsymbol{s}_t,\, \boldsymbol{\ell}_t,\, \overline{z}_t\right)}{\partial \ell_{Z,it}} &= \frac{\partial}{\partial \ell_{Z,it}} \mathbb{E}_{\boldsymbol{s}_{t+1}}\left[V^*_{t+1}\left(\boldsymbol{k}_t,\, \boldsymbol{s}_{t+1}\right) \mid \boldsymbol{s}_t,\, \boldsymbol{\ell}_t,\, \overline{z}_t\right], \\
&= \frac{\partial}{\partial \ell_{Z,it}} \mathbb{E}_{z_{it+1}}\left[\mathbb{E}_{\boldsymbol{z}_{-i,t+1},\mathcal{I}_{t+1}}\left[V^*_{t+1}\left(\boldsymbol{k}_t,\, \boldsymbol{s}_{t+1}\right) \mid \boldsymbol{z}_{-i,t},\, \mathcal{I}_t,\, \boldsymbol{\ell}_t\right] \,\middle|\, z_{it}, \overline{z}_t, \ell_{Z,it}, \theta_i \ell_{E,it}\right], \\
&= \frac{\partial}{\partial \ell_{Z,it}} \mathbb{E}_{z_{it+1}}\left[\widetilde{V}^*_{t+1}\left(z_{it+1};\, \boldsymbol{z}_{-i,t},\, \mathcal{I}_t,\, \boldsymbol{\ell}_t,\, \overline{z}_t\right) \,\middle|\, z_{it}, \overline{z}_t, \ell_{Z,it}, \theta_i \ell_{E,it}\right], \\
&= \frac{\partial}{\partial \ell_{Z,it}} \int \widetilde{V}^*_{t+1}\left(z_{it+1};\, \boldsymbol{z}_{-i,t},\, \mathcal{I}_t,\, \boldsymbol{\ell}_t,\, \overline{z}_t\right) dG\left(z_{it+1} | Z_{it}\right), \\
&= \left[\frac{\partial}{\partial \ell_{Z,it}}\left(\widetilde{V}^*_{t+1}\left(z_{it+1};\, \boldsymbol{z}_{-i,t},\, \mathcal{I}_t,\, \boldsymbol{\ell}_t,\, \overline{z}_t\right) G\left(z_{it+1} | Z_{it}\right)\right)\right]_0^\infty \\
&\quad - \frac{\partial}{\partial \ell_{Z,it}} \int \frac{\partial \widetilde{V}^*_{t+1}(z_{it+1}; \boldsymbol{z}_{-i,t}, \mathcal{I}_t, \boldsymbol{\ell}_t, \overline{z}_t)}{\partial z_{it+1}} G\left(z_{it+1} | Z_{it}\right) dz_{it+1}, \\
&= \mathbb{E}_{z_{it+1}}\left[\frac{\partial \widetilde{V}^*_{t+1}(z_{it+1}; \boldsymbol{z}_{-i,t}, \mathcal{I}_t, \boldsymbol{\ell}_t, \overline{z}_t)}{\partial z_{it+1}} \frac{-\partial G(z_{it+1}|Z_{it})/\partial Z_{it}\, \partial Z_{it}/\partial \ell_{Z,it}}{\partial G(z_{it+1}|Z_{it})/\partial z_{it+1}} \,\middle|\, z_{it}, \overline{z}_t, \ell_{Z,it}\right], \\
&= \mathbb{E}_{\boldsymbol{s}_{t+1}}\left[\frac{\partial V^*_{t+1}(\boldsymbol{k}_t, \boldsymbol{s}_{t+1})}{\partial z_{it+1}} \frac{-\partial G(z_{it+1}|Z_{it})/\partial Z_{it}}{\partial G(z_{it+1}|Z_{it})/\partial z_{it+1}} \,\middle|\, \boldsymbol{s}_t,\, \boldsymbol{\ell}_t,\, \overline{z}_t\right] \frac{\partial Z_{it}}{\partial \ell_{Z,it}}, \\
&= \mathbb{E}_{\boldsymbol{s}_{t+1}}\left[\frac{\partial V^*_{t+1}(\boldsymbol{k}_t, \boldsymbol{s}_{t+1})}{\partial z_{it+1}} \gamma_{it+1} \,\middle|\, \boldsymbol{s}_t,\, \boldsymbol{\ell}_t,\, \overline{z}_t\right] \frac{\partial Z_{it}}{\partial \ell_{Z,it}},
\end{aligned} \tag{A12}$$

[56]Again, using the CRS property of the aggregator $M_i(\cdot)$, we have $\sum_j p^*_{jt} m_{j,it} = p^*_{it} z_{it} f_{m,it} M_{it}$, which leads to the desired result.

where the third equality defines $\widetilde{V}^*_{t+1}\left(z_{it+1};\, \boldsymbol{z}_{-i,t},\, \mathcal{I}_t,\, \boldsymbol{\ell}_t\right)$, where $Z_{it} \equiv Z\left(z_{it}, \overline{z}_t, \ell_{Z,it}, \theta_i \ell_{E,it}\right)$ in the fourth equality, where in the fifth equality we have used integration by parts and the fact that the first term is zero using the assumptions in footnote 5 and the fact that $\frac{\partial}{\partial \ell_{Z,it}} \widetilde{V}^*_{t+1}\left(z_{it+1};\, \boldsymbol{z}_{-i,t},\, \mathcal{I}_t,\, \boldsymbol{\ell}_t,\, \overline{z}_t\right) = 0$, and in the last equality we have defined γ_{it+1}. Using the envelope condition in Equation (A1), we find

$$\begin{aligned}
\frac{\partial V^*_t}{\partial z_{it}} &= \lambda^*_{it} f_{it} + \beta\, \frac{\partial \widetilde{V}^*_{t+1}\left(\boldsymbol{k}_t,\, \boldsymbol{s}_t,\, \boldsymbol{\ell}_t,\, \overline{z}_t\right)}{\partial z_{it}} + \beta\, \frac{\partial \overline{z}_t}{\partial z_{it}}\, \frac{\partial \widetilde{V}^*_{t+1}\left(\boldsymbol{k}_t,\, \boldsymbol{s}_t,\, \boldsymbol{\ell}_t,\, \overline{z}_t\right)}{\partial \overline{z}_t}, \\
&= \lambda^*_{it} f_{it} + \beta\, \mathbb{E}_{\boldsymbol{s}_{t+1}}\left[\tfrac{\partial V^*_{t+1}(\boldsymbol{k}_t,\, \boldsymbol{s}_{t+1})}{\partial z_{it+1}}\, \gamma_{it+1} \,\middle|\, \boldsymbol{s}_t,\, \boldsymbol{\ell}_t,\, \overline{z}_t\right] \frac{\partial Z_{it}}{\partial z_{it}} + \beta\, \frac{\partial \overline{z}_t}{\partial z_{it}}\, \frac{\partial \widetilde{V}^*_{t+1}\left(\boldsymbol{k}_t,\, \boldsymbol{s}_t,\, \boldsymbol{\ell}_t,\, \overline{z}_t\right)}{\partial \overline{z}_t},
\end{aligned} \tag{A13}$$

where the last equality we have used the definition of γ_{it+1}. We can now rewrite Equation (A12) as

$$\begin{aligned}
\mathbb{E}_t\left[\tfrac{\partial V^*_{t+1}}{\partial z_{it+1}}\, \gamma_{it+1}\right] &= \mathbb{E}_t\left[\lambda^*_{it+1} f_{it+1} \gamma_{it+1}\right] + \beta\, \mathbb{E}_t\left[\mathbb{E}_{t+1}\left[\tfrac{\partial V^*_{t+2}}{\partial z_{it+2}} \gamma_{it+2}\right] \frac{\partial Z_{it+1}}{\partial z_{it+1}}\, \gamma_{it+1}\right] + \mathbb{E}_t\left[\mathbb{E}_{t+1}\left[\beta \tfrac{\partial \widetilde{V}^*_{t+2}}{\partial \overline{z}_{t+1}}\, \tfrac{\partial \overline{z}_{t+1}}{\partial z_{it+1}}\right] \gamma_{it+1}\right], \\
&= \mathbb{E}_t\left[\lambda^*_{it+1} f_{it+1} \gamma_{it+1}\right] + \beta\, \mathbb{E}_t\left[\frac{\omega^*_{it+1}}{\beta\, \partial Z_{it+1}/\partial \ell_{Z,it+1}}\, \frac{\partial Z_{it+1}}{\partial z_{it+1}} \gamma_{it+1}\right] \\
&\quad + \beta\, \mathbb{E}_t\left[\mathbb{E}_{t+1}\left[\tfrac{\partial \widetilde{V}^*_{t+2}}{\partial \overline{z}_{t+1}}\, \tfrac{\partial \overline{z}_{t+1}}{\partial z_{it+1}}\right] \gamma_{it+1}\right], \\
&= \mathbb{E}_t\left[\lambda^*_{it+1} f_{it+1} \gamma_{it+1}\right] + \mathbb{E}_t\left[\omega^*_{it+1} \gamma_{it+1} \tfrac{\partial Z_{it+1}/\partial z_{it+1}}{\partial Z_{it+1}/\partial \ell_{Z,it+1}}\right] + \mathbb{E}_t\left[\beta \tfrac{\partial \widetilde{V}^*_{t+2}}{\partial \overline{z}_{t+1}}\, \tfrac{\partial \overline{z}_{t+1}}{\partial z_{it+1}} \gamma_{it+1}\right].
\end{aligned} \tag{A14}$$

where we have again let $\mathbb{E}_t[\cdot] \equiv \mathbb{E}_{\boldsymbol{s}_{t+1}}[\cdot \,|\, \boldsymbol{s}_t,\, \boldsymbol{\ell}_t,\, \overline{z}_t]$ to simplify the expression, and where in the second equality, we have used Equation A11and the law of iterated expectations to let $\mathbb{E}_t\left[\cdot\right] = \mathbb{E}_t\left[\mathbb{E}_{t+1}\left[\cdot\right]\right]$.

The marginal next-period expected revenue for entrepreneurship investments are given by

$$\begin{aligned}
MRPL^*_{Z,it} &\equiv \beta\, \mathbb{E}_t\left[p^*_{it+1} f^*_{it+1} \gamma_{it+1}\right] \frac{\partial Z_{it}}{\partial \ell_{Z,it}}, \\
&= \beta\, \left(\mathbb{E}_t\left[\tfrac{\partial V^*_{t+1}}{\partial z_{it+1}}\, \gamma_{it+1}\right] - \mathbb{E}_t\left[\omega^*_{it+1} \gamma_{it+1} \tfrac{\partial Z_{it+1}/\partial z_{it+1}}{\partial Z_{it+1}/\partial \ell_{Z,it+1}}\right] - \mathbb{E}_t\left[\beta \tfrac{\partial \widetilde{V}^*_{t+2}}{\partial \overline{z}_{t+1}}\, \tfrac{\partial \overline{z}_{t+1}}{\partial z_{it+1}} \gamma_{it+1}\right]\right) \frac{\partial Z_{it}}{\partial \ell_{Z,it}}, \\
&= \omega^*_{it} \left(1 - \beta\, \left(\mathbb{E}_t\left[\frac{\omega^*_{it+1}}{\omega^*_{it}}\, \tfrac{\partial Z_{it+1}/\partial z_{it+1}}{\partial Z_{it+1}/\partial \ell_{Z,it+1}}\, \gamma_{it+1}\right] + \mathbb{E}_t\left[\tfrac{\beta}{\omega^*_{it}}\, \tfrac{\partial \widetilde{V}^*_{t+2}}{\partial \overline{z}_{t+1}}\, \tfrac{\partial \overline{z}_{t+1}}{\partial z_{it+1}}\, \gamma_{it+1}\right]\right) \frac{\partial Z_{it}}{\partial \ell_{Z,it}}\right),
\end{aligned}$$

leading to Equation (8) for the case of $j = Z$.

Finally, for the case of the entrepreneurial labor, derivations similar to that of Equation (A12) show

$$\frac{\partial \widetilde{V}^*_{t+1}\left(\boldsymbol{k}_t,\, \boldsymbol{s}_t,\, \boldsymbol{\ell}_t,\, \overline{z}_t\right)}{\partial \ell_{E,it}} = \mathbb{E}_{\boldsymbol{s}_{t+1}}\left[\tfrac{\partial V^*_{t+1}(\boldsymbol{k}_t,\, \boldsymbol{s}_{t+1})}{\partial z_{it+1}}\, \gamma_{it+1} \middle|\, \boldsymbol{s}_t,\, \boldsymbol{\ell}_t,\, \overline{z}_t\right] \frac{\partial Z_{it}}{\partial \ell_{E,it}}. \tag{A15}$$

Using the envelope condition in Equation (A13), we find

$$\mathbb{E}_t\left[\frac{\partial V^*_{t+1}}{\partial z_{it+1}}\gamma_{it+1}\right] = \mathbb{E}_t\left[\lambda^*_{it+1} f_{it+1}\,\gamma_{it+1}\,MRT^{\ell_E,\ell_Z}_{it+1}\right] + \mathbb{E}_t\left[\omega^*_{it+1}\frac{\frac{\partial Z_{it+1}}{\partial z_{it+1}}}{\frac{\partial Z_{it+1}}{\partial \ell_{Z,it+1}}}\gamma_{it+1}\frac{\frac{-\partial G_{Z,it+1}}{\partial Z_{it}}\frac{\partial Z_{it}}{\partial \ell_{Z,it}}}{g_{Z,it+1}}\right] + \mathbb{E}_t\left[\beta\frac{\partial \widetilde{V}^*_{t+2}}{\partial \overline{z}_{t+1}}\frac{\partial \overline{z}_{t+1}}{\partial z_{it+1}}\gamma_{it+1}\right]. \tag{A16}$$

where we have again let $\mathbb{E}_t[\cdot] \equiv \mathbb{E}_{\boldsymbol{s}_{t+1}}[\cdot\,|\,\boldsymbol{s}_t,\,\boldsymbol{\ell}_t,\,\overline{z}_t]$ to simplify the expression, and where in the last equality, we have used Equation (A11) and the law of iterated expectations to let $\mathbb{E}_t[\cdot] = \mathbb{E}_t[\mathbb{E}_{t+1}[\cdot]]$.

Using Equation (A5), the marginal next-period expected revenue for entrepreneurship investments are given by

$$\begin{aligned}
MRPL^*_{E,it} &\equiv \beta\,\mathbb{E}_t\left[p^*_{it+1} f^*_{it+1}\gamma_{it+1}\right]\frac{\partial Z_{it}}{\partial \ell_{E,it}},\\
&= \beta\left(\mathbb{E}_t\left[\frac{\partial V^*_{t+1}}{\partial z_{it+1}}\gamma_{it+1}\right] - \mathbb{E}_t\left[\omega^*_{it+1}\gamma_{it+1}\frac{\partial Z_{it+1}/\partial z_{it+1}}{\partial Z_{it+1}/\partial \ell_{Z,it+1}}\right] - \mathbb{E}_t\left[\beta\frac{\partial \widetilde{V}^*_{t+2}}{\partial \overline{z}_{t+1}}\frac{\partial \overline{z}_{t+1}}{\partial z_{it+1}}\gamma_{it+1}\right]\right)\frac{\partial Z_{it}}{\partial \ell_{E,it}},\\
&= \nu_{it}\,\xi\,\ell^{\phi}_{S,it}\left(1 - \beta\frac{\omega^*_{it}}{\nu_{it}\,\xi\,\ell^{\phi}_{S,it}}\left(\mathbb{E}_t\left[\frac{\omega^*_{it+1}}{\omega^*_{it}}\frac{\partial Z_{it+1}/\partial z_{it+1}}{\partial Z_{it+1}/\partial \ell_{Z,it+1}}\gamma_{it+1}\right] + \mathbb{E}_t\left[\frac{\beta}{\omega^*_{it}}\frac{\partial \widetilde{V}^*_{t+2}}{\partial \overline{z}_{t+1}}\frac{\partial \overline{z}_{t+1}}{\partial z_{it+1}}\gamma_{it+1}\right]\right)\frac{\partial Z_{it}}{\partial \ell_{Z,it}}\right),
\end{aligned}$$

which leads to Equation (8) for the case of $j = E$ if we assume that (A4) holds.

A.2 Market-Allocation MRPs and Distortions

We consider Markov strategies. Let $s_{it} \equiv (z_{it}, \mathcal{I}_{it})$ denote the state of firm i in the beginning of period t, where and $\mathcal{I}_{it} \equiv (\mathcal{I}_{C,it}, \mathcal{I}_{B,it}, \mathcal{I}_{H,it})$ denotes the sets of customers, buyers, and potential employees, respectively. We can state the problem of individual i and the firm they potentially run under the equilibrium of the model as

$$\begin{aligned}
v_{it}(\boldsymbol{k}_{t-1}, \boldsymbol{s}_t, a_{it-1}) = \max\ & \frac{C(\boldsymbol{c}_{it})^{1-\vartheta}}{1-\vartheta} - \frac{\xi}{1+\phi}\left(\sum_{i\in\mathcal{I}_{H,i't}}\ell_{i,i't} + \ell_{E,it}\right)^{1+\phi} + \beta\,\widetilde{v}_{it+1}(\boldsymbol{k}_t, \boldsymbol{\ell}_t, a_{it}; \boldsymbol{s}_t, \overline{z}_t)\\
&+ \lambda_{it}\left(z_{it} f(k_{it}, \ell_{it}, M_i(\boldsymbol{m}_{it})) - \sum_{i'\in\mathcal{I}_{B,it}} m_{i,i't} - \sum_{i\in\mathcal{I}_{B,i't}} x_{i,i't} - \sum_{i'\in\mathcal{I}_{C,it}} c_{i,i't} - c_{G,it}\right)\\
&+ \chi_{it}\left(X_i(\boldsymbol{x}_{it}) - k_{it} + (1-\delta_i)k_{it-1} - \tfrac{1}{2}\kappa_X\left(k_{it} - (1-\delta_i)k_{it-1}\right)^2\right)\\
&+ \eta_{it}\Bigg\{(1+r_t)a_{it-1} + \sum_{i\in\mathcal{I}_{i't}} w_{i't}\ell_{i,i't} + \left(1-\tau^Y_{it}\right)\left(p_{it}\sum_{i'\in\mathcal{I}_{C,it}} c_{i,i't} + \sum_{i'\in\mathcal{I}_{B,it}} p_{i,i't}(m_{i,i't} + x_{i',it})\right)\\
&\quad - \sum_{i\in\mathcal{I}_{B,i't}}\left(1+\tau^M_{i',it}\right)p_{i',it}(m_{i',it} + x_{i',it}) - \left(1+\tau^L_{it}\right)w_{it}\left(\ell_{it} + \sum_{N\in\{Z,C,B,H\}}\ell_{N,it}\right) - a_{it}\\
&\quad - \sum_{i\in\mathcal{I}_{C,i't}} p_{i't}c_{i',it}\Bigg\}\\
&+ \zeta_{it}\left[CL(k_{it-1}, a_{it-1}) - \sum_{i\in\mathcal{I}_{B,i't}}\left(1+\tau^M_{i',it}\right)p_{i',it}x_{i',it} + \left(1+\tau^L_{it}\right)w_{it}\sum_{N\in\{Z,C,B,H\}}\ell_{N,it}\right],
\end{aligned} \tag{A17}$$

where we have define where we assume that the firm takes the decisions of all other firms as given, and where the expectation is defined over the next-period state $\boldsymbol{s}_{t+1}$ under the distribution (A2).

A.2.1 First-Order Conditions

The consumption, labor supply, and savings decisions are characterized by the following first order conditions

$$\eta_{it}\, p_{jt} = u_{it}^{-\vartheta} \frac{\partial u_{it}}{\partial c_{j,it}}, \qquad \text{if } i \in \mathcal{I}_{C,jt}, \tag{A18}$$

$$\eta_{it}\, w_{jt} \le \xi\, \ell_{S,it}^{\phi}, \qquad \text{if } i \in \mathcal{I}_{H,jt}, \tag{A19}$$

$$\beta \frac{\partial \widetilde{v}_{it+1}\left(k_{it}, a_{it}, \boldsymbol{\ell}_t; \boldsymbol{k}_{t-1}, \boldsymbol{s}_t, \overline{z}_t\right)}{\partial \ell_{E,it}} \le \xi \ell_{S,it}^{\phi}, \tag{A20}$$

$$\eta_{it} = \beta\left(1 + r_{t+1}\right)\eta_{it+1} + \zeta_{it+1} \frac{\partial CL_{it+1}}{\partial a_{it}}. \tag{A21}$$

Firm i sets prices in the final markets and in the inter-firm relations in which it has pricing market power:

$$\eta_{it}\left(1 - \tau_{it}^{Y}\right)\left(d_{it} + p_{it}\frac{\partial d_{it}}{\partial p_{it}}\right) = \lambda_{it}\frac{\partial d_{it}}{\partial p_{it}},$$

$$\eta_{it}\left(1 - \tau_{it}^{Y}\right)\left(d_{i,i't} + p_{i,i't}\frac{\partial d_{i,i't}}{\partial p_{i,i't}}\right) = \lambda_{it}\frac{\partial d_{i,i't}}{\partial p_{i,i't}}, \qquad i' \in \mathcal{I}_{B,it}^{P},$$

where $d_{it} \equiv \sum_{i' \in \mathcal{I}_{it}} c_{it}^{i'}$ is the final demand for firm i and $d_{i,i't} \equiv m_{i,i't} + x_{i',it}$ is the demand from downstream firm i'. Set $\mathcal{I}_{B,it}^{P}$ denotes the set of buyers for which firm i has pricing power. The above first order conditions then lead to the following conditions

$$\eta_{it} p_{it} = \frac{\lambda_{it}}{\left(1 - \tau_{it}^{Y}\right)\left(1 - \varepsilon_{it}^{Y}\right)}, \tag{A22}$$

$$\eta_{it} p_{i,i't} = \frac{\lambda_{it}}{\left(1 - \tau_{it}^{Y}\right)\left(1 - \varepsilon_{i,i't}^{Y}\right)}, \qquad i' \in \mathcal{I}_{B,it}^{P}, \tag{A23}$$

where ε_{it}^{Y} and $\varepsilon_{i,i't}^{Y}$ denote the corresponding inverse demand elasticities. For firms $i \in \mathcal{I}_{B,it} \backslash \mathcal{I}_{B,it}^{P}$, we have

$$\eta_{it} p_{i,i't} = \frac{\lambda_{it}}{1 - \tau_{it}^{Y}}. \tag{A24}$$

We have the following first order conditions for capital, production labor, intermediates, and investments in firm i at time t

$$\chi_{it}\left(1+\kappa_X\iota_{it}\right)=\lambda_{it}\,z_{it}\,f_{k,it}+\beta\,\frac{\partial\widetilde{v}_{it+1}\left(\boldsymbol{k}_t,\boldsymbol{\ell}_t,a_{it};\boldsymbol{s}_t,\overline{z}_t\right)}{\partial k_{it}},\tag{A25}$$

$$\eta_{it}\,w_{it}\left(1+\tau^L_{it}\right)\left(1+\varepsilon^L_{it}\right)=\lambda_{it}\,z_{it}\,f_{\ell,it},\tag{A26}$$

$$\eta_{it}\,p_{jt}\left(1+\tau^M_{j,it}\right)=\lambda_{it}\,z_{it}\,f_{m,it}\,\frac{\partial M_{it}}{\partial m_{j,it}},\qquad i\in\mathcal{I}^P_{B,jt},\tag{A27}$$

$$\eta_{it}\,p_{jt}\left(1+\tau^M_{j,it}\right)\left(1+\varepsilon^M_{j,it}\right)=\lambda_{it}\,z_{it}\,f_{m,it}\,\frac{\partial M_{it}}{\partial m_{j,it}},\qquad i\in\mathcal{I}_{B,it}/\mathcal{I}^P_{B,it},\tag{A28}$$

$$\eta_{it}\,p_{jt}\left(1+\tau^M_{j,it}\right)\left(1+\zeta_{it}\right)=\chi_{it}\,\frac{\partial X_{it}}{\partial x_{j,it}},\qquad i\in\mathcal{I}^P_{B,jt},\tag{A29}$$

$$\eta_{it}\,p_{jt}\left(1+\tau^M_{j,it}\right)\left(1+\varepsilon^M_{j,it}\right)\left(1+\zeta_{it}\right)=\chi_{it}\,\frac{\partial X_{it}}{\partial x_{j,it}},\qquad i\in\mathcal{I}_{B,it}/\mathcal{I}^P_{B,it},\tag{A30}$$

where ε^L_{it} and ε^M_{it} denote the inverse elasticities of labor and upstream supplies, respectively.

The investments in upgrading and search satisfy

$$\beta\,\frac{\partial\widetilde{v}_{it+1}\left(\boldsymbol{k}_t,\boldsymbol{\ell}_t,a_{it};\boldsymbol{s}_t,\overline{z}_t\right)}{\partial\ell_{N,it}}\le\eta_{it}\,w_{it}\left(1+\tau^L_{it}\right)\left(1+\varepsilon^L_{it}\right)\left(1+\zeta_{it}\right),\qquad N\in\{Z,C,B,H\},$$

leading to Equation (19).

A.2.2 Intermediates and Labor

Equations (A27) and (A28)

$$\begin{aligned}MRPM_{j,it}&=\overline{p}_{it}\,z_{it}f_{m,it}\,\frac{\partial M_{it}}{\partial m_{j,it}},\\&=\overline{p}_{it}\frac{\eta_{it}}{\lambda_{it}}\,p_{jt}\left(1+\tau^M_{j,it}\right)\left(1+\varepsilon^M_{j,it}\right),\\&=\frac{p_{jt}\left(1+\tau^M_{j,it}\right)\left(1+\varepsilon^M_{j,it}\right)}{\left(1-\tau^Y_{it}\right)\left(1-\overline{\varepsilon}^Y_{it}\right)},\end{aligned}$$

where in the second equality we have used Equation (A23) and in the last equality we have used the following result on the average price $\overline{p}_{it}\equiv\frac{p_{it}D_{C,it}+\sum_{i'}p_{i,i't}d_{M,i,i't}}{y_{it}}$:

$$\begin{aligned}\overline{p}_{it}=\frac{p_{it}D_{C,it}+\sum_{i'}p_{i,i't}d_{M,i,i't}}{y_{it}}&=\frac{\lambda_{it}}{\eta_{it}}\,\frac{1}{1-\tau^Y_{it}}\,\frac{D_{C,it}\frac{1}{1-\varepsilon^Y_{it}}+\sum_{i'}d_{M,i,i't}\frac{1}{1-\varepsilon^Y_{i,i't}}}{y_{it}},\\&=\frac{\lambda_{it}}{\eta_{it}}\,\frac{1}{\left(1-\tau^Y_{it}\right)\left(1-\overline{\varepsilon}^Y_{it}\right)},\end{aligned}\tag{A31}$$

derived using Equations (A22) and (A23) and with the extended definition of $\varepsilon^M_{j,it}$ by setting $\varepsilon^M_{j,it}=0$ if $i\in\mathcal{I}^P_{B,jt}$. Again, using this result, we compute the MRPL under the market equilibrium, using Equations

$$\begin{aligned}
MRPL_{it} &= \overline{p}_{it} z_{it} f_{\ell,it}, \\
&= \overline{p}_{it} \frac{\eta_{it}}{\lambda_{it}} \; w_{it} \left(1+\tau_{it}^{L}\right)\left(1+\varepsilon_{it}^{L}\right), \\
&= \frac{w_{it}\left(1+\tau_{it}^{L}\right)\left(1+\varepsilon_{it}^{L}\right)}{\left(1-\tau_{it}^{Y}\right)\left(1-\overline{\varepsilon}_{it}^{Y}\right)},
\end{aligned}$$

leading to Equation (14).

A.2.3 Capital

Using envelope condition, we have

$$\begin{aligned}
\frac{\partial \widetilde{v}_{it+1}\left(\boldsymbol{k}_t, \boldsymbol{\ell}_t, a_{it}; \boldsymbol{s}_t, \overline{z}_t\right)}{\partial k_{it}} &= \mathbb{E}_{\boldsymbol{s}_{t+1}}\left[\frac{\partial v_{it+1}\left(\boldsymbol{k}_t, \boldsymbol{s}_{t+1}, a_{it}\right)}{\partial k_{it}} \,|\boldsymbol{s}_t, \boldsymbol{\ell}_t, \overline{z}_t\right], \\
&= \left(1-\delta_i\right) \mathbb{E}_{s_{it+1}}\left[\chi_{it+1}\left(1+\kappa_X \iota_{t+1}\right) + \zeta_{it+1} \frac{\partial CL_{it+1}}{\partial k_{it}} \,|s_{it}, \boldsymbol{\ell}_{it}, \overline{z}_t\right], \\
&= \left(1-\delta_i\right) \mathbb{E}_{\boldsymbol{s}_{t+1}}\left[\chi_{it+1}\left(1+\kappa_X \iota_{t+1}\right) |\boldsymbol{s}_t, \boldsymbol{\ell}_t, \overline{z}_t\right] + \mathbb{E}_{\boldsymbol{s}_{t+1}}\left[\zeta_{it+1} \tfrac{\partial CL_{it+1}}{\partial k_{it}} \,|\boldsymbol{s}_t, \boldsymbol{\ell}_t, \overline{z}_t\right].
\end{aligned} \tag{A32}$$

From Equations (A29) and (A30), we find $\chi_{it}/\eta_{it} = \left(1+\zeta_{it}\right) P_{X_i}\left(\boldsymbol{p}_t \cdot \left(1+\boldsymbol{\tau}_{it}^{M}\right) \cdot \left(1+\boldsymbol{\varepsilon}_{it}^{M}\right)\right)$, where the vectors $\boldsymbol{\tau}_{it}^{M} \equiv \left(\tau_{j,it}^{M}\right)_j$ and $\boldsymbol{\varepsilon}_{it}^{M} \equiv \left(\varepsilon_{j,it}^{M}\right)_j$ denote the vectors of taxes and upstream supply elasticities for firm i at time t, where in the latter case we have set $\varepsilon_{j,it}^{M} \equiv 0$ if firm i does not have pricing power, that is, $i \in \mathcal{I}_{B,jt}^{P}/\mathcal{I}_{B,jt}^{P}$.

Next, let us use Equations (A22) and (A25) to derive an expression for the MRPK in the market equilibrium

$$\begin{aligned}
MRPK_{it} &= \overline{p}_{it}\, z_{it} f_{k,it}, \\
&= \frac{1}{\eta_{it}} \frac{1}{\left(1-\tau_{it}^{Y}\right)\left(1-\overline{\varepsilon}_{it}^{Y}\right)}\left(\chi_{it}\left(1+\kappa_X \iota_{it}\right) - \beta\, \tfrac{\partial \widetilde{v}_{it+1}\left(k_{it}, a_{it}, \boldsymbol{\ell}_t; \boldsymbol{k}_{t-1}, \boldsymbol{s}_t, \overline{z}_t\right)}{\partial k_{it}}\right), \\
&= \frac{\chi_{it}\left(1+\kappa_X \iota_{it}\right) - \beta\left(\left(1-\delta_i\right) \mathbb{E}_{t+1}\left[\chi_{it+1}\left(1+\kappa_X \iota_{t+1}\right)\right] + \mathbb{E}_{t+1}\left[\zeta_{it+1} \frac{\partial CL_{it+1}}{\partial k_{it}}\right]\right)}{\eta_{it}\left(1-\tau_{it}^{Y}\right)\left(1-\overline{\varepsilon}_{it}^{Y}\right)}, \\
&= \frac{\left(1+\zeta_{it}\right) P_{X_i}\left(\boldsymbol{p}_t \cdot \left(1+\boldsymbol{\tau}_{it}^{M}\right) \cdot \left(1+\boldsymbol{\varepsilon}_{it}^{M}\right)\right)\left(1+\kappa_X \iota_{it}\right)}{\left(1-\tau_{it}^{Y}\right)\left(1-\overline{\varepsilon}_{it}^{Y}\right)} \\
&\quad \times\left(1-\beta\left(1-\delta_i\right) \mathbb{E}_{t+1}\left[\tfrac{1+\zeta_{it+1}}{1+\zeta_{it}} \tfrac{P_{X_i}\left(\boldsymbol{p}_{t+1} \cdot \left(1+\boldsymbol{\tau}_{it+1}^{M}\right) \cdot \left(1+\boldsymbol{\varepsilon}_{it+1}^{M}\right)\right)}{P_{X_i}\left(\boldsymbol{p}_t\right)} \tfrac{1+\kappa_X \iota_{t+1}}{1+\kappa_X \iota_{it}}\right]\right) - \beta \frac{\mathbb{E}_{t+1}\left[\zeta_{it+t} \frac{\partial CL_{it+1}}{\partial k_{it}}\right]}{\eta_{it}\left(1-\tau_{it}^{Y}\right)\left(1-\overline{\varepsilon}_{it}^{Y}\right)},
\end{aligned} \tag{A33}$$

where in the second equality we have used Equation (A31), in the third line we have used Equation (A32) with the simplified notation $\mathbb{E}_{t+1}\left[\cdot\right] \equiv \mathbb{E}_{\boldsymbol{s}_{t+1}}\left[\cdot\,|\boldsymbol{s}_t, \boldsymbol{\ell}_t, \overline{z}_t\right]$, and where in the last equation we have substituted the expression for χ_{it} computed above. Using Equations (3) and (A33), we define the capital distortion as Equation (17).

A.2.4 Upgrading, Entrepreneurial, and Search Investments

For an incumbent firm i, the investment in upgrading and in search is characterized by the first order condition in Equation (19). For the innovation investments, we have

$$\begin{aligned}
\frac{\partial \widetilde{v}_{it+1}\left(\boldsymbol{k}_t, \boldsymbol{\ell}_t, a_{it}; \boldsymbol{s}_t, \overline{z}_t\right)}{\partial \ell_{Z,it}} &= \frac{\partial}{\partial \ell_{Z,it}} \mathbb{E}_{\boldsymbol{s}_{t+1}}\left[v_{it+1}\left(\boldsymbol{k}_t, \boldsymbol{s}_{t+1}, a_{it}\right) | \boldsymbol{s}_t, \boldsymbol{\ell}_t, \overline{z}_t\right], \\
&= \frac{\partial}{\partial \ell_{Z,it}} \mathbb{E}_{z_{it+1}}\left[\mathbb{E}_{\boldsymbol{z}_{-i,t+1}, \mathcal{I}_{t+1}}\left[v_{it+1}\left(\boldsymbol{k}_t, \boldsymbol{s}_{t+1}, a_{it}\right) | \boldsymbol{z}_{-i,t}, \mathcal{I}_t, \boldsymbol{\ell}_t\right] \Big| z_{it}, \overline{z}_t, \ell_{Z,it}, \theta_i \ell_{E,it}\right], \\
&= \frac{\partial}{\partial \ell_{Z,it}} \mathbb{E}_{z_{it+1}}\left[\widetilde{v}_{it+1}\left(z_{it+1}; \boldsymbol{z}_{-i,t}, \mathcal{I}_t, \boldsymbol{\ell}_t, \overline{z}_t, a_{it}\right) \Big| z_{it}, \overline{z}_t, \ell_{Z,it}, \theta_i \ell_{E,it}\right], \\
&= \frac{\partial}{\partial \ell_{Z,it}} \int \widetilde{v}_{it+1}\left(z_{it+1}; \boldsymbol{z}_{-i,t}, \mathcal{I}_t, \boldsymbol{\ell}_t, \overline{z}_t, a_{it}\right) dG\left(z_{it+1} | Z_{it}\right), \\
&= \left[\frac{\partial}{\partial \ell_{Z,it}}\left(\widetilde{v}_{t+1}\left(z_{it+1}; \boldsymbol{z}_{-i,t}, \mathcal{I}_t, \boldsymbol{\ell}_t, \overline{z}_t, a_{it}\right) G\left(z_{it+1} | Z_{it}\right)\right)\right]_0^{\infty} \qquad \text{(A34)} \\
&\quad - \frac{\partial}{\partial \ell_{Z,it}} \int \frac{\partial \widetilde{v}_{it+1}\left(z_{it+1}; \boldsymbol{z}_{-i,t}, \mathcal{I}_t, \boldsymbol{\ell}_t, \overline{z}_t, a_{it}\right)}{\partial z_{it+1}} G\left(z_{it+1} | Z_{it}\right) dz_{it+1}, \\
&= \mathbb{E}_{z_{it+1}}\left[\frac{\partial \widetilde{v}_{it+1}\left(z_{it+1}; \boldsymbol{z}_{-i,t}, \mathcal{I}_t, \boldsymbol{\ell}_t, \overline{z}_t, a_{it}\right)}{\partial z_{it+1}} \frac{-\partial G\left(z_{it+1} | Z_{it}\right) / \partial Z_{it} \, \partial Z_{it} / \partial \ell_{Z,it}}{\partial G\left(z_{it+1} | Z_{it}\right) / \partial z_{it+1}} \Big| z_{it}, \overline{z}_t, \ell_{Z,it}\right], \\
&= \mathbb{E}_{\boldsymbol{s}_{t+1}}\left[\frac{\partial v_{it+1}\left(\boldsymbol{k}_t, \boldsymbol{s}_{t+1}, a_{it}\right)}{\partial z_{it+1}} \gamma_{it+1} \Big| \boldsymbol{s}_t, \boldsymbol{\ell}_t, \overline{z}_t\right] \frac{\partial Z_{it}}{\partial \ell_{Z,it}}, \qquad \text{(A35)}
\end{aligned}$$

where the third equality defines $\widetilde{v}_{it+1}\left(z_{it+1}; \boldsymbol{z}_{-i,t}, \mathcal{I}_t, \boldsymbol{\ell}_t, \overline{z}_t, a_{it}\right)$, in the fifth equality we have used integration by parts and the fact that the first term is zero using the assumptions in footnote 5 and the fact that $\frac{\partial}{\partial \ell_{Z,it}} \widetilde{v}_{t+1}\left(z_{it+1}; \boldsymbol{z}_{-i,t}, \mathcal{I}_t, \boldsymbol{\ell}_t, \overline{z}_t, a_{it}\right)$, and in the last equality we have defined γ_{it+1} as earlier. Using the envelope condition in Equation (A17), we find

$$\begin{aligned}
\frac{\partial v_{it}}{\partial z_{it}} &= \lambda_{it} f_{it} + \beta \frac{\partial \widetilde{v}_{it+1}\left(\boldsymbol{k}_t, \boldsymbol{\ell}_t, a_{it}; \boldsymbol{s}_t, \overline{z}_t\right)}{\partial z_{it}}, \\
&= \lambda_{it} f_{it} + \mathbb{E}_{\boldsymbol{s}_{t+1}}\left[\frac{\partial v_{it+1}\left(\boldsymbol{k}_t, \boldsymbol{s}_{t+1}, a_{it}\right)}{\partial z_{it+1}} \gamma_{it+1} | \boldsymbol{s}_t, \boldsymbol{\ell}_t, \overline{z}_t\right] \frac{\partial Z_{it}}{\partial z_{it}},
\end{aligned}$$

where, as before, the last equality defines $\gamma_{Z,it+1}$. We can now rewrite the right hand side of Equation (A35) as

$$\begin{aligned}
\mathbb{E}_t\left[\frac{\partial v_{it+1}}{\partial z_{it+1}} \gamma_{it+1}\right] &= \mathbb{E}_t\left[\lambda_{it+1} f_{it+1} \gamma_{it+1}\right] + \beta \, \mathbb{E}_t\left[\mathbb{E}_{t+1}\left[\frac{\partial v_{it+2}}{\partial z_{it+2}} \gamma_{it+2}\right] \frac{\partial Z_{it+1}}{\partial z_{it+1}} \gamma_{it+1}\right], \qquad \text{(A36)} \\
&= \mathbb{E}_t\left[\lambda_{it+1} f_{it+1} \gamma_{it+1}\right] + \mathbb{E}_t\left[\eta_{it+1} w_{it+1}\left(1 + \tau_{it+1}^L\right)\left(1 + \varepsilon_{it+1}^L\right)\left(1 + \zeta_{it+1}\right) \gamma_{it+1} \frac{\partial Z_{it+1} / \partial z_{it+1}}{\partial Z_{it+1} / \partial \ell_{Z,it+1}}\right], \\
&\qquad \text{(A37)}
\end{aligned}$$

where in the last equality we have used Equations (19) and (A35) and the law of iterated expectations to let $\mathbb{E}_t[\cdot] = \mathbb{E}_t\left[\mathbb{E}_{t+1}[\cdot]\right]$.

The marginal next-period expected revenue for entrepreneurship investments are given by

$$
\begin{aligned}
MRPL_{Z,it} &\equiv \beta\, \mathbb{E}_t \left[\overline{p}_{it+1} f_{it+1} \gamma_{it+1}\right] \frac{\partial Z_{it}}{\partial \ell_{Z,it}}, \\
&= \beta\, \mathbb{E}_t \left[\frac{1}{\eta_{it+1}} \frac{1}{\left(1-\tau^Y_{it+1}\right)\left(1-\overline{\varepsilon}^Y_{it+1}\right)} \lambda_{it+1}\, f_{it+1}\gamma_{it+1} \right] \frac{\partial Z_{it}}{\partial \ell_{Z,it}}, \\
&= \beta \left[\mathbb{E}_t \left[\frac{1/\eta_{it+1}}{\left(1-\tau^Y_{it+1}\right)\left(1-\overline{\varepsilon}^Y_{it+1}\right)} \right] \mathbb{E}_t \left[\lambda_{it+1}\, f_{it+1}\gamma_{it+1}\right] + \mathbb{C}_t \left(\frac{1/\eta_{it+1}}{\left(1-\tau^Y_{it+1}\right)\left(1-\overline{\varepsilon}^Y_{it+1}\right)}, \lambda_{it+1}\, f_{it+1}\gamma_{it+1} \right) \right] \frac{\partial Z_{it}}{\partial \ell_{Z,it}}, \\
&= \beta \left[\frac{\Xi^E_t}{\eta_{it}\left(1-\tau^Y_{it}\right)\left(1-\overline{\varepsilon}^Y_{it}\right)} \left(\frac{\frac{\partial \widetilde{v}_{it+1}}{\partial \ell_{Z,it}}}{\frac{\partial Z_{it}}{\partial z_{it}}} - \mathbb{E}_t \left[w_{it+1}\eta_{it+1}\left(1+\tau^L_{it+1}\right)\left(1+\varepsilon^L_{it+1}\right)\left(1+\zeta_{it+1}\right)\gamma_{it+1} \frac{\partial Z_{it+1}/\partial z_{it+1}}{\partial Z_{it+1}/\partial \ell_{Z,it+1}} \right] \right) \right] \frac{\partial Z_{it}}{\partial \ell_{Z,it}} \\
&\quad + \Xi^C_t \frac{\partial Z_{it}}{\partial \ell_{Z,it}}, \\
&= \beta \left[\frac{\Xi^E_t}{\eta_{it}\left(1-\tau^Y_{it}\right)\left(1-\overline{\varepsilon}^Y_{it}\right)} \left(\frac{\frac{\partial \widetilde{v}_{it+1}}{\partial \ell_{Z,it}}}{\frac{\partial Z_{it}}{\partial \ell_{Z,it}}} - \mathbb{E}_t \left[w_{it+1}\eta_{it+1}\left(1+\tau^L_{it+1}\right)\left(1+\varepsilon^L_{it+1}\right)\left(1+\zeta_{it+1}\right)\gamma_{it+1} \frac{\partial Z_{it+1}/\partial z_{it+1}}{\partial Z_{it+1}/\partial \ell_{Z,it+1}} \right] \right) \right] \frac{\partial Z_{it}}{\partial \ell_{Z,it}} \\
&\quad + \Xi^C_t \frac{\partial Z_{it}}{\partial \ell_{Z,it}}, \\
&= \beta \left[\frac{\Xi^E_t}{\eta_{it}\left(1-\tau^Y_{it}\right)\left(1-\overline{\varepsilon}^Y_{it}\right)} \left(\frac{\eta_{it}\, w_{it}\left(1+\tau^L_{it}\right)\left(1+\varepsilon^L_{it}\right)\left(1+\zeta_{it}\right)}{\beta \frac{\partial Z_{it}}{\partial \ell_{Z,it}}} \right.\right. \\
&\quad \left.\left. - \frac{1}{\Xi^E_t}\, \mathbb{E}_t \left[w_{it+1}\eta_{it+1}\left(1+\tau^L_{it+1}\right)\left(1+\varepsilon^L_{it+1}\right)\left(1+\zeta_{it+1}\right)\gamma_{it+1} \frac{\partial Z_{it+1}/\partial z_{it+1}}{\partial Z_{it+1}/\partial \ell_{Z,it+1}} \right] \right) \right] \frac{\partial Z_{it}}{\partial \ell_{Z,it}} + \Xi^C_t \frac{\partial Z_{it}}{\partial \ell_{Z,it}}, \\
&= \frac{w_{it}\left(1+\tau^L_{it}\right)\left(1+\varepsilon^L_{it}\right)\left(1+\zeta_{it}\right)\Xi^E_t}{\left(1-\tau^Y_{it}\right)\left(1-\overline{\varepsilon}^Y_{it}\right)} \left(1 - \beta\, \mathbb{E}_t \left[\frac{w_{it+1}}{w_{it}} \frac{1+\tau^L_{it+1}}{1+\tau^L_{it}} \frac{1+\varepsilon^L_{it+1}}{1+\varepsilon^L_{it}} \frac{\eta_{it+1}}{\eta_{it}} \frac{1+\zeta_{it+1}}{1+\zeta_{it}} \gamma_{it+1} \frac{\partial Z_{it+1}/\partial z_{it+1}}{\partial Z_{it+1}/\partial \ell_{Z,it+1}} \right] \frac{\partial Z_{it}}{\partial \ell_{Z,it}} \right) + \Xi^C_t \frac{\partial Z_{it}}{\partial \ell_{Z,it}}, \\
&= w^*_{it}\, \mu^L_{it} \left(1+\zeta_{it}\right) \Xi^E_t \left(1 - \beta\, \mathbb{E}_t \left[\frac{w^*_{it+1}}{w^*_{it}} \frac{1-\tau^Y_{it}}{1-\tau^Y_{it+1}} \frac{1-\overline{\varepsilon}^Y_{it}}{1-\overline{\varepsilon}^Y_{it+1}} \frac{\eta_{it}}{\eta_{it+1}} \frac{1+\zeta_{it+1}}{1+\zeta_{it}} \gamma_{it+1} \frac{\partial Z_{it+1}/\partial z_{it+1}}{\partial Z_{it+1}/\partial \ell_{Z,it+1}} \right] \frac{\partial Z_{it}}{\partial \ell_{Z,it}} \right) + \Xi^C_t \frac{\partial Z_{it}}{\partial \ell_{Z,it}},
\end{aligned}
\tag{A38}
$$

leading to Equation (8) for the case of $j = Z$, where we have used Equation and have (19) and have let

$$
\begin{aligned}
\Xi^E_t &\equiv \mathbb{E}_t \left[\frac{1-\tau^Y_{it}}{1-\tau^Y_{it+1}} \frac{1-\overline{\varepsilon}^Y_{it}}{1-\overline{\varepsilon}^Y_{it+1}} \frac{\eta_{it}}{\eta_{it+1}} \right], \\
\Xi^C_t &\equiv \frac{1}{\eta_{it}\left(1-\tau^Y_{it}\right)\left(1-\overline{\varepsilon}^Y_{it}\right)} \mathbb{C}_t \left(\frac{1-\tau^Y_{it}}{1-\tau^Y_{it+1}} \frac{1-\overline{\varepsilon}^Y_{it}}{1-\overline{\varepsilon}^Y_{it+1}} \frac{\eta_{it}}{\eta_{it+1}}, \lambda_{it+1}\, f_{it+1}\gamma_{it+1} \right), \\
&= \mathbb{C}_t \left(\frac{1-\tau^Y_{it}}{1-\tau^Y_{it+1}} \frac{1-\overline{\varepsilon}^Y_{it}}{1-\overline{\varepsilon}^Y_{it+1}} \frac{\eta_{it}}{\eta_{it+1}}, \frac{1-\tau^Y_{it+1}}{1-\tau^Y_{it}} \frac{1-\overline{\varepsilon}^Y_{it+1}}{1-\overline{\varepsilon}^Y_{it}} \frac{\eta_{it+1}}{\eta_{it}} \overline{p}_{it+1} f_{it+1}\gamma_{it+1} \right).
\end{aligned}
$$

A.3 Derivations for TFPR

For the overall MRPM, in the case of optimal allocations, we have

$$\begin{aligned}
M_{it}^{*} &= \sum_{j} \frac{\partial M_{it}^{*}}{\partial m_{j,it}^{*}} m_{j,it}^{*}, \\
&= \frac{z_{it} p_{it}^{*} f_{m,it}^{*} \sum_{j} \frac{\partial M_{it}^{*}}{\partial m_{j,it}^{*}} m_{j,it}^{*}}{z_{it} p_{it} f_{m,it}}, \\
&= \frac{\sum_{j} p_{jt}^{*} m_{j,it}^{*}}{z_{it} p_{it}^{*} f_{m,it}^{*}}, \\
&= \frac{M_{it}^{*} P_{M_i}\left(\boldsymbol{p}_{t}^{*}\right)}{z_{it} p_{it}^{*} f_{m,it}^{*}}.
\end{aligned}$$

Let us next derive the expressions for the TFPR. First, note that the defintion of the unit cost function is given by

$$P_f\left(\boldsymbol{R}_{it}\right) \equiv \min_{\left(k_{it}, \ell_{it}, M_{it}\right)} R_{K,it}\, k_{it} + R_{L,it}\, \ell_{it} + R_{M,it} M_{it} + \widetilde{\vartheta}_{it}\left(1 - f\left(k_{it}, \ell_{it}, M_{it}\right)\right),$$

leading to the following first order conditions

$$R_{K,it} = \widetilde{\vartheta}_{it}\, f_{k,it}, \qquad R_{L,it} = \widetilde{\vartheta}_{it}\, f_{\ell,it}, \qquad R_{M,it} = \widetilde{\vartheta}_{it}\, f_{M,it},$$

and we can find

$$P_f\left(\boldsymbol{R}_{it}\right) = \widetilde{\vartheta}_{it}\left(k_{it} f_{k,it} + \ell_{it}\, f_{\ell,it} + M_{it}\, f_{M,it}\right) = \widetilde{\vartheta}_{it} f\left(k_{it}, \ell_{it}, M_{it}\right) = \widetilde{\vartheta}_{it}.$$

Therefore, from Equations (3), (5), and (6), we conclude that $p_{it}^{*} z_{it} = P\left(\boldsymbol{MRP}_{it}^{*}\right)$. From Equations (13) and (15), and the definition of the MRP of intermediates, we find $p_{it} z_{it} = P\left(\boldsymbol{MRP}_{it}\right)$.