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Keywords: Lease-induced debt, External finance, Misallocation of finance.
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This paper documents a large overestimation of measured finance misallocation (Whited and Zhao, 2021) when lease-induced debt is ignored among US manufacturing firms. Appropriately accounting for leases on the liability side translates into a 5.5% real value-added gain. Such gain is more salient within small firms and is countercyclical. Leasing improves the allocation of finance by raising the total amount of finance as well as by alleviating inefficient debt-equity combinations across firms. Finally, we find that factoring in lease-induced debt lowers both the level and dispersion of finance costs, consistent with the mitigation effect of lease-adjustment on finance allocation efficiency.

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1 Introduction

It has been well recognized in the corporate finance literature that operating lease is an important external financing method and a critical element of the capital structure (e.g., Eisfeldt and Rampini (2009), Rauh and Sufi (2012), and Rampini and Viswanathan (2013)).[1] In fact, recent lease accounting rule changes in ASC 842 (or IFRS 16) require lessees to recognize most operating leases from off-balance-sheet activities back on their balance sheets, emphasizing the importance of lease-related activities for both the asset and liability sides.[2] In this paper, we argue that, from the liability side, leasing lifts the cross-sectional allocation efficiency of finance sources, as it not only increases the total amount of finance available to firms but also alleviates the inefficient mix of finance types. Our estimates show that a total rise of 5.5% in terms of real value-added can be achieved by factoring in lease-induced debt, and we provide supportive evidence that both channels are equally important.Then we assess the implications of lease-induced debt for allocation efficiency on the liability side in the time series and in the cross-section, and find that this gain from lease-adjustment not only grows over time, but is also countercyclical and more salient for small firms.

We start by recognizing that lease-induced debt constitutes a significant component of firms' external financing - we replicate that lease-induced debt amounts to about half of the traditional debt used by US manufacturing firms, and that this proportion is higher among small firms and lower among large firms. Defining rental leverage as the ratio between lease-

[1]Other notable examples include Miller and Upton (1976), Myers et al. (1976), Ang and Peterson (1984), Smith Jr and Wakeman (1985), Bayless and Diltz (1986), Marston and Harris (1988), Lewis and Schallheim (1992), Graham (2000), Beattie et al. (2000), Yan (2006), Schallheim et al. (2013), Gavazza (2011), and Li and Tsou (2019).

[2]Starting in 2019, public firms are required to adopt a new accounting rule with respect to operating leases (Accounting Standards Update No. 2016-02, Leases (Topic 842)). Prior to this rule, operating leases were not recorded as assets or liabilities on firms' balance sheets. After the adoption of this rule, firms are required to include on their balance sheets the estimated present value of operating leases as operating lease assets and operating lease liabilities. Similar to ASC 842, IFRS 16 conducted the requirement to report leases on firms' balance sheets starting from 2019. There is another type of lease – finance lease (capital lease), in which the lessee acquires ownership of the asset at the end of the lease's term. Operating lease remains our main focus, as finance lease is already on the balance sheet, and is almost negligible in magnitude in the US. In this paper, unless otherwise specified, we use lease to represent operating lease. Appendix B provides detailed institutional backgrounds.

induced debt and total assets, we find that the high dispersion in rental leverage can almost offset the high dispersion in the ratio between traditional debt to total assets.[3] That is, the ratio between lease-adjusted total debt and total assets follows a rather flat pattern across firms of different sizes, consistent with Rampini and Viswanathan (2013). The significant amount of lease-induced debt and the stark changes in the pattern of total debt-to-asset ratios emphasize the important role leasing plays in facilitating firms to get the right amount of finance and the optimal mix of finance types. However, to our best knowledge, the current literature on the allocation of finance sources that fund capital goods and payrolls has left such important proportion of external financing unmeasured (Whited and Zhao, 2021). We fill this gap and explicitly account for leasing as a crucial financing component in measuring the (mis)allocation of finance.

To quantify the losses from misallocation of finance, we follow the framework of Whited and Zhao (2021). Within this static setting, we study the cross-sectional factor allocation, in which firms face downward-sloping demand in a monopolistic competitive market. We specify different types of financial liabilities as the primitive inputs ("factors") into the production process, in which we explicitly account for the unmeasured lease-induced debt. This modeling strategy is reasonable because all true production factors are ultimately backed by various financing methods. This strategy also offers a tractable alternative to dynamic equilibrium models in measuring the extent of finance misallocation, rather than focus upon sources behind each friction (Whited and Zhao, 2021). Similar to Whited and Zhao (2021), who model debt and equity to be imperfect substitutes, we add extra flexibility to the relation between traditional debt and lease-induced debt. However, by using a sensitivity analysis, we empirically show that assuming imperfect or perfect substitutes between traditional debt and lease-induced debt makes little difference. Hence, we restrict our focus to the case of perfect substitutes between traditional and lease-induced debt in our baseline model. In this framework, we show how distortions that drive wedges between the marginal contributions of

[3] In this paper, we use "lease" and "rent" interchangeably.

each finance source across firms will lower the total factor benefit.[4] A key result we exploit is that the marginal contributions of each source of finance to nominal value-added should be equalized across firms within the same industry at an optimal allocation. To the extent such marginal contributions differ across firms, we can infer any distortions empirically. These deviations manifest themselves as large differences in ratios of different financing types (e.g., debt-equity) across firms in an industry. The greater such distortions, the larger the losses relative to an efficient allocation.

Theoretically, there are two channels through which lease-induced debt can mitigate the allocation inefficiency of finance. First, leasing provides "100% financing," - it involves more debt capacity and naturally brings more resources to firms. The higher debt capacity results from the major benefit of leasing, which allows a lessor to easily repossess an asset, and hence implicitly extend more credit than a lender whose claim is secured by the same asset (Eisfeldt and Rampini, 2009). Therefore, the problem of a mismatch between a firm's productivity and a firm's total finance amount can be greatly alleviated because firms are able to borrow more. Second, and relatedly, the additional debt capacity associated with leasing is more valued by small and financially constrained firms, which leads to a reallocation of finance sources cross-sectionally. Such cross-sectional heterogeneity reveals the effect of leasing on the funding for the mix of finance types. These above two arguments together suggest that leasing not only enables firms to acquire greater amount of finance with respect to their productivities, but also optimizes the mix of finance types.

To empirically investigate the effect of leasing as unmeasured finance in terms of losses from finance misallocation, we first capitalize the rental expense to obtain a gauge of the amount of lease-induced debt, following standard accounting practices and Rauh and Sufi (2012) and Rampini and Viswanathan (2013). We find that small firms rely more on leasing as a crucial external financing channel, consistent with the finding in Rampini and Viswanathan

[4]Total factor benefit is directly analogous to total factor productivity (TFP). We provide more details in Section 2.

(2013) and Rauh and Sufi (2012). In terms of losses from misallocation, we find a magnitude of around 24% losses in terms of aggregate real value-added among US manufacturing firms. Adjusting for lease, the losses from misallocation of finance can be reduced by about 5.5% over the sample. Such an allocation gain from lease-adjustment can be decomposed into a channel related to the total amount of finance, which we denote as the scale channel, as well as into a channel related to finance type allocations, which we denote as the type channel. Our decomposition shows that both channels are important, with the former accounting for 60% of the total gains and the latter accounting for the rest.

Apart from the implications in the aggregate, we also study the patterns in the time series. We document that the allocation gain from lease-adjustment grows over time, although the misallocation of finance has deteriorated in the US for measures with and without lease-adjustment. Moreover, this lease-adjustment-generated gain exhibits a strong countercyclical pattern (with a correlation coefficient of -0.48 at the 1% significance level), echoing the countercyclicality feature of the rental share (Zhang, 2012; Gal and Pinter, 2017; Li and Xu, 2020). Next we analyze the results in the cross-section. We find that the gain from lease-adjustment amounts to nearly 20% for small firms, but is only 1% for large firms, as large firms rely less on leasing and are typically already more efficient in obtaining and allocating finance sources, compared to small firms.

Our framework also allows us to estimate the distortion-inclusive costs of finance (debt and equity) for each firm. While the drop in both costs is significant, the drop in the cost of debt is 76% higher than that for the cost of equity. We compare the cross-sectional patterns in these costs in the US with and without lease-adjustment, and we document that our estimated costs drop significantly, especially for small firms. Specifically, the drop in small firms is over 32% for the cost of debt and 15% for the cost of equity, while it is only 15% and 14% among large firms for these two costs, respectively. Intuitively, as an alternative external finance method, leasing relaxes financial constraints and is associated with cheaper costs relative to the expensive marginal value of net worth due to financial constraints, and this effect is markedly higher for small firms because of their high financial constraint levels. Additionally, we find a positive relation exists between the dispersion in costs of finance and losses from misallocation. Using a set of kernel density plots, we show that the lease-adjustment effectively narrows the dispersion of costs for different finance types. More importantly, this narrowing effect is more salient among small firms and among costs of debt. This is intuitive, since leasing is more intensively used in small firms, and since leasing is similar to debt and is treated as liabilities, both in practice and in the literature.

Next, to conduct robustness checks, we alter the substitutibility of traditional debt and rental debt, change the measurement of firm-level nominal benefit, use different values for the elasticity of substitution of the real benefit between firms in a sector, and plug in an alternative proxy for the traditional debt. Our benchmark results continue to hold in all variations.

Finally, our paper has implications for cross-country comparisons. Chang et al. (2021) study China's leasing industry and document that about 90% of all leases in China are finance leases and play a role in circumventing banking regulation. Different from operating lease, finance lease (or capital lease) is another form of secured lending, and is already an on-balance sheet item before ASC 842. Therefore, adjusted by the debt induced by operating lease, the estimated real losses in China would barely differ with those in Whited and Zhao (2021). Given the fact that operating lease constitutes a significant proportion of borrowing in the US but only a negligible proportion in China, hypothetically reallocating lease-adjusted liabilities of Chinese firms to mimic the efficiency observed in the US would produce starkly higher real value-added gains than those in Whited and Zhao (2021).[5]

Related literature This paper relates to the strand of finance literature that connects firms' capital structure to asset collateralizability (see Albuquerque and Hopenhayn (2004); Eisfeldt and Rampini (2007); Nikolov et al. (2021); and Ai et al. (2020a)). Hennessy and

[5]The estimate in Whited and Zhao (2021) ranges from 51% to 69%.

Whited (2005) present a dynamic model of optimal investment and leverage, and Hennessy and Whited (2007) estimate financing costs in a similar framework with defaultable debt. Schmid (2008) considers the quantitative implications of dynamic financing with collateral constraints. Rampini and Viswanathan (2010, 2013) and Li et al. (2016) study dynamic contracting models based on limited commitment.[6] Similar to these studies, we also emphasize the financing role that debt and collateral play. However, most of these studies, with the exceptions of Rampini and Viswanathan (2010, 2013), do not consider the possibility that firms might lease to finance; in this paper, we use a reduced-form setting to capture lease-induced liabilities and focus on the macroeconomic implications.

This paper is connected to literature that estimates leased capital and brings lease-adjustment to both a firm's liability and asset side. Eisfeldt and Rampini (2009), Rauh and Sufi (2012) and Lim et al. (2017) provide estimations for the amount of leased capital. On the liability side, Ang and Peterson (1984), Bayless and Diltz (1986), Marston and Harris (1988), Beattie et al. (2000), Yan (2006), and Schallheim et al. (2013) provide correlative evidence supporting either lease-debt substitution or complementarity. Rampini and Viswanathan (2013) provide a strong case that leased capital cannot be ignored if one wants to understand the capital structure. On the asset side, Li and Tsou (2019) study expected stock returns in the cross-section by arguing that leasing allows firms to hedge asset price uncertainty associated with the resale of purchased assets. Li and Xu (2020) study the implications of leasing on the real economy, and they find that adjusting a firm's investment by leased capital sharply changes the measured capital misallocation and capital reallocation. Our paper is closely related to Li and Xu (2020) and Rampini and Viswanathan (2013), but with an important distinction: we focus on the liability side and consider how to impute real losses related to debt-to-equity ratios.[7]

[6] Strebulaev and Whited (2012) and Bazdresch et al. (2018) provide excellent surveys on dynamic corporate finance.

[7] Our study builds on the theories of corporate leasing decisions. See Miller and Upton (1976), Myers et al. (1976), Smith Jr and Wakeman (1985), Lewis and Schallheim (1992), Graham (2000), Gavazza (2011), Eisfeldt and Rampini (2009), Rampini and Viswanathan (2013), Zhang (2012), Gal and Pinter (2017), Li and Tsou (2019), Li and Xu (2020), Chu (2020), and Binfare et al. (2020). Kermani and Ma (2020) study

This paper builds upon the large macroeconomics literature that examines the role of financial frictions in generating fluctuations across the business cycle (see Quadrini (2011) and Brunnermeier et al. (2012) for extensive reviews). The papers closely related to ours include Kiyotaki and Moore (1997, 2012), Gertler and Kiyotaki (2010), He and Krishnamurthy (2013), Brunnermeier and Sannikov (2014), and Elenev et al. (2018). Gomes et al. (2015) study the asset pricing implications of credit market frictions in a production economy. Our paper differs in that we allow firms to rely on leasing as an alternative external financing method and in that our paper is largely empirical.

Our paper is also related to the literature that links aggregate total factor productivity (TFP) to capital misallocation caused by financial frictions at the firm level (for example, Gilchrist et al. (2013), Chen and Song (2013), Midrigan and Xu (2014), Moll (2014), Buera and Moll (2015), Gopinath et al. (2017), Bai et al. (2018), and Ai et al. (2019)). Buera et al. (2011) study quantitatively the relation between TFP and financial frictions. Cavalcanti et al. (2021) explore the role of dispersion in financing costs on aggregate development and firm dynamics in Brazil. Our paper differs with these studies in three aspects. First, our framework is mainly empirical while these previous studies rely on calibrated dynamic models. Second, we focus more on the intensive margin. Finally, none of these papers focus on the effect of lease-induced liabilities on finance misallocation as we do. The paper most closely related to ours is Whited and Zhao (2021), who study the misallocation of finance and compare real losses in the US and China. We follow their reduced-form framework but explicitly consider leasing as unmeasured finance to examine the implication for misallocation of finance in the US.

More broadly, our paper is connected to the general capital misallocation and capital reallocation literature, seminal examples of which include Hsieh and Klenow (2009) and Eisfeldt and Rampini (2006) (see Restuccia and Rogerson (2017), Hopenhayn (2014), and Eisfeldt

cash-based debt and asset-based debt, the latter of which is similar to operating leases when the lessor can eventually repossess the leased assets at the end of leasing contracts. Lian and Ma (2021) provide empirical evidence on debt types for US nonfinancial firms.

and Shi (2018) for extensive reviews). Empirically, Hsieh and Klenow (2009), David and Venkateswaran (2019) and David et al. (2020) find substantial capital misallocation in the US.[8] Eisfeldt and Rampini (2006), Kehrig (2015) and Ai et al. (2020b) document that the amount of capital reallocation is procyclical while the benefit of capital reallocation is countercyclical.[9] Li and Xu (2020) emphasize that leasing provides an additional channel of capital reallocation and partially reconciles these puzzling facts. While our paper is closely related to Li and Xu (2020), we study the cyclical patterns of the gains generated by lease-adjustment from the liability side, and we further decompose the gains into channels originated from the scale of finance and the mix of finance types.

The rest of our paper is organized as follows. We sketch an empirical framework with lease-adjustment in Section 2. In Section 3, we summarize empirical facts on the importance of leased-induced leverage, the adjusted misallocation of finance, the costs of finance, as well as other implications of our model. We then provide robustness checks in Section 4. In Section 5, we conclude our paper. Details on data construction, lease accounting rule changes, and model details are delegated to Appendices A to D.

[8] There is a vast literature on sources of capital misallocation, but we do not attempt to summarize it here. A partial list includes adjustment costs (Asker et al., 2014), information frictions (David et al., 2016), markups (Peters, 2020; Edmond et al., 2018; Haltiwanger et al., 2018), as well as firm-level risk premia (David et al., 2020). Song and Wu (2015) estimate a model with permanent distortions, adjustment costs, and heterogeneity in markups and technologies. David and Venkateswaran (2019) develop a methodology to disentangle various sources of capital misallocation. Relatedly, Lanteri and Rampini (2021) analyze pecuniary externalities in an equilibrium model with capital misallocation and reallocation. Dou et al. (2021) study the asset pricing implications of capital misallocation.

[9] Eisfeldt and Rampini (2006) rationalize these puzzling facts using a model in which the cost of capital reallocation is correlated with TFP shocks. Eisfeldt and Rampini (2008), Kurlat (2013), Fuchs et al. (2016) and Li and Whited (2015) all analyze models of capital reallocation with adverse selection. Cui (2017) studies the effects of financing constraints and partial irreversibility on the cyclicality of capital liquidation. Lanteri (2018) analyzes a model with endogenous partial irreversibility and used investment goods. Dong et al. (2020) develop a search-based neoclassical model with capacity utilization to explain these facts. Ai et al. (2020b) study the link between financial intermediation and capital reallocation.

2 Model environment and misallocation of finance

In this section, we first describe our model environment with heterogeneous firms in monopolistic competition. We use this model to illustrate the effect of misallocation of finance with lease-adjustment on aggregate output. We then discuss the measurements with respect to finance misallocation through a list of optimality conditions. Our model closely follows Melitz (2003), Hsieh and Klenow (2009), and Whited and Zhao (2021), except that our model explicitly considers leasing as a source of external finance and, hence, as the debt of a firm.

2.1 Model

In our framework, firms are financed by equity, traditional debt, and lease-induced debt.[10] Through these financing sources, firms gain proximate factors of production. That is, we directly specify different types of underlying financial liabilities as the primitive inputs into the production process. This production process generates real benefit to shareholders, which is represented by the real value-added at each time in our static model.[11]

We assume that the economy-wide total real benefit of finance (or, value-added) F is generated by a representative firm. This firm combines the real benefit F_s of S sectors using a Cobb-Douglas aggregator:

$$F = \prod_{s=1}^{S} F_s^{\theta_s}, \quad \text{where } \sum_{s=1}^{S} \theta_s = 1 \tag{1}$$

Here, θ_s is the weight of sector s.

Cost minimization of this aggregator implies:

$$P_s F_s = \theta_s P F \tag{2}$$

[10] As in Whited and Zhao (2021), we do not distinguish between external and internal equity.

[11] In this paper, we use real benefit and real value-added interchangeably for almost all of our analysis.

where P_s denotes the sector price of acquiring one unit of real benefit in sector s, and $P = \prod_{s=1}^{S} \left(\frac{P_s}{\theta_s} \right)^{\theta_s}$ is the minimum price of acquiring a unit of the aggregate real benefit in the whole economy. Here, the nominal benefit satisfies value additivity at the sector level, i.e., $\sum_{s=1}^{S} P_s F_s = PF$.

The sector real benefit F_s is a CES aggregate of I_s differentiated real benefit:

$$F_s = \left(\sum_{i=1}^{I} F_{si}^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}} \tag{3}$$

where F_{si} is the real benefit of firm i, and σ is the elasticity of substitution of the real benefit. We denote by P_{si} the price of firm i's real benefit. Firms face an isoelastic demand for their real benefit given by $F_{si} = \left(\frac{P_{si}}{P_s} \right)^{-\sigma} F_s$. Similarly, we assume that the nominal benefit satisfies value additivity at the firm level, so $\sum_{i=1}^{I} P_{si} F_{si} = P_s F_s$.

The aggregator (synthetic "production" function) for an individual firm using its various sources of financing is given by the following CES form:

$$F_{si} = A_{si} \left(\alpha_s \left[D_{si} + K_{si}^{l} \right]^{\frac{\gamma-1}{\gamma}} + (1 - \alpha_s) E_{si}^{\frac{\gamma-1}{\gamma}} \right)^{\frac{\gamma}{\gamma-1}} \tag{4}$$

where D_{si}, K_{si}^{l}, and E_{si} are the levels of traditional debt, lease-induced debt, and equity for firm i in sector S. We denote total debt to include both traditional debt and lease-induced debt.[12] $\alpha_s \in (0, 1)$ denotes the weight on the importance of total debt in generating the real benefit, and γ_s is the elasticity of substitution between total debt and equity. A_{si} is analogous to total factor productivity (TFP), which represents the total factor benefit (TFB) in our study. We assume that there is imperfect substitutability between total debt and equity, and that in term of total debt, traditional debt and leasing are perfect substitutes. We view this latter simplification as innocuous for our purposes, which are primarily empirical. We later extend this assumption in our robustness checks.

[12]This is motivated by our empirical evidence, as shown in Section 3.

Denoting the inverse demand function by $P(F_{si})$, firms choose their price, traditional debt, leasing, and equity to maximize their profits π_{si}:

$$\max_{P_{si},D_{si},K^l_{si},E_{si}} \pi_{si} = P_{si}F_{si} - \left[(1+\tau_{D_{si}})\, r_{si}D_{si} + (1+\tau_{E_{si}})\,\lambda_{si}E_{si} + \left(1+\Delta_{K^l_{si}}\right)\tau^l_{si}K^l_{si} \right] \quad (5)$$

where r_{si}, λ_{si}, and τ^l_{si} denote the costs associated with using traditional debt, equity, and lease-induced debt, respectively. $\tau_{D_{si}}$ denotes a firm-specific wedge that distorts traditional debt, $\tau_{E_{si}}$ denotes a firm-specific wedge that distorts equity, and $\Delta_{K^l_{si}}$ denotes a firm-specific wedge that distorts leasing.[13] Here, π_{si} can be interpreted as economic value-added, which is easy to measure empirically.

The optimality conditions yield the standard condition that a firm's choice of P_{si} is a fixed markup over the marginal cost:

$$\begin{aligned} P_{si} = \frac{\sigma}{\sigma-1}\Bigg[\frac{1}{A_{si}}\Bigg((1+\tau_{D_{si}})\, r \left(\alpha_s + (1-\alpha_s)\, Z_{si}^{-\frac{\gamma-1}{\gamma}}\right)^{-\frac{\gamma}{\gamma-1}} \\ + (1+\tau_{E_{si}})\,\lambda\left(\alpha_s Z_{si}^{\frac{\gamma-1}{\gamma}} + (1-\alpha_s)\right)^{-\frac{\gamma}{\gamma-1}}\Bigg)\Bigg] \end{aligned} \quad (6)$$

in which Z_{si}, the optimal ratio of total debt-to-equity, is:[14]

$$Z_{si} = \frac{D_{si}+K^l_{si}}{E_{si}} = \left(\frac{\alpha_s}{1-\alpha_s}\frac{(1+\tau_{E_{si}})\,\lambda_{si}}{(1+\tau_{D_{si}})\, r_{si}}\right)^{\gamma} \quad (7)$$

[13] Positive values of these wedges indicate that firms face additional costs of finance, whereas negative values represent favorable financing conditions. Also note that we have:

$$\frac{(1+\tau_{D_{si}})\, r_{si}D_{si}}{\left(1+\Delta_{K^l_{si}}\right)\tau^l_{si}K^l_{si}} = 1$$

[14] The zero profit condition of the representative firm which aggregates firms' real benefit to the sector level implies that:

$$P_s = \left(\sum_{i=1}^{I} P_{si}^{-(\sigma-1)}\right)^{-\frac{1}{\sigma-1}}$$

2.2 Losses from misallocation of finance

Our model framework enables us to calculate the losses from misallocation of finance (or equivalently, the real gains from reallocation). To do so, we first obtain the expression for the efficient levels of financing. We start by solving a social planner problem, who first maximizes the firm real benefit by allocating financing types, subject to the total amount of finance already allocated to the firm. This implies that the optimal debt-equity ratio is the same across firms at the sector level, $\frac{\hat{D}_{si}+\hat{K^{l}_{si}}}{\hat{E}_{si}} = \frac{D_s+K^l_s}{E_s}$, where we use hat above variables to indicate the efficient level of allocation.

Then we solve the problem of reallocating financing sources to maximize the sector-level real benefit. We differentiate Eq. (3) with respect to firm-level real benefit. Along with the optimal debt-to-equity ratio in a sector, we have:

$$\hat{D}_{si} + \hat{K^{l}_{si}} = \frac{A_{si}^{\sigma-1}}{\sum_j A_{sj}^{\sigma-1}} \left(D_s + K^l_s\right) \tag{8}$$

$$\hat{E}_{si} = \frac{A_{si}^{\sigma-1}}{\sum_j A_{sj}^{\sigma-1}} E_s \tag{9}$$

That is, in an efficient allocation, firms with the highest A_{si} receive the most finance at an optimal allocation.

Additionally, we need A_{si}. We can write it in terms of $P_{si}F_{si}$:

$$A_{si} = \frac{1}{P_s\left(P_sF_s\right)^{\frac{1}{\sigma-1}}} \frac{\left(P_{si}F_{si}\right)^{\frac{\sigma}{\sigma-1}}}{\left(\alpha_s\left(D_{si}+K^l_{si}\right)^{\frac{\gamma-1}{\gamma}} + \left(1-\alpha_s\right)E_{si}^{\frac{\gamma-1}{\gamma}}\right)^{\frac{\gamma}{\gamma-1}}} \tag{10}$$

where the first item on the right-hand side is identical for all firms within the same sector.[15] All variables in the second term on the right-hand side are observable.

Having identified the efficient levels of total debt and equity of an individual firm, we can

[15] This means that the losses from misallocation do not depend on this first term, and can thus be separated from the problem; thus, we can safely normalize it to one.

obtain the optimal real benefit at the firm level, and then aggregate them to the sector-level and to the aggregate economy:

$$\hat{F}_{si} = A_{si}\left(\alpha_s\left(\hat{D}_{si} + \hat{K}^l_{si}\right)^{\frac{\gamma-1}{\gamma}} + (1-\alpha_s)\,\hat{E}_{si}^{\frac{\gamma-1}{\gamma}}\right)^{\frac{\gamma}{\gamma-1}} \tag{11}$$

$$\hat{F}_s = \left(\sum_i \hat{F}_{si}^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}} \tag{12}$$

$$\hat{F} = \prod_s \hat{F}_s^{\theta_s} \tag{13}$$

On the other hand, the original real benefit can be computed by replacing $\hat{D}_{si} + \hat{K}^l_{si}$ and $\hat{E}_{si}$ by the actual, observable total debt, $D_{si} + K^l_{si}$ and equity, E_{si}. We define the fractional benefit as the ratio of the observed allocation as a fraction of the efficient allocation, $\frac{F}{\hat{F}}$. Therefore, losses from misallocation can be quantified as $\frac{\hat{F}-F}{F}$.

To sum up, we first plug the optimal allocations of total debt and equity into the firm-level CES aggregate to obtain the first-best real benefit of finance for each firm. Next, we estimate its counterpart, the actual firm-level real benefit, by plugging in the actual observed total debt and equity. We then aggregate these benefits to sectors and to the aggregate economy. Eventually, we compare the actual with the optimal aggregated real benefit to measure losses from misallocation of finance.

2.3 Costs of finance

The model framework also enables us to calculate the distortion-inclusive costs of financing. To solve for such costs, we first write the nominal benefit of finance as:

$$P_{si}F_{si} = P_s F_s^{\frac{1}{\sigma}} F_{si}^{\frac{\sigma-1}{\sigma}}$$

The marginal nominal benefit of debt must equal the marginal nominal cost of debt for the maximizing firm, so the first-order condition with respect to $D_{si} + K^l_{si}$ gives:

$$\alpha_s \frac{\sigma-1}{\sigma} \frac{P_{si}F_{si}}{\alpha_s(D_{si}+K^l_{si})+(1-\alpha_s)(D_{si}+K^l_{si})^{\frac{1}{\gamma_s}} E_{si}^{\frac{\gamma_s-1}{\gamma_s}}}$$
$$= \frac{\partial}{\partial(D_{si}+K^l_{si})}\left[(1+\tau_{D_{si}})\, r_{si} D_{si} + (1+\tau_{E_{si}})\,\lambda_{si}E_{si} + \left(1+\Delta_{K^l_{si}}\right)\tau^l_{si}K^l_{si}\right] \quad (14)$$

Similarly, the first-order condition with respect to E_{si} reads:

$$(1-\alpha_s)\,\frac{\sigma-1}{\sigma} \frac{P_{si}F_{si}}{\alpha_s(D_{si}+K^l_{si})^{\frac{\gamma_s-1}{\gamma_s}} E_{si}^{\frac{1}{\gamma_s}}+(1-\alpha_s)E_{si}}$$
$$= \frac{\partial}{\partial E_{si}}\left[(1+\tau_{D_{si}})\, r_{si} D_{si} + (1+\tau_{E_{si}})\,\lambda_{si}E_{si} + \left(1+\Delta_{K^l_{si}}\right)\tau^l_{si}K^l_{si}\right]. \quad (15)$$

An important feature is, the marginal cost of debt and equity are equal to the marginal costs from the Modigliani and Miller (1958) (MM hereafter) benchmark when $\sigma \to \infty, \gamma_s \to \infty$, and $\tau_{D_{si}} = \tau_{E_{si}} = \Delta_{K^l_{si}} = 0$ (i.e., when total debt and equity become perfect substitutes and no wedges exist). We provide further details in Appendix D.

3 Empirical analysis

In this section, we provide evidence that highlights the role of leasing as an important source of external finance. We then discuss the implications of adjusting for leasing with respect to losses from the misallocation of finance and the costs of finance, both in the cross-section and in the time series.

3.1 Data

Our sample consists of US public firms from Compustat in the manufacturing sector with Standard Industrial Classification (SIC) codes between 2000 and 3999 during the period 1978 to 2017. We measure firm-level traditional debt using the sum of DLTT, DLC, and AP, where DLTT, DLC, and AP denote long-term debt, debt in current liabilities, and accounts payable, respectively. We measure shareholder's equity E_{si} using AT-LT, where AT and LT denote total assets and total liabilities, respectively.[16] With respect to the unmeasured debt from leasing activities, we follow Rampini and Viswanathan (2013), Lim et al. (2017) and Li and Tsou (2019) to estimate its amount K^l_{si}. This is also equal to the measured amount of leased capital. We calculate the value-added of firm i in industry j at time t using data on operating income (OIBDP), rental expense (XRENT), the number of employees (EMP), and wage information from NBER-CES Manufacturing Industry Database. As in Covas and Den Haan (2011), our main analysis drops the top 10% of firms by asset size. We also exclude observations with key missing variables. The details of the data construction are provided in Appendix A.

3.2 Stylized facts of leasing

We define (traditional) debt leverage as the ratio of a firm's total borrowing over the sum of leased capital and total assets, and define rental leverage as the ratio of lease-induced debt over the sum of leased capital and total assets.[17] Lease-adjusted leverage is the sum of debt leverage and rental leverage. The rental share is calculated as the ratio between rental expense over the sum of capital expenditure (CAPX) plus rental expense, measuring the proportion of total capital expenditure from leasing activities in a firm's investment. Table 1 reports the summary statistics of leverage and rental share for the aggregate and for the cross-sectional firms in our sample.

[Place Table 1 about here]

Panel A presents two salient observations. First, the lease-adjusted leverage, defined as the sum of debt and rental leverage, is 66% larger than the debt leverage. It suggests that

[16] As in Whited and Zhao (2021), we do not distinguish between external and internal equity.

[17] The literature also measures debt leverage using DLTT only, or using DLTT+DLC. In untabulated results and robustness checks, we confirm that using these measures generates even more salient effects.

leasing is an essential source of external finance, which complements traditional financial debt. Second, leasing activities are substantial: the rental share gives a proportion of 27%. Consistent with Eisfeldt and Rampini (2009) and Li and Xu (2020), this observation implies that leasing also plays a key role in a firm's production and investment.

In Panel B, we sort firms into three groups based on their size. We use total book assets as our measure of size. First, we observe a large dispersion in the traditional debt leverage, ranging from 0.19 to 0.28. The lease-adjusted leverage, however, is rather flat across size groups. This finding reveals that the size-leverage puzzle, which documents that "small firms have low leverage," can be largely reconciled by rental leverage, similar to that observed in Rampini and Viswanathan (2013). Second, the average rental share of small firms (0.34) is significantly higher than that of large firms (0.23).

The next two facts are about the cyclical properties of leasing activities. These have been documented in previous studies (see Zhang (2012), Gal and Pinter (2017), and Li and Xu (2020)):

1. Leasing is becoming a more significant part of aggregate capital expenditures and production inputs.
2. Leasing is countercyclical. There is an obvious increase in leasing activities whenever there is a recession.

In summary, these stylized facts recognize that leasing can be an even more important source of external finance, particularly for small firms, and that its importance is growing over time. In Sections 3.4 and 3.5, we will present evidence to show that lease-induced debt is an important source of "unmeasured" debt, which leads to significant implications on misallocation of finance and costs of finance.

3.3 Key parameter estimation

Before we present our results on misallocation and costs of finance, we discuss our estimation of key parameters in this section. Only with these in hand can we compute the targets in our model.

We first estimate γ_s at the sector level. The most natural and common approach is to use the simple ordinary least squares (OLS) regression. However, OLS is subject to endogeneity problems, as factor inputs are choice variables of the firm, which depend on the unobserved A_{si}. This leads to a natural correlation of the error term with the regressors, since the error term is a function of A_{si}. We extend the method in Kmenta (1967) and use OLS estimation with fixed effects. This specification with fixed effects avoids the endogeneity issues by assuming that A_{si} varies only in the cross-section but not over time.[18]

[Place Table 2 about here]

Table 2 summarizes the sector-level estimates of γ_s. Without lease-adjustment, we find that the sector-level estimates range between 1.09 and 2.36 in the US. After we make the adjustment, the range is between 1.33 and 2.35. For each individual sector, the change of estimates ranges from -0.07 to 0.29.

We next turn our attention to the elasticity of substitution σ. The losses from misallocation of finance are increasing in σ. This is because a low σ implies that efficiently reallocating debt and equity would result in the most productive firms receiving only a modest amount of finance. Hence, a larger size implies movement down a steep demand curve, which limits losses from misallocation, or equivalently, the reallocation gains. Hsieh and Klenow (2009) set the elasticity of substitution between plant value-added to $\sigma = 3$, consistent with the range given by the trade and industrial organization literatures (which is typically from three to ten) (Broda and Weinstein, 2006; Hendel and Nevo, 2006). Whited and Zhao (2021) chooses

[18] We construct the regressand (i.e., the real value-added) by deflating nominal value-added by the shipments price deflator from the NBER productivity database.

$\sigma = 1.77$. We choose the average of these two studies and set $\sigma = 2.39$. Later we entertain the values of 1.77 and 3 for σ as robustness checks, as in Hsieh and Klenow (2009) and Whited and Zhao (2021). Of course, the elasticity surely differs across goods, so our single σ is a strong simplifying assumption.

3.4 Losses from misallocation of finance

3.4.1 Aggregate results

On the basis of these parameters and the firm data, we infer the extent of finance misallocation of finance within our model framework. Specifically, at the firm level, we compare the value-added under efficient levels of financing with the value-added under actual levels of financing. We then aggregate these value-added to sectors and to the aggregate economy.[19] We compare these aggregated value-added to measure losses from misallocation of finance. We conduct the same procedure both with and without adjusting for leasing.

[Place Table 3 about here]

Table 3 reports the estimates of losses from misallocation of finance across firms within a sector for eight subperiods. Columns (2) and (4) report the observed unadjusted and adjusted US real benefit of finance as a fraction of the optimal real benefit, $\frac{F_{\text{unadj.}}}{\hat{F}_{\text{unadj.}}}$ and $\frac{F_{\text{adj.}}}{\hat{F}_{\text{adj.}}}$, respectively. Columns (3) and (5) show the corresponding losses from finance misallocation for both unadjusted and adjusted measures, calculated as $\frac{\hat{F}_{\text{unadj.}} - F_{\text{unadj.}}}{F_{\text{unadj.}}}$ and $\frac{\hat{F}_{\text{adj.}} - F_{\text{adj.}}}{F_{\text{adj.}}}$, respectively. We find that the percent discrepancy between the optimal and the observed allocation of finance for US firms is 24.3% under the unadjusted measure, while the percent discrepancy for the adjusted measure is only 18.8%. Thus, merely adjusting for lease, US manufacturing firms would stand to gain about 5.5% in terms of real value-added. Applying this magnitude for total economy real GDP, this amount represents billions of dollars.[20]

[19]We define sectors by three-digit SIC industry codes.

[20]This magnitude of gain is estimated to be a sizable amount of about 800 billion dollars in 2007.

Importantly, although a simple static model based on the framework in Melitz (2003), Hsieh and Klenow (2009), and Whited and Zhao (2021) could be misspecified, our comparison of the two estimates of misallocation for unadjusted and adjusted measures effectively deals with this issue and isolates the gains from adjusting for lease-induced liabilities.

3.4.2 Reallocation decomposition

To understand whether the adjustment impacts the amount of finance available to US firms or the type of finance, we compare the percentage gains in Table 3 to the case in which $\gamma_s = \infty$. When $\gamma_s = \infty$, the type of finance does not matter for aggregate value-added because debt and equity become perfect substitutes. Hence, the corresponding losses are all attributed to misallocation of scale (i.e., the mismatch of TFB and the total amount of finance). Then, the difference in percentage gains between these two cases originates from the effect of lease-adjustment on the type of finance.

[Place Table 4 about here]

Table 4 reports our results, indicating that the consideration of leasing not only improves the mix of finance types, but also lifts total firm resources with respect to their productivities. The effects on both aspects are equally important. Specifically, we find that, on average, around 60% of the allocation gains from lease-adjustment can be attributed to the improved allocation of scale.

We dig deeper on the relation between the dispersion of debt-to-equity ratios and the result on the misallocation of finance types. As shown in Table 1, the dispersion in traditional debt-to-equity ratios is large, while the dispersion using total debt is rather flat across different size groups. This finding raises a two-fold questions: why are the losses from mix of finance types are low, despite a large dispersion in the traditional debt-to-equity ratio? Why are over 50% of efficiency gains from lease-adjustment attributed to the improvement in misallocation of scale? First of all, even if different finance types have a low elasticity of substituitions, they still have substitutibility with each other, which weakens the effect of misallocated finance types. Also, scale distortions mitigate mix distortions, meaning that a large scale distortion will make mix distortions less severe. These together explain the first part of our two-fold question. As a result (and in response to the second part), though adjusting for lease-induced debt reveals a sharp drop of debt-to-equity ratio dispersion, the overall effect is not as large as that for the total scale of finance.

3.4.3 Results over time

The results over different subperiods in Table 3 suggest that the difference between two losses from misallocation - specifically, the allocation efficiency gain from adjusting for lease - grows over time. It accounts for nearly 6.7% by the end of the sample, compared to less than 2.5% at the beginning of our sample. The top panel in Figure 1 also confirms this finding. This growing magnitude echoes the stylized fact that the leasing intensity has increased over the last 40 years.

[Place Figure 1 about here]

Furthermore, we find that the gap between two different measures increases during recessions and drops in booms, implying a nontrivial role that leasing plays with respect to the allocation efficiency over the business cycle. We zoom in and study the relation between H-P filtered cyclical components and the output. The bottom panel in Figure 1 compares these two series and exhibits a clear pattern of countercyclicality.

We then calculate the correlations of our interested variables with output. The unadjusted measure is significantly positively correlated with output, having a correlation coefficient of 0.35. This means that $\frac{F_{\text{unadj.}}}{\hat{F}_{\text{unadj.}}}$ is procyclical, and correspondingly, the losses from misallocation of finance are high in bad times and low in good times (i.e., countercyclical). This finding is consistent with the extant literature. However, the adjusted measure is less significantly correlated with output, with the correlation coefficient being only 0.19. This represents a less procyclical pattern in the fractional benefit and hence less countercycality in the imputed losses. Finally, we compute the correlation coefficient between the allocation gain from lease-adjustment and the output. We find a negative correlation coefficient of -0.48, which is significant at the 1% level. Our result demonstrates an important role leasing plays in reducing efficiency losses and smoothing efficiency fluctuations over the business cycle.

3.4.4 Results in the cross-section

We now stratify our sample by firm size and present the 10-year estimates of losses from finance misallocation.

[Place Table 5 about here]

Table 5 conveys two important messages. First, small US firms suffer substantially more losses from misallocation of finance, both for unadjusted and adjusted measures. For unadjusted measures, the implied losses in the smallest group (59.1%) are significantly higher than those for the largest group (7.9%). For adjusted measures, the magnitude of implied losses is lower but the gap between the smallest and the largest groups is still present: the losses are 39.4% and 6.6% for the smallest and the largest firms, respectively. There are multiple reasons why large firms are closer to operating at an optimal allocation. For example, large firms are more productive and have more access to resources, hold higher bargaining power, and are less subject to financial frictions.

Second, smaller firms enjoy larger allocation gains after adjusting for lease-induced debt. We observe that the gain from adjusting lease-induced debt is more than 19% in the smallest group, whereas it is only 1.4% in the largest group. Indeed, large firms seldom lease; hence, the lease-adjustment would play a negligible role for them. As presented in Section 3.2, leasing accounts for a more important channel of external financing activities for small firms, and it is the first-order determinant of the capital structure of these firms' liability side. Therefore, and more importantly, explicitly accounting for such proportions brings more financing sources to small firms and enables them to lift the allocation efficiency to a greater extent.

3.5 Costs of finance

In this section, we estimate the costs of debt and equity, and present the adjustment to them simultaneously when we take leasing into account. The dispersion in these estimates draws a close connection to efficiency gains and losses in Section 3.4. This mapping is analogous to the link between TFP losses and the dispersion of the marginal product of capital in the capital misallocation literature (Hsieh and Klenow, 2009; Midrigan and Xu, 2014).

3.5.1 Aggregate results

As shown in Section 2.3, these marginal costs include the debt and equity wedges. Table 6 summarizes these post-distortion costs.

[Place Table 6 about here]

We observe that the distortion-inclusive costs of debt and equity decline over time for both the unadjusted and adjusted measures. Also, the average drop in the cost of debt is 0.07, which is about 22% of the original cost of debt, while the average drop in the cost of equity is 0.04, which is over 14% of the unadjusted cost of equity.[21] We note that it is challenging to connect the magnitudes of these costs to the standard returns to loans and securities, as our measures embed frictions and wedges that relate to misallocation of scale and mix.

[21] Using different measures of debt leads to slightly different estimates of costs of finance. Nonetheless, the pattern within each group is similar.

3.5.2 Results in the cross-section

Table 7 presents the distortion-inclusive costs of debt and equity when we partition the sample by size instead of year. In both measures, the average costs of both debt and equity decrease with size. These costs fall more sharply for the unadjusted measures. Incorporating leases lead to a lower cost of debt, and this effect is more salient for small firms. Intuitively, leasing relaxes financial constraints and is cheaper than secured loans, particularly for small and financially constrained firms. Small firms lease more; as a result, their costs of debt drop more when leases are factored in.

[Place Table 7 about here]

3.5.3 Dispersion in costs of finance

Motivated by the capital misallocation literature (Hsieh and Klenow, 2009; Midrigan and Xu, 2014), we use this part to investigate the dispersion in costs of finance and draw the link between such dispersion and efficiency gains/losses. This result is reflected in Figure 2, in which we plot the kernel density estimates of the costs of debt and equity for both the unadjusted and adjusted measures.[22]

[Place Figure 2 about here]

We find a distinct difference in costs of debt in Figure 2a: the distribution of the unadjusted measure has a significantly lower mean and is less spread out. The variance difference between the unadjusted and adjusted measures is 0.21. However, for costs of equity shown in Figure 2b, there is only a minor left shift of the mean, and almost no difference in the distribution of costs of equity across two measures. Indeed, the difference in variance between two measures is only 0.04.

[22] We follow Whited and Zhao (2021) and don't consider risk here.

In Figures 3 and 4, we present the distributions of costs for the first and tenth deciles of firm size. With respect to costs of debt, we observe a more salient drop in small firms and a less obvious decrease in large firms, with the variance difference across the unadjusted and the adjusted measures being 0.29 and 0.12, respectively. For costs of equity, we find that the effects of lease-adjustment are similar across different size groups, with the variance difference being 0.05 and 0.04, respectively.

[Place Figure 3 about here]

[Place Figure 4 about here]

These findings indicate that the inefficiency from debt-to-equity ratio and the heterogeneity in costs of finance stem more from the debt side. This is exactly where leasing, as a source of finance on the liability side, exerts more impact on. Moreover, our results reveal that the decrease of the dispersion in finance costs is larger for small firms, echoing the efficiency gains from lease-adjustment in the cross-section in Section 3.4.4. This empirical exercise establishes the mapping between the distribution in costs of finance (and the reduction in their dispersion) and efficiency losses (and the gains from lease-adjustment). In fact, if we remove the flexibility in the substitution elasticity between different types of finance and instead assume a Cobb-Douglas form, then under a joint log-normal distribution of A_{si} and $P_{si}A_{si}$, we can analytically show the existence of a direct link between efficiency losses and the cross-sectional variance of finance costs, as well as a link between efficiency gains and the reduction in the finance costs variance. Nevertheless, we confirm the close connection of the distribution of marginal costs and efficiency losses, which is directly analogous to the analysis in capital misallocation literature (Hsieh and Klenow, 2009; Midrigan and Xu, 2014) on TFP losses and the dispersion in marginal products of capital.

4 Robustness

In this section, we consider several extensions of our analysis and examine the robustness of our results.

4.1 The substitability between traditional debt and lease-induced debt

First, we examine the robustness of our results in Table 3 to the perfect substitutability assumption between traditional debt and lease-induced debt. We now define the total debt of a firm as a CES bundle of traditional debt and lease-induced debt: $D_{si}^{adj.} = \left[\alpha_s^{\frac{1}{\epsilon}} D_{si}^{\frac{\epsilon-1}{\epsilon}} + (1-\alpha_s)^{\frac{1}{\epsilon}} K_{si}^{l\,\frac{\epsilon-1}{\epsilon}}\right]^{\frac{\epsilon}{\epsilon-1}}$.

We assign a wide range of ϵ and re-calculate the losses from misallocation. When ϵ goes to infinity, we obtain the perfect substitutability case. Table 8 reports our estimates when ϵ is equal to 1.5, 5, 10, 20, 100, and 5000, respectively.[23] We find that choosing different values for the elasticity between traditional debt and lease-induced debt has a negligible effect on the estimated efficiency losses in the US when leases are explicitly accounted for.

[Place Table 8 about here]

4.2 Measurement of firm-level benefit

As pointed out in more recent studies in the literature (e.g., Bils et al. (2021)), the measures of value-added are likely to contain large measurement errors. To alleviate this issue, we use the sum of the market values of debt and equity as an alternative measure. We report our results in Table 9, and find similar results in Table 3.

[Place Table 9 about here]

[23] The choice of 10 is motivated by Gal and Pinter (2017).

4.3 Values for σ

We next vary the parameter value for σ. We set it to the value in Hsieh and Klenow (2009) and Whited and Zhao (2021), and report the estimated losses in Table 10. Our results indicate a positive relation between losses of misallocation and σ. As explained in Section 3.3, a high value of σ implies small price responses to reallocation, which are associated with larger losses and higher gains from reallocation. In light of the evidence in Broda and Weinstein (2006), the value $\sigma = 1.77$ in Whited and Zhao (2021) is conservative, since this lower estimate compresses the efficient size distribution in contrast to the actual observed distribution. When σ rises and gets closer to 3 as in Hsieh and Klenow (2009), the efficient size distribution would substantially expand, which magnifies the losses from misallocation and the reallocation gains become quite large. Nevertheless, within this reasonable range, we find that the percentage gain in efficiency simply from accounting for leasing is sizable, and it is at least 4%.

[Place Table 10 about here]

4.4 Proxy for traditional debt

Finally, we investigate whether our results are robust to different proxies for traditional debt. Instead of using total borrowing in our benchmark analysis, we alternatively plug in the long-term debt as the proxy for traditional debt.[24] As presented in Table 11, our results are largely similar across different measures of traditional debt in our analysis.

[Place Table 11 about here]

[24] This issue is important because financial frictions can influence firms' choices of cash balances as well as their choices of debt.

5 Conclusion

Operating lease induced debt accounts for over half of the traditional financial debt. As an important source of external financing, such rental debt has yet to be explicitly considered in quantifying misallocation of finance (Whited and Zhao, 2021). In this paper, we show how taking rental leverage into account affects the misallocation of finance in US manufacturing firms. Overall speaking, explicitly considering lease-induced debt produces gains of 5.5% in real value-added. In the cross-section, this effect is more salient within small firms. Conditionally, such efficiency gain improvement is countercyclical. Furthermore, we document a substantial drop of costs of finance in our sample, and this drop is more salient among small firms because of their higher lease intensity. Our empirical investigation emphasizes the importance of adjusting for lease-induced debt, as there are strong implications in terms of allocation efficiency, costs of finance, and leverage ratios, among others.

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Tables and Figures

Table 1: Summary statistics

	Panel A	Panel B		
	Aggregate	Size		
Variables	Median	S	M	L
Debt Leverage	0.238	0.193	0.226	0.282
Rental Leverage	0.124	0.150	0.116	0.113
Lease adj. Lev.	0.395	0.379	0.375	0.421
Rental Share	0.265	0.336	0.249	0.233

This table presents summary statistics for the variables related to lease-induced debt in our sample. Rental share is defined as the ratio between rental expense over the sum of capital expenditure (CAPX) plus rental expense. Debt leverage is the ratio of total borrowing (the sum of DLTT, DLC, and AP) over the sum of leased capital and total assets (AT). Rental leverage is the ratio of lease-induced debt over the sum of leased capital and total assets (AT). Leased adjusted leverage is the sum of debt leverage and rental leverage. On the right panel, we split the whole sample into subgroups according to their size each year. Size is defined by total assets. We use 'S', 'M', and 'L' to denote small, medium, and large firm groups. We report time series averages of the cross section median in the table. The sample is from 1978 to 2017 and excludes firms that are not incorporated in the US and/or do not report in US dollars from the analysis.

Table 2: Sector estimates

	Unadj.	Adj.	Diff.
Mininum two-digit γ_s	1.09	1.33	-0.07
Maximum two-digit γ_s	2.36	2.35	0.29
Mean two-digit γ_s	1.54	1.61	0.07

This table presents summary statistics from the two-digit sector-level estimation of the elasticity of substitution between total debt and equity, γ_s. The last two rows show the whole economy γ estimate using the Kmenta (1967) method with fixed effects. The sample is from 1978 to 2017 and excludes firms that are not incorporated in the US and/or do not report in US dollars from the analysis.

Table 3: Reallocation Gains by Year (unadj. v.s. adj.)

	Unadj.		**Adj.**		**Unadj. vs. Adj.**	
Year	**Fraction**	**Losses**	**Fraction**	**Losses**	**Fraction Diff**	**Percent Gain**
1978-1987	0.878	13.9%	0.898	11.4%	0.019	2.46%
1988-1997	0.806	24.1%	0.841	18.9%	0.035	5.23%
1998-2007	0.762	31.2%	0.813	23.1%	0.051	8.16%
2008-2017	0.773	29.5%	0.814	22.8%	0.042	6.66%
mean	0.805	24.3%	0.841	18.8%		5.5%

This table presents the 10-year losses from misallocation in the US for unadjusted and adjusted measures. The sample is from 1978 to 2017 and excludes firms that are not incorporated in the US and/or do not report in US dollars from the analysis.

Table 4: Reallocation Gains Decomposition

	Losses (Unadj.)		**Losses (Adj.)**		**Unadj. vs. Adj.**	
Year	**Scale**	**Type**	**Scale**	**Type**	**Scale Gain**	**Type Gain**
1978-1987	10.0%	3.9%	8.5%	2.9%	1.5%	1.0%
1988-1997	16.7%	7.4%	13.7%	5.1%	3.0%	2.3%
1998-2007	21.8%	9.4%	16.3%	6.8%	5.5%	2.7%
2008-2017	19.5%	9.9%	16.0%	6.8%	3.5%	3.1%
mean	16.8%	7.5%	13.5%	5.3%	3.3%	2.2%

This table presents the decomposition of the 10-year losses from misallocation in the US for unadjusted and adjusted measures. The sample is from 1978 to 2017 and excludes firms that are not incorporated in the US and/or do not report in US dollars from the analysis.

Table 5: Reallocation Gains by Size

	S			**M**			**L**		
Year	**Unadj.**	**Adj.**	**Gain Diff**	**Unadj.**	**Adj.**	**Gain Diff**	**Unadj.**	**Adj.**	**Gain Diff**
1978-1987	0.775	0.832	8.9%	0.912	0.917	0.6%	0.944	0.954	1.1%
1988-1997	0.673	0.801	23.9%	0.785	0.813	4.3%	0.914	0.925	1.3%
1998-2007	0.534	0.602	21.3%	0.769	0.817	7.6%	0.885	0.911	3.2%
2008-2017	0.534	0.634	29.4%	0.672	0.719	9.8%	0.963	0.964	0.1%
mean	0.629	0.717	19.6%	0.785	0.817	5.0%	0.927	0.939	1.4%

This table presents the 10-year losses from misallocation across size groups for unadjusted and adjusted measures. The sample is from 1978 to 2017 and excludes firms that are not incorporated in the US and/or do not report in US dollars from the analysis.

Table 6: Costs of Debt and Equity by Year (unadj. v.s. adj.)

	Unadj. (Median)		**Adj. (Median)**		**Unadj. vs. Adj.**	
Year	**Debt**	**Equity**	**Debt**	**Equity**	**Debt Diff**	**Equity Diff**
1978-1987	0.384	0.378	0.309	0.311	0.075	0.067
1988-1997	0.363	0.313	0.280	0.265	0.083	0.048
1998-2007	0.319	0.252	0.247	0.221	0.072	0.030
2008-2017	0.311	0.223	0.245	0.201	0.066	0.022
mean	0.344	0.292	0.270	0.250	0.074	0.042

This table presents the 10-year median costs of finance for unadjusted and adjusted measures. The sample is from 1978 to 2017 and excludes firms that are not incorporated in the US and/or do not report in US dollars from the analysis.

Table 7: Costs of Debt and Equity by Size (unadj. v.s. adj.)

	Unadj.		**Adj.**		**Unadj. vs. Adj.**	
Group	**Debt**	**Equity**	**Debt**	**Equity**	**Debt Diff**	**Equity Diff**
S	0.422	0.304	0.285	0.259	0.137	0.045
M	0.360	0.287	0.282	0.246	0.078	0.042
L	0.303	0.301	0.257	0.258	0.046	0.043

This table presents the costs of finance across size groups for unadjusted and adjusted measures. The sample is from 1978 to 2017 and excludes firms that are not incorporated in the US and/or do not report in US dollars from the analysis.

Table 8: Reallocation Gains by Year (unadj. v.s. adj.) for CES of debt and lease

	Fraction	**Average Losses**	**Gain**
Unadj.	0.805	24.28%	
Adj.			
Perfect Substitutes	0.841	18.84%	5.44%
ϵ=5000	0.841	18.84%	5.44%
ϵ=100	0.842	18.83%	5.45%
ϵ=20	0.842	18.80%	5.48%
ϵ=10	0.842	18.76%	5.52%
ϵ=5	0.842	18.72%	5.56%
ϵ=1.5	0.840	19.06%	5.22%

This table presents the mean losses from misallocation in the US for unadjusted and adjusted measures, when traditional debt and lease are not perfect substitutes. The sample is from 1978 to 2017 and excludes firms that are not incorporated in the US and/or do not report in US dollars from the analysis.

Table 9: Reallocation Gains by Year (unadj. v.s. adj.) with Market Value Benefit

	Unadj.		**Adj.**		**Unadj. vs. Adj.**	
Year	**Fraction**	**Losses**	**Fraction**	**Losses**	**Fraction Diff**	**Percent Gain**
1978-1987	0.860	16.3%	0.905	10.5%	0.045	5.8%
1988-1997	0.751	33.1%	0.796	25.6%	0.045	7.5%
1998-2007	0.678	47.4%	0.720	38.9%	0.042	8.6%
2008-2017	0.724	38.1%	0.768	30.1%	0.044	8.0%
mean	0.753	32.7%	0.797	25.4%		7.3%

This table presents the 10-year losses from misallocation in the US for unadjusted and adjusted measures, when the nominal benefit of finance is measured as the market value of debt plus the market value of equity. The sample is from 1978 to 2017 and excludes firms that are not incorporated in the US and/or do not report in US dollars from the analysis.

Table 10: Reallocation Gains by Year (unadj. v.s. adj.) under Different σ

	Unadj.		**Adj.**		**Unadj. vs. Adj.**	
Year	**Fraction**	**Losses**	**Fraction**	**Losses**	**Fraction Diff**	**Percent Gain**
σ=1.77						
1978-1987	0.900	11.1%	0.917	9.0%	0.017	2.1%
1988-1997	0.843	18.6%	0.873	14.5%	0.030	4.1%
1998-2007	0.807	23.8%	0.849	17.8%	0.041	6.0%
2008-2017	0.815	22.7%	0.850	17.6%	0.035	5.0%
mean	0.841	18.8%	0.872	14.6%		4.2%
σ=3						
1978-1987	0.858	16.6%	0.879	13.8%	0.021	2.8%
1988-1997	0.769	30.0%	0.810	23.4%	0.041	6.6%
1998-2007	0.719	39.0%	0.778	28.6%	0.058	10.4%
2008-2017	0.732	36.6%	0.780	28.2%	0.048	8.4%
mean	0.770	29.9%	0.812	23.2%		6.8%

This table presents the 10-year losses from misallocation in the US for unadjusted and adjusted measures, when we vary the value of parameter σ. The sample is from 1978 to 2017 and excludes firms that are not incorporated in the US and/or do not report in US dollars from the analysis.

Table 11: Reallocation Gains by Year (unadj. v.s. adj.) with Alternative Debt

	Unadj.		**Adj.**		**Unadj. vs. Adj.**	
Year	**Fraction**	**Losses**	**Fraction**	**Losses**	**Fraction Diff**	**Percent Gain**
1978-1987	0.853	17.2%	0.890	12.4%	0.037	4.8%
1988-1997	0.746	34.1%	0.821	21.8%	0.075	12.3%
1998-2007	0.706	41.6%	0.780	28.2%	0.073	13.3%
2008-2017	0.716	39.7%	0.773	29.4%	0.057	10.30%
mean	0.755	32.4%	0.816	22.6%		9.8%

This table presents the 10-year losses from misallocation in the US for unadjusted and adjusted measures, when the we use DLTT as the measurement of traditional debt. The sample is from 1978 to 2017 and excludes firms that are not incorporated in the US and/or do not report in US dollars from the analysis.

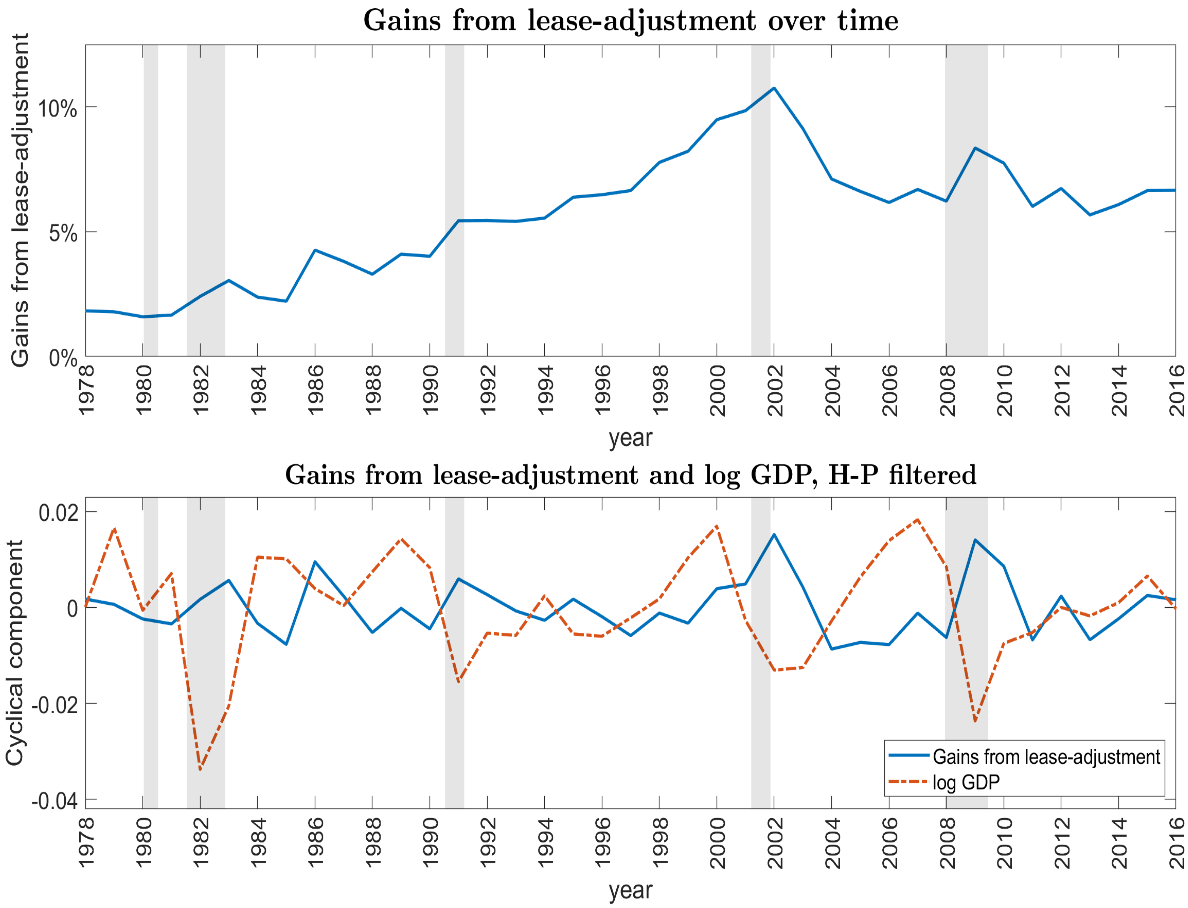


Figure 1: This figure shows the evolution and cyclical patterns of gains in misallocation when lease is explicitly adjusted.

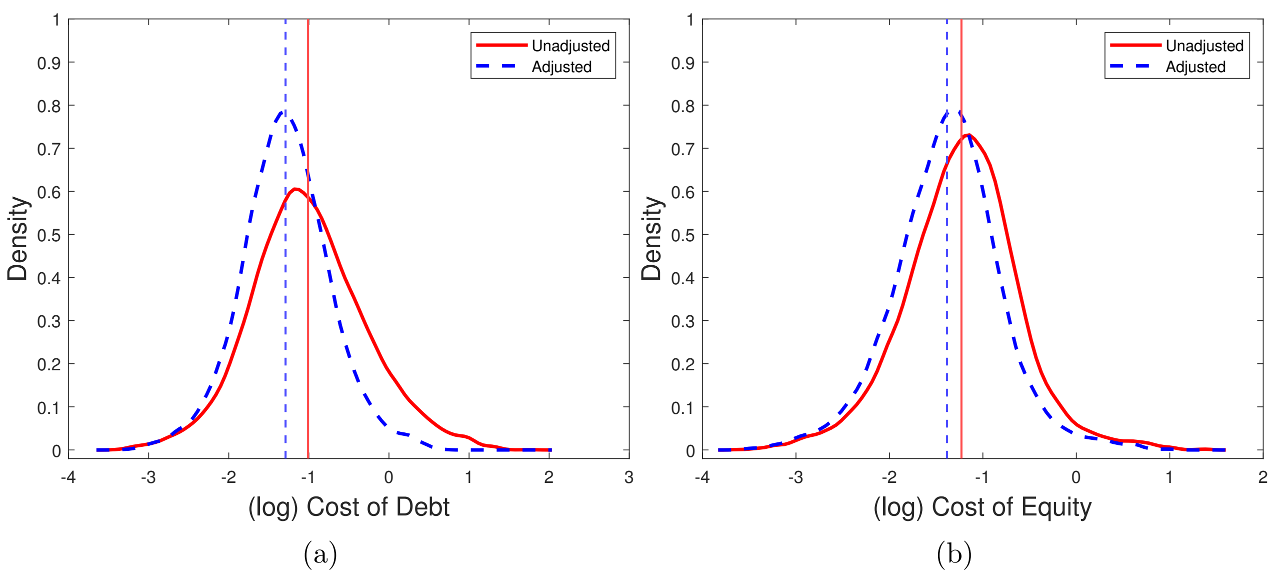
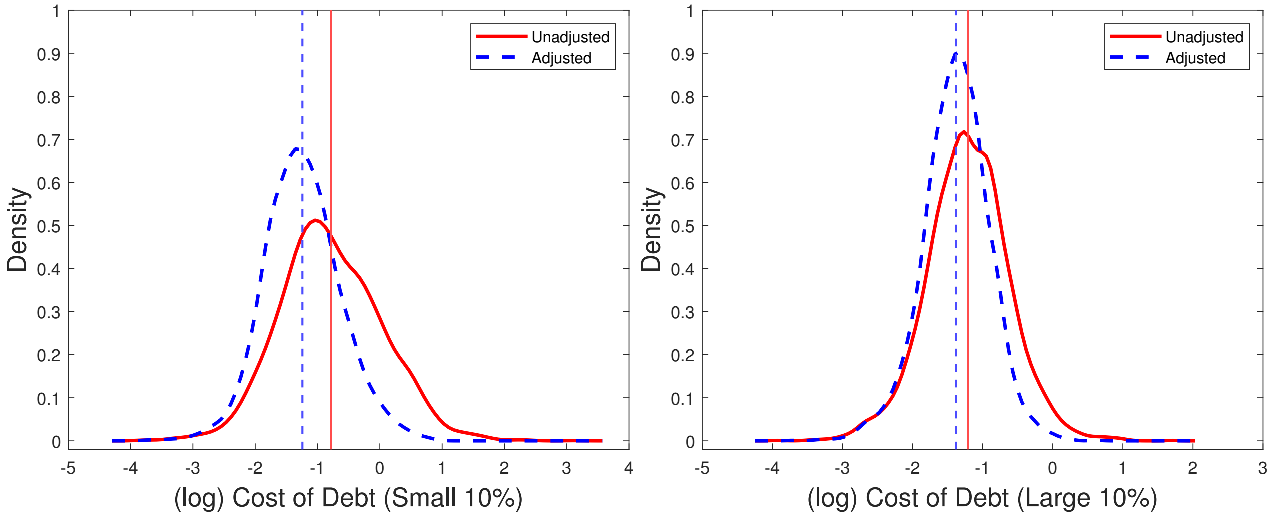
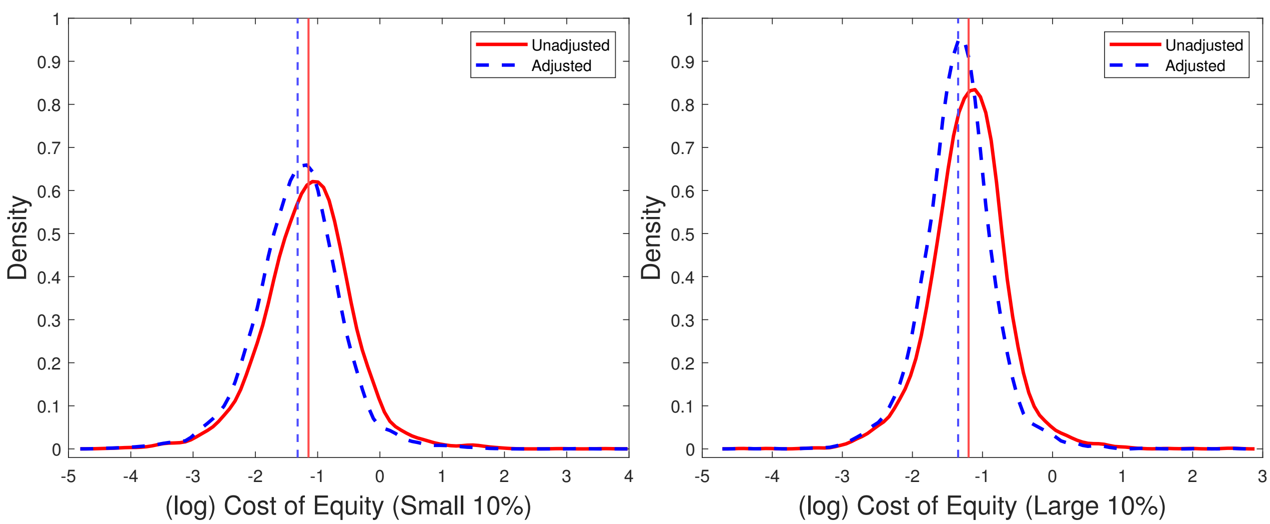


Figure 2: Distribution of (log) Costs of Finance



(a) (b)

Figure 3: Distribution of (log) Costs of Debt for Top and Bottom 10% Firms



(a) (b)

Figure 4: Distribution of (log) Costs of Equity for Top and Bottom 10% Firms

Appendix for Online Publication

A: Data construction

Our sample consists of US public firms from Compustat and includes those with positive rental expenditure data and with Standard Industrial Classification (SIC) codes between 2000 and 3999 (i.e., the manufacturing sector). We keep the years from 1978 to 2017. We measure firm-level traditional debt using the sum of long-term debt (DLTT), debt in current liabilities (DLC), and accounts payable (AP). We measure shareholder's equity E_{si} using total assets (AT) subtracted by total liabilities (LT). The unmeasured debt induced from leasing activities, or the leased capital stock, is estimated by 10 times rental expenses, as in Rampini and Viswanathan (2013), Lim et al. (2017), Li and Tsou (2019), as well as in common industry practice. As in Covas and Den Haan (2011), our main analysis drops the top 10% of firms by asset size, measured by AT.

We have two measures for value-added, one for unadjusted and the other for adjusted. Both follow İmrohoroğlu and Tüzel (2014) and are computed as Sales (Compustat item, SALE) - Materials, deflated by the GDP price deflator from US NIPA. Materials is measured as Total expenses minus Labor expenses. Total expenses is approximated as the difference between firm Sales and firm operating profits. For the unadjusted measure, the operating profit is equal to Operating Income Before Depreciation and Amortization (OIBDP); for the adjusted measure, the operating profit is calculated as Operating Income Before Depreciation and Amortization + Rental expense (OIBDP+XRENT), similar to Rauh and Sufi (2012). Labor expenses is calculated by multiplying the number of employees from Compustat (EMP) by average wages at the three-digit SIC industry level from the National Bureau of Economic Research and US Census Bureau's Center for Economic Studies (NBER-CES) Manufacturing Industry Database. The stock of labor (L_{ijt}) is measured by the number of employees from Compustat (EMP). These steps lead to our value-added definitions that are proxied by (unadjusted and adjusted) operating profits+labor expenses; and we deflate them by the aggregate gross domestic product (GDP) deflator from the US NIPA.

We also construct a measure of real value-added in the estimation process in Section 3.3. We deflate the value-added estimated above using the shipments price deflator from NBER-CES.

B: Accounting rule

In February 2016, the Financial Accounting Standards Board (FASB) issued updated accounting standards for lease (ASU 2016-02, Topic 842). Effective from 2019, firms are required to recognize lease assets and lease liabilities from off-balance-sheet activities on their balance sheets, which increases the transparency and comparability among organizations and disclosing key information about leasing transactions. The exact adoption rule differs across firms. For public firms and certain other entities, ASC 842 is effective for annual periods beginning after December 15, 2018. For private firms, the new lease accounting adoption was set be effective for reporting periods beginning subsequent to December 15, 2019.

After adopting the new accounting rule, firms now report "Lease right-of-use asset" on the asset side, and report both short-term and long-term lease liabilities on the liability side. These items were absent before the adoption of the new operating lease accounting rule. Additionally, firms are required to report the estimates of their operating leases, including the value, average regaining life, and discount rate, as well as disclose the possibility of renewing or extending existing leases. Figure B.1 shows the example from Shake Shack's financial statement in 2019. We see the new rule has a major impact on both Shake Shack's asset and liability side.

ASC 842 has proved a major change in accounting, and FASB has issued several accounting standard updates and amendments to it since the publishment in 2016. In response to

SHAKE SHACK INC.
CONSOLIDATED BALANCE SHEETS
(in thousands, except share and per share amounts)

	December 25 2019	December 26 2018
ASSETS		
Current assets:		
Cash and cash equivalents	$ 37,099	$ 24,750
Marketable securities	36,508	62,113
Accounts receivable	9,970	10,523
Inventories	2,221	1,749
Prepaid expenses and other current assets	1,877	1,984
Total current assets	87,675	101,119
Property and equipment, net	314,862	261,854
Operating lease assets	274,426	—
Deferred income taxes, net	279,817	242,533
Other assets	11,488	5,026
TOTAL ASSETS	$ 968,268	$ 610,532
LIABILITIES AND STOCKHOLDERS' EQUITY		
Current liabilities:		
Accounts payable	$ 14,300	$ 12,467
Accrued expenses	24,140	22,799
Accrued wages and related liabilities	11,451	10,652
Operating lease liabilities, current	30,002	—
Other current liabilities	19,499	14,030
Total current liabilities	99,392	59,948

Figure B.1: This figure shows excerpts from Shake Shack's balance sheet in its 2019 financial statement. It includes the asset side and the liability side.

COVID-19, FASB has proposed the deferral of the new lease accounting standard effective date for certain entities such as private entities, including private not-for-profit entities.

The International Accounting Standards Board (IASB) also released IFRS 16 on new lease standards requiring nearly all leases to be reported on lessees' balance sheets as assets and liabilities in 2016, effective for annual periods beginning on or after January 1, 2019.

C: Model derivations

$$\max_{\{F_{si}\}} \left\{ p_s F_s - \int_{[0,1]} p_{si} F_{si} di \right\} = p_s \left[\int_{[0,1]} F_{si}^{\frac{\eta-1}{\eta}} di \right]^{\frac{\eta}{\eta-1}} - \int_{[0,1]} p_{si} F_{si} di$$

FOC wrt $[F_{si}]$:

$$p_{si} = p_s F_{si}^{-\frac{1}{\eta}} F_s^{\frac{1}{\eta}}$$

We present the Lagrangian of firm i :

$$\begin{aligned} L_i &= \max\left[\pi_{si}\right] \\ + \quad \eta_{i1} & \left\{p_{si}F_{si} - \left[\left(1+\tau_{D_{si}}\right) rD_{si} + \left(1+\tau_{E_{si}}\right)\lambda E_{si} + \left(1+\Delta_{K_{si}^l}\right)\tau_l K_{si}^l\right] - \pi_{si}\right\} \end{aligned}$$

FOCs:

$$[D_{si}] : p_s\alpha_s\left(1-\frac{1}{\eta}\right)F_s^{\frac{1}{\eta}}F_{si}^{\frac{-1}{\eta}}\left\{A_{si}\left(\alpha_s\left[D_{si}+K_{si}^l\right]^{\frac{\gamma-1}{\gamma}} + (1-\alpha_s)E_{si}^{\frac{\gamma-1}{\gamma}}\right)^{\frac{1}{\gamma-1}}\left[D_{si}+K_{si}^l\right]^{\frac{-1}{\gamma}}\right\} - \left(1+\tau_{D_{si}}\right)r = 0 \quad \text{(C1)}$$

$$[E_{si}] : p_s\left(1-\alpha_s\right)\left(1-\frac{1}{\eta}\right)F_s^{\frac{1}{\eta}}F_{si}^{\frac{-1}{\eta}}\left\{A_{si}\left(\alpha_s\left[D_{si}+K_{si}^l\right]^{\frac{\gamma-1}{\gamma}} + (1-\alpha_s)E_{si}^{\frac{\gamma-1}{\gamma}}\right)^{\frac{1}{\gamma-1}}\left[E_{si}\right]^{\frac{-1}{\gamma}}\right\} - \left(1+\tau_{E_{si}}\right)\lambda = 0 \quad \text{(C2)}$$

$$[K_{si}^l] : p_s\alpha_s\left(1-\frac{1}{\eta}\right)F_s^{\frac{1}{\eta}}F_{si}^{\frac{-1}{\eta}}\left\{A_{si}\left(\alpha_s\left[D_{si}+K_{si}^l\right]^{\frac{\gamma-1}{\gamma}} + (1-\alpha_s)E_{si}^{\frac{\gamma-1}{\gamma}}\right)^{\frac{1}{\gamma-1}}\left[D_{si}+K_{si}^l\right]^{\frac{-1}{\gamma}}\right\} - \left(1+\Delta_{K_{si}^l}\right)\tau_l = 0 \quad \text{(C3)}$$

The first two equations imply that:

$$\frac{\alpha_s\left[D_{si}+K_{si}^l\right]^{\frac{-1}{\gamma}}}{\left(1-\alpha_s\right)\left[E_{si}\right]^{\frac{-1}{\gamma}}} = \frac{\left(1+\tau_{D_{si}}\right)r}{\left(1+\tau_{E_{si}}\right)\lambda}$$

$$\Rightarrow \left[\frac{\alpha_s\left(1+\tau_{E_{si}}\right)\lambda}{\left(1-\alpha_s\right)\left(1+\tau_{D_{si}}\right)r}\right]^{\gamma} = \frac{D_{si}+K_{si}^l}{E_{si}}$$

Similarly, we have:

$$\left[\frac{\alpha_s\left(1+\tau_{E_{si}}\right)\lambda}{\left(1-\alpha_s\right)\left(1+\Delta_{K_{si}^l}\right)\tau_l}\right]^{\gamma} = \frac{D_{si}+K_{si}^l}{E_{si}}$$

$$\frac{\left(1+\tau_{D_{si}}\right)r}{\left(1+\Delta_{K_{si}^l}\right)\tau_l} = 1$$

From now on, we calculate p_{si}. We replace $p_s F_s^{\frac{1}{\eta}} F_{si}^{\frac{-1}{\eta}}$ with p_{si}. Hence:

$$\begin{cases} p_{si}\alpha_s\left(1-\frac{1}{\eta}\right)A_{si}\left(\frac{F_{si}}{A_{si}}\right)^{\frac{1}{\gamma}} = \left(1+\tau_{D_{si}}\right)r\left[D_{si}+K_{si}^l\right]^{\frac{1}{\gamma}} \\ p_{si}\left(1-\alpha_s\right)\left(1-\frac{1}{\eta}\right)A_{si}\left(\frac{F_{si}}{A_{si}}\right)^{\frac{1}{\gamma}} = \left(1+\tau_{E_{si}}\right)\lambda\left[E_{si}\right]^{\frac{1}{\gamma}} \\ p_{si}\alpha_s\left(1-\frac{1}{\eta}\right)A_{si}\left(\frac{F_{si}}{A_{si}}\right)^{\frac{1}{\gamma}} = \left(1+\Delta_{K_{si}^l}\right)\tau_l\left[D_{si}+K_{si}^l\right]^{\frac{1}{\gamma}} \end{cases} \tag{C4}$$

$$\left(1-\frac{1}{\eta}\right)p_{si}A_{si}\left(\frac{F_{si}}{A_{si}}\right)^{\frac{1}{\gamma}} = \left(1+\tau_{D_{si}}\right)r\left[D_{si}+K_{si}^l\right]^{\frac{1}{\gamma}} + \left(1+\tau_{E_{si}}\right)\lambda\left[E_{si}\right]^{\frac{1}{\gamma}}$$

$$\Longrightarrow p_{si} = \frac{1}{A_{si}}\left(\frac{A_{si}}{F_{si}}\right)^{\frac{1}{\gamma}}\frac{1}{\left(1-\frac{1}{\eta}\right)}\left(\left(1+\tau_{D_{si}}\right)r\left[D_{si}+K_{si}^l\right]^{\frac{1}{\gamma}} + \left(1+\tau_{E_{si}}\right)\lambda\left[E_{si}\right]^{\frac{1}{\gamma}}\right)$$

When we plug in the definition of F_{si}, we have:

$$\Longrightarrow p_{si} = \frac{1}{A_{si}}\left(\frac{1}{1\left(\alpha_s\left[D_{si}+K_{si}^l\right]^{\frac{\gamma-1}{\gamma}} + \left(1-\alpha_s\right)E_{si}^{\frac{\gamma-1}{\gamma}}\right)^{\frac{\gamma}{\gamma-1}}}\right)^{\frac{1}{\gamma}}\frac{1}{\left(1-\frac{1}{\eta}\right)}\left(\left(1+\tau_{D_{si}}\right)r\left[D_{si}+K_{si}^l\right]^{\frac{1}{\gamma}} + \left(1+\tau_{E_{si}}\right)\lambda\left[E_{si}\right]^{\frac{1}{\gamma}}\right)$$

$$\begin{aligned} \Longrightarrow \quad p_{si} &= \frac{1}{A_{si}}\frac{\eta}{\eta-1}\left(\alpha_s\left[\frac{D_{si}+K_{si}^l}{E_{si}}\right]^{\frac{\gamma-1}{\gamma}} + \left(1-\alpha_s\right)\right)^{\frac{-1}{\gamma-1}}\left(1+\tau_{D_{si}}\right)r\left[\frac{D_{si}+K_{si}^l}{E_{si}}\right]^{\frac{1}{\gamma}} \\ &+ \frac{1}{A_{si}}\frac{\eta}{\eta-1}\left(\alpha_s\left[\frac{D_{si}+K_{si}^l}{E_{si}}\right]^{\frac{\gamma-1}{\gamma}} + \left(1-\alpha_s\right)\right)^{\frac{-1}{\gamma-1}}\left(1+\tau_{E_{si}}\right)\lambda \end{aligned}$$

D: Modigliani and Miller (MM) benchmark

Importantly, without the wedges, the marginal cost of debt and equity are just the marginal costs from the MM benchmark, in which $\sigma \to \infty, \gamma_s \to \infty$, and $\tau_{D_{si}} = \tau_{E_{si}} = \Delta_{K_{si}^l} = 0$. We refer to this case as the MM benchmark or limit. In particular, as the elasticity of substitution between total debt and equity goes to infinity, debt and equity become perfect substitutes. In general, a nontrivial elasticity of substitution between debt and equity can be interpreted as the result of some not-explicitly modeled financial frictions.

In this limit, the nominal profit of finance converges to zero, as follows:

$$\pi_{si} = P_{si}F_{si} - \left(r_{si}D_{si} + \lambda_{si}E_{si} + \tau^l_{si}K^l_{si}\right) = 0.$$

Next, from a dual problem in which the total amount of finance is the firm's sole financial liability, we can derive a similar expression:

$$P_{si}F_{si}/u_{si} = D_{si} + K^l_{si} + E_{si},$$

where u_{si} is the average cost of capital for firm i in sector s. This relation is essentially MM Proposition I. That is, the nominal benefit of finance of any firm is independent of its capital structure, but rather depends only on the sum of its liabilities. We can therefore obtain a standard expression for the weighted average cost of capital:

$$u_{si} = r_{si}\frac{D_{si} + K^l_{si}}{D_{si} + K^l_{si} + E_{si}} + \lambda_{si}\frac{E_{si}}{D_{si} + K^l_{si} + E_{si}}$$

where u_{si} can also be interpreted as the fixed return on unlevered equity. As is standard, one implication is that the costs of debt, r_{si}, and equity, λ_{si}, adjust to satisfy MM Proposition II, which is:

$$\lambda_{si} = u_{si} + \frac{D_{si} + K^l_{si}}{E_{si}}\left(u_{si} - r_{si}\right)$$

We note that r_{si} and λ_{si} are functions of the debt-to-equity ratio, $(D_{si} + K^l_{si})/E_{si}$. That said, we do not assume a specific functional form, as many possible forms of r_{si} and λ_{si} can satisfy MM Proposition II as long as u_{si} is fixed at the firm level.