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Multinational firms, internal borrowing, and domestic bank loans

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Abstract

This paper studies the external and internal financing decisions of multinational enterprises (MNEs) and their role in the transmission of shocks across borders. We augment the costly-state-verification model of Bernanke et al. [1999] with the internal capital market constraint of an MNE and derive predictions for the optimal response of external and internal borrowing, both at home and abroad, to a change in the return on capital of a foreign affiliate. Using mandatory-reporting data on all Austrian MNEs and their FDI relationships with German affiliates for 2007–2022, we validate our theoretical predictions empirically and find that Austrian parent firms extend less internal credit to more productive German affiliates and reduce their own stock of external liabilities with domestic banks relative to the affiliate's total assets, whereas more productive German affiliates reduce their share of internal liabilities with Austrian parents and increase their external leverage instead.

JEL codes: D24, E44, F23, G32.

Keywords: Bank lending, external finance, financial frictions, internal capital markets, multinational firms.

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The views expressed in this paper are those of the authors and do not necessarily reflect those of the Eurosystem or the OeNB.

1 Introduction

Financial markets are crucial for firm outcomes and affect both their domestic and international operations. Existing empirical evidence shows that access to external funding differs between countries and that firms tend to be constrained by the financial market conditions in their home location.[1] This constraint is more likely binding for firms operating in a single location than for multinational enterprises (MNEs) with a network of affiliate firms spread across different locations. Like local firms, the affiliates of an MNE may operate as separate legal entities that differ in their productivity and raise external funding independently to finance capital investments subject to local credit conditions, such as institutional quality and the maturity of the financial market.[2] In contrast to local firms, however, they may also borrow and lend through the MNE's internal capital market, which can reallocate financial capital between units to exploit differences in firm-specific productivity or external borrowing conditions in their locations of operation [see, e.g., Egger et al., 2014, Biermann and Huber, 2024].[3] In the presence of financial frictions, the cost of external borrowing may differ across countries as well as between firms with different returns on capital within the same country, as in the costly-state-verification (CSV) framework in Bernanke et al. [1999].

This paper develops a theoretical model of the optimal financing and investment decisions of an MNE operating in different locations, where affiliates may differ in their returns on capital and costs of external borrowing. Following Bernanke et al. [1999], we model the cost of external borrowing at the firm level in the presence of financial frictions due to asymmetric information about affiliates' ex-post productivity realizations. As a result, the optimal debt contract between an affiliate and a domestic bank depends on the country-specific loan rate as well as the firm's expected return on capital. The MNE maximizes its profits by optimally choosing the amount invested and the leverage ratio of each affiliate, subject to the banks' participation constraints. In contrast to the standard CSV framework, which does *not* allow for financial interactions between firms, the affiliates in our model may borrow externally from a domestic bank as well as internally from a foreign affiliate or the parent firm.

Our theoretical analysis provides novel insights into an MNE's optimal use of internal and external capital markets to allocate productive capital between the parent and its affiliates in different locations. The higher an affiliate firm's return on capital relative to the local risk-free interest rate — a.k.a. the "external finance premium" (EFP) — the higher is the affiliate's

[1]The corporate finance literature shows that cross-country differences in the availability of external finance are important for firm outcomes. For an overview, see Levine [2005] and La Porta et al. [2008], for example.

[2]Companies operating in a single country typically rely on domestic external capital [see, e.g., Henderson et al., 2006].

[3]For earlier empirical evidence on the relevance of internal capital markets, see Meyer and Kuh [1957], Blanchard et al. [1994], and Lamont [1997], for example.

leverage ratio, which implies higher state-verification costs and a higher non-default loan rate to satisfy the bank's participation constraint. Differences in capital returns between affiliates can thus induce the MNE to actively use its internal capital market, which in turn affects its collateral (i.e. the sum of equity and internal funds) and external borrowing conditions in all locations. Accordingly, we find that the leverage ratios and capital investments of affiliates of the same MNE in different locations are interrelated. The model also predicts that internal and external borrowing shares vary systematically with the return on capital of affiliates of the same parent, even if they are located in the same country. By investigating the optimal borrowing decisions of individual firms in a tractable framework, we contribute to earlier research on the relevance of internal capital markets for MNEs, which focus on cross-country differences in borrowing costs only.[4] As one of our main results, we show that internal capital markets can serve to transmit external borrowing conditions between affiliates across borders, a key fact that is neglected in existing studies.

We test our model's theoretical predictions empirically by matching two comprehensive panel datasets provided by the Oesterreichische Nationalbank (OeNB) containing information on the universe of MNE firms in Austria, their foreign affiliates, and their financial relationships with Austrian banks. First, the OeNB's foreign direct investment (FDI) dataset contains detailed balance sheet data for all Austrian MNE firms and their foreign parents or affiliates, such as their location, total assets, external debt, and internal assets and liabilities. Second, the OeNB's credit register contains loan-level data for the universe of Austrian banks, including information on credit volumes at the firm-bank-loan level for all loans above the mandatory reporting threshold of EUR 350,000. In our empirical analysis, we focus on outward FDI relationships of Austrian parent firms with foreign affiliates in Germany — the most important destination (and origin) of Austrian FDI — and the sample period 2007–2022.[5]

Our econometric specifications exploit differences in rates of return on capital between affiliates and over time to investigate the use of external and internal capital markets by MNEs with Austrian parent firms and German affiliates. According to our theoretical predictions, more productive foreign affiliates should optimally finance a larger share of their domestic capital investment using external borrowing and a smaller share using internal borrowing. Our theoretical model further predicts that the domestic parent of a more productive foreign affiliate should borrow less externally and more internally relative to the affiliate's total assets. In line with these theoretical predictions, we find that German affiliates with a higher rate of

[4]Egger et al. [2014] model differences in external borrowing costs through country-specific capital market imperfections, whereas the vast majority of the literature on internal capital markets assumes perfect markets.

[5]We exclude observations prior to 2007 due to a change in the reporting rules for FDI relationships in 2006.

return on capital borrow a significantly smaller fraction of their total assets internally from their Austrian parents and a larger fraction externally, whereas Austrian parents of a more productive German affiliate borrow a smaller fraction of the affiliate's total assets externally from Austrian banks and a larger fraction internally from the German affiliate. These results are robust to different combinations of fixed effects and hold even for two German affiliates of the same Austrian parent firm in the same year.

Related literature

Our paper relates to the literature investigating the functions of internal capital markets in MNEs. According to this literature, MNEs use internal borrowing and lending to reallocate capital between entities and exploit cross-country differences in financial development, investment opportunities, and tax rates. For example, Desai et al. [2004] find that affiliates of U.S. MNEs use internal capital markets more actively in countries where external capital markets are poorly developed and the cost of external financing is higher. In their study, internal borrowing offsets about three quarters of the reduction in external borrowing due to adverse domestic credit market conditions. Buettner et al. [2009] find the same qualitative result for German MNEs. Antràs et al. [2009] develop a theoretical model in which MNEs and FDI flows arise endogenously due to concerns about mismanagement and imperfections in capital markets, because parent firms are assumed to be more efficient monitors of foreign affiliates. They confirm their theoretical predictions empirically using U.S. FDI data. Egger et al. [2014] show that internal capital is allocated to affiliates that are located in financially underdeveloped countries, are more productive, or subject to lower tax rates.

The literature also shows that, because MNEs are less likely to be constrained by local conditions than domestic firms, they suffer less from adverse financial market conditions. For example, Manova et al. [2015] find that foreign-owned affiliates and joint ventures in China export more than domestic firms in financially vulnerable sectors, especially to destinations where trade costs are high. They argue that, using their internal capital markets, MNEs may cover fixed trade costs more easily than domestic firms. Using a worldwide panel of countries, Alfaro and Chen [2012] find that foreign affiliates were less affected by the global financial crisis of 2007–2009 compared to domestic firms, especially those with stronger vertical production and financial relationships with their parents. Desai et al. [2008] and Kalemli-Özcan et al. [2016] investigate the performance of firms during periods of large currency devaluations in the U.S. and South America (Argentina, Brazil, and Mexico), respectively, and find that MNEs expanded their sales, investment, and assets significantly more than domestic firms, because they were able to circumvent financial constraints and substitute internal borrowing for domestic bank loans. Imbierowicz et al. [2025] find that U.K. affiliates of large MNEs off-set adverse credit supply shocks due to the Brexit referendum by borrowing internally, which shielded them from negative real effects. All of these studies exploit exogenous variation in external borrowing conditions — between countries and sectors or over time — to investigate the determinants of firm outcomes and jointly conclude that internal capital markets play an important role for the financing decisions of MNEs.

In the above literature, the cost of external borrowing is generally assumed to be exogenous and identical for firms operating in the same location. However, credit conditions may be subject to bargaining between the borrower and the lender and may vary with the borrower's leverage ratio and default risk, see, e.g., Ottonello and Winberry [2020], Lian and Ma [2021] for empirical evidence. In this paper, we therefore extend the theory of the optimal debt contract between firms and banks in Bernanke et al. [1999] to the case of an MNE. According to our model, the spread between the return on capital and the risk-free interest rate (i.e. the EFP) affects the optimal use of internal and external borrowing of the MNE both at home and abroad. Our empirical results confirm that variation in capital returns and thus in the EFP between affiliates is associated with different shares of internal and external borrowing both between firms — even if they are located in the same country — and over time. Importantly, our model suggests that the EFP of one affiliate also affects the external borrowing conditions of other units abroad, including the parent. As a consequence, internal capital markets can transmit financial conditions and economic outcomes across borders.

Only very few studies distinguish between firm-level determinants of internal borrowing and the effects on firm outcomes, with two notable exceptions. Egger et al. [2014] find that the internal liabilities of German affiliates increase with firm productivity as well as with a lack of financial development and the statutory tax rate in the host country. Biermann and Huber [2024] provide evidence for an increased use of internal credit by German MNEs as a substitute for external debt in response to a credit crunch during the financial crisis of 2007–2009. The authors use variation in the dependence of German MNE parents on bank loans from German Commerzbank to show that internal borrowing from foreign affiliates increased more for more dependent parents, when financial difficulties led to an unexpected deterioration of external funding conditions for the bank's clients. They also find that the credit crunch transmitted internationally, as foreign affiliates of Commerzbank-dependent parents became financially constrained and experienced a drop in sales relative to the affiliates of non-dependent parents.[6] In contrast to both of these studies, we observe not only the internal borrowing and lending between MNE parents and affiliates, but also the external borrowing of parent firms from Austrian banks.

[6]According to Biermann and Huber [2024], the largest effect occurred in Austria, where aggregate sales dropped by 0.4%.

In sum, we provide three main contributions to the literature. First, we extend the theory of the optimal debt contract in Bernanke et al. [1999] and highlight the channels through which internal capital markets help MNEs use differences in firm productivity and external borrowing conditions across borders. Second, we combine unique data on the FDI relationships and bank credit for the universe of Austrian MNEs. Third, we exploit variation in the return on capital of German affiliates to show that affiliates' financing and investment decisions are consistent with the predictions of our theoretical model even for affiliates of the same Austrian parent firm located in the same host country. Our results highlight that internal capital markets link the investment and external borrowing decisions of MNE parents and affiliates across borders due to country-level and firm-level differences.

The rest of the paper is organized as follows. Section 2 develops the theoretical model, derives comparative statics for the optimal debt contract of an MNE, and formulates testable predictions. Section 3 presents the OeNB's FDI and credit register data to test our theoretical predictions. Section 4 presents and discusses our empirical results, while Section 5 concludes.

2 Theoretical model

We study the capital investment and borrowing decisions of a multinational enterprise (MNE), building on the costly-state-verification framework in Bernanke et al. [1999].[7] In our model, an MNE consists of $n > 1$ different firms in some location j. Investment and borrowing decisions are taken by the parent firm $j = 1$ also on behalf of its affiliate firms $j \in \{2, ..., n\}$. We are interested in the MNE's optimal response to variation in the affiliates' external finance premium (EFP) — the return on capital relative to a risk-free interest rate — due to differences in the expected return on capital between foreign affiliates operating in the same host country.[8]

2.1 The model framework

Consider a firm j belonging to an MNE that uses its net worth N_j (e.g. retained past earnings) and borrowed funds to finance its productive capital investment K_j. Although we build on the model framework in Bernanke et al. [1999], in our setting, firm j can borrow B_j *externally* from domestic banks and borrow I_j *internally* from the MNE's other affiliates or the parent.

[7]We focus on the static optimal contracting problem in partial equilibrium without aggregate risk, taking capital returns and the price of capital (set equal to 1) as exogenous.

[8]This is in contrast to Bernanke et al. [1999], where the expected return on capital is the same for all firms. In our subsequent empirical analysis, we focus on German affiliates with a controlling share of the Austrian parent of 75% or more.

Consequently, its productive capital investment amounts to

$$K_j = N_j + B_j + I_j. \tag{1}$$

The return on capital of firm j is ex ante uncertain. It consists of an expected return R_j^k and an idiosyncratic productivity realization ω_j that is unknown to both the MNE and its external lender (hereafter called "bank") prior to investment. We assume that ω_j is i.i.d. across firms with a continuous and once-differentiable cumulative distribution function $F(\omega_j)$ over non-negative support and $E(\omega_j) = 1$. The bank can observe ω_j by paying a monitoring cost equal to a share $0 < \mu < 1$ of the realized return on capital, $\mu\omega_j R_j^k K_j$, after the investment decision has been made. Consistent with the assumption in Antràs et al. [2009] that "developers of technologies" (i.e. MNE parent firms) are particularly efficient monitors of local entrepreneurs, we assume no information asymmetries between entities of the same MNE, in particular between the parent and its foreign affiliates.

2.1.1 The firm's expected return

Firm j chooses K_j, B_j, and I_j before it knows its idiosyncratic productivity realization ω_j. After the realization, the firm repays its external borrowing B_j at the contractual loan rate Z_j, if (and only if) ω_j is equal to or greater than some threshold value $\bar{\omega}_j$, which satisfies

$$\bar{\omega}_j R_j^k K_j = Z_j B_j. \tag{2}$$

If $\omega_j \geq \bar{\omega}_j$, the firm retains the gross return $\omega_j R_j^k K_j$ net of its repayment $Z_j B_j$ to the bank. If $\omega_j < \bar{\omega}_j$, the firm defaults and receives nothing. Its expected return is therefore given by

$$\underbrace{\int_{\bar{\omega}_j}^{\infty} \omega R_j^k K_j dF(\omega)}_{\text{expected return on capital}} - \underbrace{[1 - F(\bar{\omega}_j)] \cdot Z_j B_j}_{\text{expected cost of credit}}, \tag{3}$$

where $\bar{\omega}_j$ depends on R_j^k through Equation (2). In Equation (3), the first term denotes the expected gross return conditional on non-default, while the second term denotes the cost of credit in case of non-default.

2.1.2 The MNE's internal borrowing constraint

Note that internal borrowing I_i enters Equation (3) implicitly via the accounting identity in Equation (1), since it represents a diversion of net worth or funds borrowed from affiliates. Ceteris paribus, a higher internal borrowing from other affiliates or the parent substitutes for external borrowing from the bank, and thus lowers the default threshold.

Across all firms, the MNE must satisfy the net-zero internal borrowing constraint

$$\sum_{j=1}^{n} I_j = \sum_{j=1}^{n} (K_j - B_j - N_j) = 0, \tag{4}$$

which requires that the internal borrowing of the parent and its affiliates in all locations $j = 1, \ldots, n$ aggregates to zero.

2.1.3 The bank's participation constraint

As in Bernanke et al. [1999], we assume a risk-neutral external lender, which requires that the expected return on a loan to firm j net of the expected monitoring costs in case of default equals the opportunity cost of instead investing the amount at the exogenous risk-free interest rate, R_j. Conditional on $R_j^k > R_j$, the bank's participation constraint is therefore given by

$$\underbrace{[1 - F(\bar{\omega}_j)] \cdot Z_j B_j}_{\text{no-default repayment}} + \underbrace{(1-\mu) \cdot \int_0^{\bar{\omega}_j} \omega R_j^k K_j dF(\omega)}_{\text{expected recovery after default}} = R_j B_j. \tag{5}$$

In Equation (5), the first term on the left-hand side is the contractual repayment multiplied by the probability that $\omega_j \geq \bar{\omega}_j$, and the second term is the expected recovery value net of the monitoring cost share μ of the expected return on capital in case of default, while the term on the right-hand side is the bank's opportunity cost of the loan. Using the definition of $\bar{\omega}_j$ in Equation (2) to substitute for $Z_j B_j$, this can be expressed equivalently as

$$\left\{ [1 - F(\bar{\omega}_j)] \cdot \bar{\omega}_j + (1-\mu) \cdot \int_0^{\bar{\omega}_j} \omega dF(\omega) \right\} \cdot R_j^k K_j = R_j B_j.$$

2.1.4 Firm production and return on capital

In what follows, we solve for the optimal borrowing behavior of the MNE at home and abroad, assuming that the net worth of all firms is predetermined. We are interested in the effects of differences in the return on capital between locations. Hence, we include a total-factor-productivity (TFP) term in our specification of the production function. Each affiliate and the parent firm in location j produces according to the Cobb-Douglas production function

$$Y_j = A_j K_j^{\alpha} L_j^{1-\alpha}$$

with constant returns to scale, where Y_j denotes output, A_j the TFP term, K_j the productive capital stock in Equation (1), and L_j employment. Assuming perfect competition in the market for productive capital, we thus endogenize the return on capital of firm j as

$$R_j^k = \alpha A_j K_j^{\alpha-1} L_j^{1-\alpha}. \tag{6}$$

2.2 The optimal debt contract

The MNE maximizes the sum of expected payoffs of the parent and its affiliates in all locations j,[9]

$$\max_{K_j, B_j, \bar{\omega}_j} \quad \sum_{j=1}^{n} \left\{ \int_{\bar{\omega}_j}^{\infty} \omega dF(\omega) - \left[1 - F(\bar{\omega}_j)\right] \cdot \bar{\omega}_j \right\} \cdot \underbrace{\alpha A_j K_j^{\alpha} L_j^{1-\alpha}}_{R_j^k K_j}, \tag{7}$$

subject to the set of (state-contingent) bank participation constraints in all locations j,

$$\left\{ [1 - F(\bar{\omega}_j)] \cdot \bar{\omega}_j + (1-\mu) \cdot \int_0^{\bar{\omega}_j} \omega dF(\omega) \right\} \cdot \underbrace{\alpha A_j K_j^{\alpha} L_j^{1-\alpha}}_{R_j^k K_j} = R_j B_j \quad \forall j, \tag{8}$$

where we have used Equation (6) to substitute for $R_j^k K_j$ in Equations (3) and (5), respectively, as well as its internal borrowing constraint,

$$\sum_{j=1}^{n} (K_j - B_j - N_j) = 0. \tag{9}$$

From Equation (9), the assets and liabilities on the MNE's balance sheet must be identical.[10]

Using short-hand notation, we can express the shares of expected gross profits, $R_j^k K_j = \alpha A_j K_j^{\alpha} L_j^{1-\alpha}$, going to the firm and the bank as functions $1 - \Gamma(\bar{\omega}_j)$ and $\Gamma(\bar{\omega}_j) - \mu G(\bar{\omega}_j)$ of the default threshold, $\bar{\omega}_j$, where

$$\Gamma(\bar{\omega}_j) \equiv \int_0^{\bar{\omega}_j} \omega f(\omega) d\omega + \bar{\omega}_j \int_{\bar{\omega}_j}^{\infty} f(\omega) d\omega \quad \forall j,$$

[9] For simplicity, we consider affiliates owned by one parent firm and disregard the case of partial ownership, in line with a controlling share of the parent firm of 75% or more in our empirical analysis (see footnote 8).

[10] Substituting (8) into (7), we can re-write the MNE's objective function as

$$\sum_{j=1}^{n} \left[1 - \mu \int_0^{\bar{\omega}_j} \omega dF(\omega)\right] \cdot \alpha A_j K_j^{\alpha} L_j^{1-\alpha},$$

i.e., the MNE internalizes the expected monitoring cost in case of default and ensures that the bank obtains the equivalent of the risk-free interest rate.

and

$$\mu G(\bar{\omega}_j) \equiv \mu \int_0^{\bar{\omega}_j} \omega f(\omega)\, d\omega \quad \forall j.$$

We follow Bernanke et al. [1999] and assume that $\bar{\omega}_j h(\bar{\omega}_j)$ is increasing in $\bar{\omega}_j$, so the bank's expected share of profits, $\Gamma(\bar{\omega}_j) - \mu G(\bar{\omega}_j)$, is increasing in $\bar{\omega}_j$ for $\bar{\omega}_j < \bar{\omega}_j^*$, attains a global maximum at $\bar{\omega}_j = \bar{\omega}_j^*$, and is decreasing in $\bar{\omega}_j$ for $\bar{\omega}_j > \bar{\omega}_j^*$.[11]

The MNE's constrained profit-maximization problem in Equations (7)–(9) can then be summarized as

$$\max_{K_j,B_j,\bar{\omega}_j} \sum_{j=1}^{n} [1-\Gamma(\bar{\omega}_j)] \cdot \alpha A_j K_j^{\alpha} L_j^{1-\alpha} + \lambda_{1j} \cdot \left\{ [\Gamma(\bar{\omega}_j) - \mu G(\bar{\omega}_j)] \cdot \alpha A_j K_j^{\alpha} L_j^{1-\alpha} - R_j B_j \right\}$$
$$- \lambda_2 \cdot \sum_{j=1}^{n} (K_j - B_j - N_j) \quad \forall j, \qquad (10)$$

where the Lagrange multipliers on the banks' participation constraints and the internal capital market constraint satisfy $\lambda_{1j} > 0$ and $\lambda_2 > 0$, respectively.

As in Egger et al. [2014], we assume that the MNE parent and each of its affiliate firms are separate legal entities that do not honor each other's external debt in the case of default. Instead, each entity is resolved separately while its collateral is liquidated by the bank after paying the monitoring cost. This assumption is consistent with the "separation principle" in Austrian insolvency law, according to which each legal entity must undergo its own insolvency proceedings, and the entities' collateral is not pooled to compensate the MNE's creditors (see, e.g., Der Standard, 2012, Der Standard, 2023).[12]

2.2.1 First-order conditions

The following first-order conditions (FOCs) with respect to K_j, B_j, $\bar{\omega}_j$, λ_{1j}, and λ_2 characterize the solution to the constrained profit-maximization problem of the MNE in Equation

[11] If $\bar{\omega}_j h(\bar{\omega}_j)$ is increasing in $\bar{\omega}_j$, then $\Gamma'(\bar{\omega}_j) - \mu G'(\bar{\omega}_j) = [1 - F(\bar{\omega}_j)] \cdot [1 - \mu \bar{\omega}_j h(\bar{\omega}_j)] \lesseqgtr 0$ for $\bar{\omega}_j \gtreqless \bar{\omega}_j^*$, where $h(\bar{\omega}_j) \equiv f(\bar{\omega}_j) / [1 - F(\bar{\omega}_j)]$ denotes the "hazard rate"[see Bernanke et al., 1999, p. 1382].

[12] In Appendix A.3, we derive the optimal debt contract with an alternative legal structure of the MNE that allows the pooling of risks and the cross-financing of external debt. Consequently, the default threshold $\bar{\omega}$ applies to the MNE as a whole rather than to the parent and each affiliate separately (see Equation (A.22)). In this setting, the implications for optimal net internal borrowing are the opposite of our theoretical predictions in Section 2.4 and at odds with our empirical results in Section 4.

(10):[13]

$$
\begin{aligned}
K_j: \quad & [1-\Gamma(\bar{\omega}_j)] \cdot \alpha^2 A_j K_j^{\alpha-1} L_j^{1-\alpha} \\
& + \lambda_{1j} \cdot [\Gamma(\bar{\omega}_j) - \mu G(\bar{\omega}_j)] \cdot \alpha^2 A_j K_j^{\alpha-1} L_j^{1-\alpha} - \lambda_2 = 0 \quad \forall j, & (11) \\
B_j: \quad & -\lambda_{1j} R_j + \lambda_2 = 0 \quad \forall j, & (12) \\
\bar{\omega}_j: \quad & \Gamma'(\bar{\omega}_j) - \lambda_{1j} \cdot [\Gamma'(\bar{\omega}_j) - \mu G'(\bar{\omega}_j)] = 0 \quad \forall j, & (13) \\
\lambda_{1j}: \quad & [\Gamma(\bar{\omega}_j) - \mu G(\bar{\omega}_j)] \cdot \alpha A_j K_j^{\alpha} L_j^{1-\alpha} - R_j B_j = 0 \quad \forall j, & (14) \\
\lambda_2: \quad & \sum_{j=1}^{n} (K_j - B_j - N_j) = 0. & (15)
\end{aligned}
$$

Using Equation (12) to replace $\lambda_2 = \lambda_{1j} R_j$, we rewrite Equation (11) as

$$\{[1-\Gamma(\bar{\omega}_j)] + \lambda_{1j} \cdot [\Gamma(\bar{\omega}_j) - \mu G(\bar{\omega}_j)]\} \cdot \alpha^2 A_j K_j^{\alpha-1} L_j^{1-\alpha} - \lambda_{1j} R_j = 0. \qquad (11')$$

Equations (11') and (13) are identical to the FOCs with respect to the capital-net worth ratio, $k \equiv K/N$, and the default threshold, $\bar{\omega}$, in Bernanke et al. [1999] (p. 1383), when adopting the notation that $\lambda_{1j} = \lambda \; \forall j$ and $\alpha^2 A_j K_j^{\alpha-1} L_j^{1-\alpha}/R_j = \alpha R_j^k / R_j \equiv s$.

In contrast to Bernanke et al. [1999], in our model, the MNE faces a trade off between investing at home and abroad while $\lambda_2 > 0$, as an increase in capital investment in country j reduces the funds available for investment in all countries $j' \neq j$, ceteris paribus. Any capital investment beyond the firm's net worth, N_j, may be financed by external borrowing from a bank in country j or internal borrowing from an affiliate (or parent) in country $j' \neq j$. In equilibrium, the marginal cost of external borrowing must be the same across countries, so $\lambda_{1j} R_j = \lambda_{1j'} R_{j'}$, $j \neq j'$, from Equation (12). This relation implies that the optimal capital investment and default threshold in country j may depend on the cost of external borrowing in j as well as in the locations of the MNE's affiliates (or parent) other than j.

Equation (14) corresponds to the FOC with respect to λ in Bernanke et al. [1999], when adopting the notation $\alpha A_j K_j^{\alpha-1} L_j^{1-\alpha}/R_j = R_j^k/R_j \equiv s$, $K_j \equiv K/N$, and $B_j \equiv B/N$. The participation constraint in our setting must be satisfied for all j and ensures that banks in each location obtain the equivalent of the risk-free interest rate in expectation.

Moreover, external borrowing in location j, $B_j = K_j - N_j - I_j$ is related to the firm's internal borrowing, I_j, which in turn depends on the MNE's allocation of capital investment and external borrowing in all locations $j = 1, \ldots, n$ via the internal capital market constraint. According to Equation (15), the internal liabilities of firm j are identical to the sum of internal

[13]Following Bernanke et al. [1999], we assume that $(R_j^k/R_j) < 1/(\Gamma(\bar{\omega}_j^*) - \mu G(\bar{\omega}_j^*))$, which implies that $0 < \bar{\omega}_j < \bar{\omega}_j^*$ and ensures an interior solution to the problem.

assets of other affiliates and the parent in all locations $j' \neq j$,

$$I_j = -\sum_{j' \neq j} (K_{j'} - B_{j'} - N_{j'}) .$$

Any shock to the EFP in location j, R_j^k/R_j, can therefore affect the domestic firm's external and internal borrowing as well as the external and internal borrowing of the MNE's affiliates and the parent in other locations.

2.2.2 Auxiliary relationships

As in the standard model, the optimal debt contract of the MNE yields a positive relationship between the EFP and the optimal share of external borrowing.[14] Note that the FOC with respect to $\bar{\omega}_j$ in Equation (13) can be written as

$$\lambda_{1j}(\bar{\omega}_j) = \frac{\Gamma'(\bar{\omega}_j)}{\Gamma'(\bar{\omega}_j) - \mu G'(\bar{\omega}_j)}, \tag{16}$$

where $\lambda_{1j}'(\bar{\omega}_j) > 0$.[15]

The FOCs with respect to K_j and B_j in Equations (11) and (12) imply that the spread between the expected rate of return on capital and the risk-free interest rate demanded by the bank in location j equals[16]

$$\frac{R_j^k}{R_j} = \rho\left(\bar{\omega}_j\right), \tag{17}$$

where

$$\rho\left(\bar{\omega}_j\right) \equiv \frac{\lambda_{1j}(\bar{\omega}_j)}{\alpha \cdot \{1 - \Gamma(\bar{\omega}_j) + \lambda_{1j}\left(\bar{\omega}_j\right) \cdot \left[\Gamma\left(\bar{\omega}_j\right) - \mu G\left(\bar{\omega}_j\right)\right]\}}.$$

Together with the bank's participation constraints in Equation (14), this implies a unique ratio of external borrowing to capital, conditional on the productivity cutoff $\bar{\omega}_j \in (0, \bar{\omega}_j^*)$ in each location j:

$$\frac{B_j}{K_j} = \psi\left(\frac{R_j^k}{R_j}\right), \tag{18}$$

where

$$\psi\left(\frac{R_j^k}{R_j}\right) = \left[\Gamma(\bar{\omega}_j) - \mu G(\bar{\omega}_j)\right] \cdot \frac{R_j^k}{R_j}, \tag{19}$$

[14] In Bernanke et al. [1999], the entrepreneur's optimal debt contract yields a positive relationship between the (expected) EFP and the optimal capital-net worth ratio, $k \equiv K/N$, or, equivalently, the optimal share of debt financing, B/K. The latter follows directly from $K = B + N$ and, thus, $B/K = 1 - N/K$.

[15] The positive sign of the first partial derivative follows from the assumptions that $\bar{\omega}_j h(\bar{\omega}_j)$ is increasing in $\bar{\omega}_j$ for $\bar{\omega}_j \in (0, \bar{\omega}_j^*)$ (see Footnote 11).

[16] Compare Bernanke et al. [1999], Equation (A.1).

and $\psi'(R^k_j/R_j) > 0$ for $R^k_j/R_j \in \left(1, 1/\left[\Gamma(\bar{\omega}^*_j) - \mu G(\bar{\omega}^*_j)\right]\right)$. Consequently, the optimal share of capital financed by external borrowing, B_j/K_j, increases in the EFP, R^k_j/R_j.

2.3 Cross-border effects of firm productivity on optimal borrowing and investment

In this subsection, we consider the role of firm productivity for optimal shares of external borrowing and capital investments across all MNE locations. More precisely, we distinguish between one domestic and $n-1$ foreign locations and investigate the cross-border effects of a change in the productivity of an affiliate (or the parent) located in j, A_j.

For this purpose, we totally differentiate the system of FOCs in (11'), (12), (13), (14) and (15) with respect to A_j, holding the productivity in all other locations, $A_{j'}$ $\forall j' \neq j$, fixed (see Appendix A.1 for details). In what follows, we summarize our analytical results for the effects of a productivity change in location j on the MNE's external borrowing and capital investment decisions in all locations j'.[17]

Proposition 1 *In response to an increase of total factor productivity in location j, $dA_j > 0$, the share of capital financed by external borrowing increases for the parent and its affiliates in all locations j':*

$$\frac{d(B_{j'}/K_{j'})}{dA_j} > 0 \quad \forall j'. \tag{20}$$

Proof: Totally differentiating the external borrowing share in Equations (18)–(19), we obtain

$$\frac{d(B_{j'}/K_{j'})}{dA_j} = \underbrace{[\Gamma'(\bar{\omega}_{j'}) - \mu G'(\bar{\omega}_{j'})]}_{>0} \cdot \frac{R^k_{j'}}{R_{j'}} \cdot \underbrace{\frac{d\bar{\omega}_{j'}}{dA_j}}_{>0} + [\Gamma(\bar{\omega}_{j'}) - \mu G(\bar{\omega}_{j'})] \cdot \frac{1}{R_{j'}} \cdot \underbrace{\frac{dR^k_{j'}}{dA_j}}_{>0} > 0,$$

where $\Gamma'(\bar{\omega}_{j'}) - \mu G'(\bar{\omega}_{j'}) > 0$ by assumption (see Footnote 11). Note further that $d\lambda_{1j}/dA_j > 0$ implies $d\lambda_{1j'}/dA_j > 0$ from Equation (A.7) and, in turn, $d\bar{\omega}_{j'}/dA_j > 0$ from Equation (A.8). Finally, $dR^k_{j'}/dA_j > 0$ $\forall j'$ follows from Equation (6) and Appendix A.1.1.

■

Intuitively, a higher TFP in location j increases the expected return on capital and, ceteris paribus, lowers the productivity cutoff for repayment in Equation (2). This allows firm j to

[17] As in Bernanke et al. [1999], optimal investment and debt financing in our framework hinge on the EFP — the return on capital relative to the risk-free interest rate. In our empirical analysis, we exploit differences in the rate of return on capital *between firms* driven by differences in firm-level TFP, A_j. While we focus on firm-level productivity (i.e. the numerator of the EFP) in the main text, we present analytical results for an exogenous change in the opportunity cost of capital (i.e. the denominator of the EFP) in Appendix A.2. We do not test the latter findings empirically, since risk-free rates are identical for all parents and affiliates within the same country and very similar across euro area member states, such as Austria and Germany.

increase its external borrowing from the domestic bank and its leverage ratio, B_j/K_j. In our setting, the associated tightening of the bank's participation constraint according to Equation (16) spills over to all other locations via the MNE's internal capital market constraint in Equation (15), since both constraints are linked via the FOC with respect to B_j in Equation (12). As a result, the effect of a higher productivity in location j, $dA_j > 0$, is translated across borders, and the optimal share of external borrowing increases not only in location j but also in all other locations $j' \neq j$. Ceteris paribus, the increase in the share of external borrowing is greater in location j than in locations $j' \neq j$.[18]

For $j' = j$, Proposition 1 follows directly from Equations (18)–(19) and generalizes the mechanism in Bernanke et al. [1999] with respect to optimal leverage to the case of an MNE.[19] Its implications for optimal external and internal borrowing also depend on the response of $K_{j'}$ in the denominator of the leverage ratio, and on the results of the following two propositions.

Proposition 2 *In response to an increase of total factor productivity in location j, $dA_j > 0$, the MNE's capital investment decreases in all other locations $j' \neq j$:*

$$\frac{dK_{j'\neq j}}{dA_j} < 0. \tag{21}$$

Proof: Totally differentiating the FOC with respect to capital investment in Equation (11) (see Equation (A.6) in the Appendix) and using Equations (18)–(19) to substitute for

$$[\Gamma(\bar{\omega}_{j'}) - \mu G(\bar{\omega}_{j'})] \cdot \alpha A_{j'} K_{j'}^{\alpha-1} L_{j'}^{1-\alpha} = \frac{B_{j'}}{K_{j'}} \cdot R_{j'},$$

we obtain

$$\{[1 - \Gamma(\bar{\omega}_{j'})] + \lambda_{1j'} \cdot [\Gamma(\bar{\omega}_{j'}) - \mu G(\bar{\omega}_{j'})]\} \cdot \alpha^2 \underbrace{(1-\alpha)}_{>0} A_{j'} K_{j'}^{\alpha-2} L_{j'}^{1-\alpha} \cdot \frac{dK_{j'}}{dA_j} + \underbrace{\left(1 - \alpha \frac{B_{j'}}{K_{j'}}\right)}_{>0} R_{j'} \cdot \frac{d\lambda_{1j'}}{dA_j}$$

$$= \{[1 - \Gamma(\bar{\omega}_{j'})] + \lambda_{1j'} \cdot [\Gamma(\bar{\omega}_{j'}) - \mu G(\bar{\omega}_{j'})]\} \cdot \alpha^2 K_{j'}^{\alpha-1} L_{j'}^{1-\alpha} \cdot \frac{dA_{j'}}{dA_j}.$$

Given our assumption that $dA_{j'}/dA_j = 0$ for $j' \neq j$, it follows that

$$\frac{dK_{j'}}{dA_j} \gtreqless 0 \quad \text{if} \quad \frac{d\lambda_{1j'}}{dA_j} \lesseqgtr 0 \quad \forall j' \neq j.$$

[18]This follows from $dR_j^k/dA_j > dR_{j'\neq j}^k/dA_j = 0$.

[19]With symmetric countries, $d\bar{\omega}_j/dA_j = d\bar{\omega}_{j'}/dA_j$ also implies that $d\left(B_j/K_j\right)/dA_j > d\left(B_{j'}/K_{j'}\right)/dA_j$, since $dR_j^k/dA_j > 0$ and $dR_{j'}^k/dA_j = 0$ $\forall j' \neq j$. Thus, the leverage ratio increases by more for the MNE's affiliate in location j than for the parent or affiliates in other locations.

Since $dA_{j'\neq j}/dA_j = 0$ and $d\lambda_{1j'}/dA_j > 0$ from Proposition 1 and Equation (A.7), it follows that

$$\frac{dK_{j'}}{dA_j} < 0, \quad j' \neq j.$$

■

Proposition 3 *In response to an increase of total factor productivity in location j, $dA_j > 0$, the MNE's capital investment in location j increases:*

$$\frac{dK_j}{dA_j} > 0. \tag{22}$$

Proof: Totally differentiating the bank's participation constraint in Equation (14) and the MNE's internal capital market constraint in Equation (15) (see Equations (A.9) and (A.10) in the Appendix), using Equation (6) to express $dB_{j'}/dA_j$ in Equation (A.9) as a function of the return on capital in location j', $R^k_{j'}$, and substituting into Equation (15), after transforming, we obtain

$$\sum_{j'} \frac{dK_{j'}}{dA_j} \cdot \left\{1 - [\Gamma(\bar{\omega}_{j'}) - \mu G(\bar{\omega}_{j'})] \cdot \alpha \frac{R^k_{j'}}{R_{j'}}\right\} =$$
$$\sum_{j'} \underbrace{[\Gamma'(\bar{\omega}_{j'}) - \mu G'(\bar{\omega}_{j'})]}_{>0} \cdot \frac{R^k_{j'}}{R_{j'}} \cdot \underbrace{\frac{d\bar{\omega}_{j'}}{dA_j}}_{>0} + [\Gamma(\bar{\omega}_{j'}) - \mu G(\bar{\omega}_{j'})] \cdot \alpha \frac{R^k_{j'}}{R_{j'}} \frac{1}{A_{j'}} \cdot \underbrace{\frac{dA_{j'}}{dA_j}}_{\geq 0}.$$

Together with Equations (18)–(19) and Proposition 1, the above equation implies that

$$\sum_{j'} \frac{dK_{j'}}{dA_j} \cdot \left\{1 - [\Gamma(\bar{\omega}_{j'}) - \mu G(\bar{\omega}_{j'})] \cdot \alpha \frac{R^k_{j'}}{R_{j'}}\right\} = \sum_{j'} \frac{dK_{j'}}{dA_j} - \alpha \sum_{j'} \left(\frac{B_{j'}}{K_{j'}} \cdot \frac{dK_{j'}}{dA_j}\right)$$
$$= \underbrace{\left(1 - \alpha \frac{B_j}{K_j}\right)}_{>0} \cdot \frac{dK_j}{dA_j} + \sum_{j'\neq j} \underbrace{\left(1 - \alpha \frac{B_{j'\neq j}}{K_{j'\neq j}}\right)}_{>0} \cdot \underbrace{\frac{dK_{j'\neq j}}{dA_j}}_{<0} > 0 \tag{23}$$

and, therefore,

$$\frac{dK_j}{dA_j} > 0.$$

■

According to Propositions 2 and 3, a higher total factor productivity in location j induces the MNE to increase its capital investment in location j and decrease its capital investment in all other locations $j' \neq j$.[20] This is consistent with empirical evidence of a substitution effect between foreign and domestic investments of MNEs [see, e.g., Feldstein, 1995, Herzer and Schrooten, 2008]. A higher opportunity cost of credit in location j, R_j, may instead affect domestic and foreign capital investments in the same or in opposite directions (see Appendix A.2), in line with empirical evidence for positive and negative relationships between domestic and foreign investment activities of MNEs in the literature [see, e.g., Desai et al., 2009, Goldbach et al., 2019].

Intuitively, a higher total factor productivity in location j increases the shadow cost of capital of an MNE with an internal capital market for the domestic firm as well as the affiliates and the parent in all other locations $j' \neq j$. In equilibrium, the MNE equalizes the costs of external borrowing across locations via the internal capital market constraint in Equation (4). In response to an increase of total factor productivity in location j, external borrowing from the domestic bank substitutes for internal borrowing from foreign affiliates (or the parent). From Equations (A.7) and (A.8) in the Appendix, the shadow cost of external borrowing, λ_1, and the default threshold $\bar{\omega}$ thus also increase for affiliates (or the parent) in $j' \neq j$, as banks are willing to tolerate a higher leverage ratio and probability of default. In the latter case, the lower capital investment found in Proposition 2 facilitates lower *absolute* external borrowing abroad despite an increase in the leverage ratio.

In summary, we find that an MNE with higher productivity in some location j may afford a higher leverage ratio both at home and abroad. While this reflects an increase of both capital investment and external borrowing in location j, the MNE's optimal capital investment in all other locations $j' \neq j$ falls. This finding extends existing results in corporate finance, which do not take location-specific borrowing conditions and constraints into account.[21]

[20] If the countries are symmetric, such that $B_j/K_j \equiv B/K \ \forall j$, Equation (23) can be written as

$$\left(1 - \alpha \frac{B}{K}\right) \cdot \sum_{j'} \frac{dK_{j'}}{dA_j} > 0,$$

which implies that, in response to an increase of total factor productivity in location j, $dA_j > 0$, total capital investment and total external borrowing by the MNE increases:

$$\sum_{j'} \frac{dK_{j'}}{dA_j} = \sum_{j'} \frac{dB_{j'}}{dAj} > 0,$$

where the equality follows from Equation (A.10) in the Appendix.

[21] For example, Biermann and Huber [2024] find that an increase in the EFP decreases the leverage abroad. The authors qualify that this effect may be mitigated by changes in firms' borrowing constraints. We specify these changes in borrowing constraints and find that leverage abroad may increase rather than decrease in response to an increase in the EFP due to higher affiliate productivity.

2.4 Testable predictions

In Section 4, we use comprehensive data on Austrian MNEs to empirically test our theoretical model. Corollaries 1, 2, and 3 in this subsection derive testable predictions for the responses of key financial variables, the empirical counterparts of which we observe in our FDI data. In particular, we investigate how the use of external and internal financing by Austrian parents and their German affiliates in the data relates to the affiliates' profitability. For this purpose, we focus on the case of an MNE's affiliate in location j (Germany) with a parent firm in location j' (Austria).

For each FDI relationship between a foreign affiliate in location j and its parent in location $j' \neq j$, we observe the (stock and flow of) net internal borrowing, $I_j = -I_{j' \neq j}$, the MNE's capital investment (defined as total assets of the affiliate scaled by the ownership share of the Austrian parent), K_j, and the return on capital (defined as FDI revenue over scaled total assets), R_j^k.[22] For each Austrian parent, we observe the (stock and flow of) net internal borrowing from its foreign affiliates, $I_{j'}$, and its external borrowing from Austrian banks, $B_{j'}$.[23] For these variables, we obtain the following testable predictions from our theoretical model in Subsection 2.1 and our theoretical results in Subsection 2.3.

Corollary 1 *Let the fraction of affiliate net worth over total assets, N_j/K_j, be given. Then, the greater the return on capital of an affiliate in location j, R_j^k, the smaller is the optimal fraction of its total assets that the affiliate borrows internally from its foreign parent, I_j/K_j:*

$$\frac{d(I_j/K_j)}{dR_j^k} < 0.$$

Proof: This follows from Proposition 1 and the accounting identity in Equation (1), which we first divide by K_j and then totally differentiate with respect to R_j^k:

$$\frac{d(I_j/K_j)}{dR_j^k} = -\underbrace{\frac{d(B_j/K_j)}{dR_j^k}}_{>0} - \underbrace{\frac{d(N_j/K_j)}{dR_j^k}}_{=0}.$$

Keeping constant the fraction of net worth relative to total assets, $d(N_j/K_j)/dR_j^k = 0$, the expression on the left-hand side must be negative. Since $dR_j^k/dA_j > 0$ from Equation (6), a higher productivity of affiliate j thus implies a lower share of net internal borrowing from its parent. ■

[22] We do *not* directly observe external borrowing of affiliate j, which we back out as the difference between total assets, FDI net worth, and net internal borrowing.

[23] We do *not* directly observe the capital stock of Austrian parent j', as its total assets include the financial investments in all of its foreign affiliates.

Corollary 2 *Let the fraction of affiliate net worth over total assets in location j, N_j/K_j, be given. Then, the greater the return on capital of an affiliate in location j, R_j^k, the greater is the optimal net internal borrowing of the parent in location j' relative to the affiliate's total assets, $I_{j'}/K_j$:*

$$\frac{d(I_{j'}/K_j)}{dR_j^k} > 0.$$

Proof: This follows directly from Corollary 1 and the fact that

$$\frac{d(I_{j'}/K_j)}{dR_j^k} = -\frac{d(I_j/K_j)}{dR_j^k}.$$

Keeping constant the fraction of net worth relative to total assets, $d(N_j/K_j)/dR_j^k = 0$, the expression on the left-hand side must be positive. From Equation (6), a higher productivity of affiliate j implies more net internal borrowing by its parent in location j' as a fraction of the affiliate's total assets. ■

Corollary 3 *Let the fractions of affiliate net worth in location j and all other locations $i \neq j, j'$ as well as the fraction of parent net worth in $j' \neq j, i$ relative to total assets of the affiliate in j, N_j/K_j, N_i/K_j, and $N_{j'}/K_j$ be given. Then, the greater the return on capital of the affiliate in location j, R_j^k, the smaller is the optimal external borrowing of the parent in location j' relative to the affiliate's total assets, $B_{j'}/K_j$:*

$$\frac{d(B_{j'}/K_j)}{dR_j^k} < 0.$$

Proof: Dividing the internal budget constraint in Equation (4) by total assets of affiliate j, K_j, we get

$$\begin{aligned}\frac{B_{j'}}{K_j} + \frac{N_{j'}}{K_j} - \frac{K_{j'}}{K_j} &= \frac{1}{K_j} \cdot \sum_{j \neq j'} (K_j - B_j - N_j) \\ &= \left(1 - \frac{B_j}{K_j} - \frac{N_j}{K_j}\right) + \sum_{i \neq j, j'} \left(\frac{K_i}{K_j} - \frac{B_i}{K_j} - \frac{N_i}{K_j}\right),\end{aligned}$$

where K_i, B_i, and N_i denotes the total assets, external borrowing, and net worth, respectively, of affiliates in locations other than j and the parent's location j'.

Substituting for $B_i/K_j = (B_i/K_i) \cdot (K_i/K_j)$ and totally differentiating the above equation with respect to R_j^k, we obtain

$$\frac{d(B_{j'}/K_j)}{dR_j^k} + \underbrace{\frac{d(N_{j'}/K_j)}{dR_j^k}}_{=0} - \underbrace{\frac{d(K_{j'}/K_j)}{dR_j^k}}_{<0} = -\underbrace{\frac{d(B_j/K_j)}{dR_j^k}}_{>0} - \underbrace{\frac{d(N_j/K_j)}{dR_j^k}}_{=0} + \sum_{i\neq j,j'} \underbrace{\left(1-\frac{B_i}{K_i}\right)}_{>0}\cdot\underbrace{\frac{d(K_i/K_j)}{dR_j^k}}_{<0} - \sum_{i\neq j,j'}\frac{K_i}{K_j}\cdot\underbrace{\frac{d(B_i/K_i)}{dR_j^k}}_{>0} - \sum_{i\neq j,j'}\underbrace{\frac{d(N_i/K_j)}{dR_j^k}}_{=0}.$$

From Proposition 1, $d\left(B_{j'}/K_{j'}\right)/dA_j > 0\ \forall j'$ implies that $d\left(B_j/K_j\right)/dA_j > 0$ as well as $d\left(B_i/K_i\right)/dA_j > 0\ \forall i \neq j, j'$. From Propositions 2 and 3, $dK_{j'\neq j}/dA_j < 0$, $j' \neq j$ and $dK_j/dA_j > 0$ implies that $d\left(K_{j'}/K_j\right)/dA_j < 0$ as well as $d\left(K_i/K_j\right)/dA_j < 0\ \forall i \neq j, j'$. Assuming furthermore that $d\left(N_{j'}/K_j\right)/dR_j^k = d\left(N_j/K_j\right)/dR_j^k = d\left(N_i/K_j\right)/dR_j^k = 0$, $dR_j^k/dA_j > 0$ from Equation (6) implies that all non-zero terms on the right of the above equation are negative and yields the result in Corollary 3 that a greater return on capital of the affiliate in location j implies less external borrowing by the parent in $j' \neq j$ relative to the affiliate's stock of total assets.

■

In what follows, we test empirically our theoretical predictions for the optimal internal and external borrowing decisions of an MNE in response to differences in the return on capital of its foreign affiliates both over time and between firms.

3 Data

In our empirical analysis, we combine two main datasets. First, we use firm-level data on foreign direct investment (FDI) relationships between Austrian firms (the *"domestic parent"*) and foreign firms (the *"foreign affiliate"*) collected via mandatory annual reports to the Oesterreichische Nationalbank (OeNB), which capture all outward FDI relationships of Austrian firms.[24] The annual panel spans the period 2007–2022 and contains a rich set of information on both stocks and flows for all FDI relationships and each foreign affiliate,

[24] An FDI relationship is defined as any firm investment exceeding 10% of total assets in an establishment operating in a different country than that of the investor. This follows the definition used in the International Financial Statistics of the International Monetary Fund. Direct investments are characterized by long-term capital investments and therefore differ fundamentally from short-term portfolio investments. For detailed information on the concept of Austrian FDI data, see Oesterreichische Nationalbank [2025].

including investment volume, investment share, industry, country, internal and total liabilities, equity, total assets, and sales revenue. We complement the data on FDI relationships with firm-level financial information from the Sabina database maintained by the Bureau van Dijk, which provides information on the industry classification, equity, total assets, and sales revenue for each Austrian parent firm. Incorporating these data is essential, as mandatory FDI reports provide detailed information on the structure and nature of foreign affiliates but lack key financial accounting information for the domestic parent firms.

Second, we use data from the Austrian credit register to match each domestic firm involved in an FDI relationship with loans outstanding at an Austrian bank of at least EUR 350,000. For each credit-granting bank, we observe a wide range of balance sheet variables, including the credit exposure associated with each firm-bank relationship. The Austrian credit register contains end-of-year observations for 2007–2019 and tracks the entire history of domestic bank credit for Austrian FDI firms, even after they cease to hold FDI positions. Due to a unique identifier provided by the OeNB, we are able to perfectly match Austrian firms in the FDI and credit register datasets.

Our analysis focuses on outward FDI relationships, where the Austrian parent firm holds an ownership stake greater than 75% in the foreign affiliate firm. We restrict the sample to relationships between non-financial Austrian parents and non-financial foreign affiliates. As a result, we deliberately exclude the activities of Austrian banks in Eastern Europe, which represent a non-trivial fraction of total Austrian FDI. Figure 1 illustrates the evolution of Austrian FDI activities over time. In the upper panel, each colored line tracks the number of Austrian firms meeting the selection criterion of non-financial parent and affiliate firms, an ownership share above 75%, and at least one German affiliate, respectively, throughout our sample period. The lower panel of Figure 1 tracks the evolution of FDI relationships in terms of the Austrian parent firms' total capital invested abroad (in billion Euros). Although the number of Austrian FDI firms remains relatively stable during our sample period, except for a hump-shaped increase after the financial crisis of 2009, the total capital invested abroad displays a clear upward trend.[25]

During 2007–2022, we consider 1,965 individual Austrian FDI firms with a total of 8,606 foreign affiliates worldwide. On average, an Austrian parent firm controls 4.4 affiliates and is approximately ten times larger than its average foreign affiliate in terms of total assets. Table 1 summarizes the data-cleaning steps to construct our final estimation sample. In our analysis, we narrow the focus to FDI relationships between Austrian parent firms and their German affiliates, as Germany is both as a leading destination for Austrian outward

[25]FDI total capital denotes the aggregate financial investment of Austrian firms in foreign affiliated firms, including both FDI equity investments and inter-company loans.

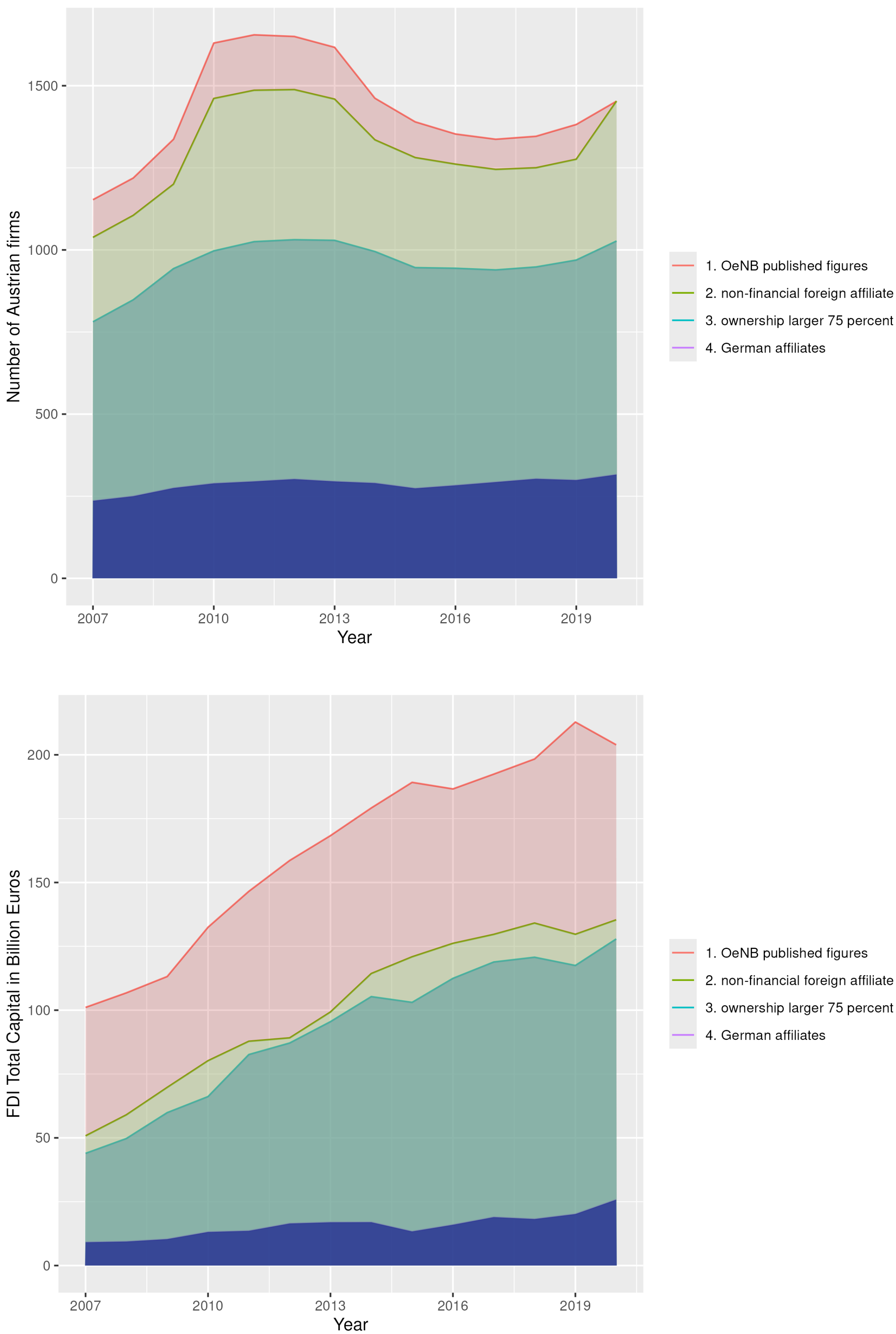

Figure 1: Development of Austrian outward FDI activities over time

Table 1: Overview of estimation sample construction

	Austrian Firms	Affiliated Firms	Number of Obs.	Austrian Assets	Affiliate Assets
FDI parent firms in Austria	1,965	8,606	121,956	639.94	57.32
FDI affiliate firms in Germany	636	1,260	7,964	688.54	74.76
imputed counterpart total assets	23	45	307		73.13
imputed domestic total assets	74	100	468	722.39	
Mean FDI total > 0	590	1,114	7,184	695.71	78.89
Mean counterpart total assets > 0	570	1,026	6,998	702.28	78.64
Mean net internal borrowing $\neq 0$	221	391	3,182	821.30	101.16
Ratios outlier correction [+/− 1.5]	218	386	3,068	818.60	104.60

Notes: Austrian non-financial firms with outward FDI relationships with non-financial affiliates and an ownership share > 75% for the years 2007–2022. *Assets* denote the average value of total assets in million euros held by Austrian parent firms and their foreign affiliates.

FDI and an important origin of inward FDI, accounting for approximately 30% of all FDI activities conducted by Austrian firms.[26] After refining the sample to non-financial firms with a minimum FDI ownership share of 75%, our dataset comprises 636 Austrian FDI firms with a total of 1,260 German affiliates.

We are interested in the external and internal financing decisions of multinational firms. For this reason, we restrict our analysis to FDI relationships with non-zero average FDI total assets and focus on parent-affiliate pairings that have actively used an internal capital market (ICM) for inter-company loans between the parent and affiliate firms at some point during our sample period. For about two thirds of Austrian FDI firms and their German affiliates, (net) inter-company loan positions are zero on average, as they never engage in mutual ICM transactions. These FDI relationships are disregarded below.

Table 2 reports descriptive statistics for our final sample of firms that are part of an Austrian outward FDI relationship that meets all selection criteria. We report values separately for the Austrian parent firms and their foreign affiliates. An Austrian firm may have one or several German affiliate firms as well as zero or non-zero affiliate firms in countries other than Germany. Less than 10% of Austrian FDI firms have foreign affiliates *only* in Germany (i.e., zero affiliates in other countries). Our baseline regression results are based on a sample of 218 Austrian firms with 386 German affiliates, where the Austrian parents are on average 8-times larger than their German affiliate in terms of total assets (and around 3-times larger

[26] Other important destinations for Austrian outward FDI in terms of total capital invested after applying the selection criteria include the Netherlands, the United States, Switzerland, and France. In terms of the number of foreign affiliates, further important destinations are the Czech Republic and Hungary.

Table 2: Firm-level summary statistics

	N	Min	Mean	Median	Max
AT parent firm count	3,068	1.00	12.27	14.00	16.00
DE affiliated firm count	3,068	1.00	3.67	2.00	22.00
Other countries affiliated firm count	3,068	0.00	9.59	5.00	63.00
AT parent firms	218				
Total assets	3,068	0.27	818.60	246.87	16,558.01
Equity	3,068	−100.65	368.88	109.84	13,420.47
Liabilities	3,068	−227.87	438.32	111.13	7,250.93
Employees	3,068	0.00	733.66	196.00	23,996.00
Domestic bank credit	2,355	0.00	68.77	25.25	918.45
DE affiliated firms	386				
Total assets	3,068	0.03	104.60	21.63	4,238.65
Total FDI	3,068	−210.28	44.88	7.91	3,298.95
Revenue	3,068	−266.71	3.37	0.22	817.18
Equity	3,068	−215.15	35.72	4.50	2,582.68
Liabilities	3,068	−0.02	53.94	10.10	2,677.80
Employees	3,068	0.00	254.72	70.00	38,520.00
Net internal borrowing	3,068	−557.55	8.66	0.00	1,685.06
Ratio net internal borrowing	3,068	−1.00	0.11	0.00	1.47
Ratio revenues	3,068	−1.34	0.04	0.02	0.96
Ratio equity	3,068	−1.21	0.36	0.34	1.82
Other affiliated firms	310				
Total assets	3,068	0.14	469.64	104.11	5,743.34
Total FDI	3,068	−437.03	201.75	56.91	2,671.35
Revenue	3,068	−534.94	13.88	2.17	381.24
Equity	3,068	−58.81	163.62	35.01	2,463.22
Liabilities	3,068	0.00	251.68	52.37	3,500.51
Employees	3,068	0.00	1,349.93	390.00	13,379.00
Net internal borrowing	3,068	−1,483.66	38.12	4.75	760.31
Ratio net internal borrowing	3,068	−0.59	0.12	0.02	4.88
Ratio revenues	3,068	−0.80	0.03	0.02	0.81
Ratio equity	3,068	−1.27	0.33	0.32	1.19

Notes: Summary statistics for firm-level estimation panel for the years 2007–2022. Variables (other than ratios) in million Euros. *Employees* in absolute numbers. *Ratio* defined as the respective variable over total assets. *AT parent firms* counts the number of AT firms in the sample. *DE* and *Other affiliated firms* counts the number of firms affiliated with AT parents. *Domestic bank credit* of AT parents only available for the years 2007–2019.

in terms of the number of employees). If an Austrian firm has a German affiliate, we consider all relevant information on its foreign affiliates in other countries as well.

Regarding the financial dimension, we focus on ICM transactions between an Austrian parent firm and its German affiliate(s), where we net out inter-company loans within the multinational firm for each FDI relationship, i.e. funds borrowed by the Austrian parent from its German affiliate and funds lent by the Austrian parent to its German affiliate. Given that the inter-company liabilities of one entity correspond to the inter-company assets of another entity at each point in time, these (net) ICM positions between the MNE's entities are reciprocal, whereas transactions may occur simultaneously in both directions, underscoring the bidirectional nature of ICM flows.[27]

In what follows, we define *net internal borrowing* as the difference between the Austrian parent's inter-company loans to the German affiliate and the German affiliate's inter-company loans to the Austrian parent. A negative value therefore indicates that the German affiliate lends more to than it borrows from the Austrian parent. On average across FDI relationships, the net internal borrowing position is positive, indicating that Austrian parents lend more to than they borrow from their German affiliates. All German affiliates in our sample engage in some form of ICM transaction with the Austrian parent at some point during the observation period, albeit not necessarily in all years, as we allow for zero net ICM positions.

In line with our theoretical model, an MNE's Austrian parent and foreign affiliate firms may complement their internal borrowing with the strategic use of external borrowing. In both Austria and Germany, the dominant source of external funds for non-financial firms is borrowing from a domestic bank. To investigate empirically the prevalence of either funding option, we draw on credit register data to monitor the Austrian parents' external borrowing positions. From the summary statistics in Table 2, on average, one quarter of total liabilities of Austrian FDI parents (with German affiliates) originate from domestic credit lines. Among the 194 Austrian firms in the sample, 17 exhibit zero external borrowing across all years, while 55 show zero external borrowing in at least one year.

Building on our insights from the theoretical model, we empirically test our key predictions from Section 2.4 in the following. To ensure the comparability of outward FDI relationships across MNEs of different size, prior to the regressions, we rescale most variables by dividing them by the total assets of either the parent or the affiliate at the firm level.

[27] We identify all balance sheet positions relevant to the MNE's ICM activities. For example, an Austrian parent's ICM asset position reflects all internal funds lent to a foreign affiliate, while its ICM liability position reflects all internal funds borrowed from a foreign affiliate. Consequently, these positions are reciprocal, and the ICM assets of the Austrian parent are identical to the (sum of) ICM liabilities of its German affiliate(s).

4 Empirical results

In this section, we test empirically the predictions of our theoretical model from Section 2.4, starting with the optimal demand for internal capital market borrowing of German affiliates, followed by the optimal demand for internal and external borrowing of Austrian parents.[28]

4.1 Internal financing of German affiliates

As a first empirical exercise, we test our theoretical prediction regarding the optimal share of internal borrowing of foreign affiliates in Corollary 1. For our sample of FDI relationships between German affiliates and Austrian parents, we estimate the following regression equation with fixed effects at the affiliate level:

$$\frac{I_{jt}}{K_{jt}} = \alpha + \beta \cdot R^k_{jt} + \gamma \cdot \frac{N_{jt}}{K_{jt}} + \beta' \cdot R^k_{Other,t} + \gamma' \cdot \frac{N_{Other,t}}{K_{jt}} + \delta_t + \mu_s + \phi_p + \epsilon_{jt}, \tag{24}$$

where I_{jt} denotes the net internal borrowing of German affiliate j with an Austrian parent, K_{jt} the total assets, R^k_{jt} the return on capital — defined as the ratio of FDI revenues to total assets — and N_{jt} the net worth of the affiliate in year t. Given that we may construct the external liabilities of the German affiliate, B_{jt}, only as a residual of total assets minus the sum of FDI net worth and (net) internal borrowing, the estimated coefficient on R^k_{jt} in the corresponding regression equals $-\hat{\beta}$ by construction (see the proof of Corollary 1).[29]

In all specifications, we include year fixed effects δ_t to absorb joint dynamics that affect the supply or demand for internal borrowing, including differences in risk-free interest rates and capital-market conditions between Austria and Germany. In two extensions, we include *either* sector fixed effects μ_s to account for time-constant heterogeneity in the use of internal borrowing across sectors *or* parent fixed effects ϕ_p to account for time-constant differences in the characteristics of Austrian parents. ϵ_{jt} denotes the regression residual for affiliate j in year t. To account for potential differences in productivity and equity between the affiliate networks of different Austrian parents and over time, we further control for the average return on capital, $R^k_{Other,t}$, and net worth ratio, $N_{Other,t}/K_{jt}$, of affiliates located in *countries other than Germany*. In an alternative specification, we use parent-year fixed effects to account, more generally, for all observable or latent characteristics of a given Austrian parent firm in a given year. Our results and conclusions are qualitatively unchanged.

In our baseline results, we report heteroskedasticity and autocorrelation (HAC) robust Newey and West [1987] standard errors with 2 lags in annual data. In our robustness checks,

[28] It is important to recall that we only consider FDI relationships where the Austrian parent owns at least 75% of the German affiliate's total assets.

[29] The regression results for the share of external borrowing are available upon request.

Table 3: Internal borrowing of German affiliates

		Dependent variable:		
		Net internal borrowing $I_{DE,t}/K_{DE,t}$		
		(1)	(2)	(3)
DE affiliates return on capital	$R^k_{DE,t}$	-0.125^{***}	-0.108^{***}	-0.168^{***}
		(0.041)	(0.039)	(0.042)
DE affiliates net worth	$N_{DE,t}/K_{DE,t}$	-0.283^{***}	-0.306^{***}	-0.245^{***}
		(0.019)	(0.020)	(0.024)
Other affiliates return on capital	$R^k_{Other,t}$	0.109^{*}	0.110^{**}	0.057
		(0.056)	(0.054)	(0.049)
Other affiliates net worth	$N_{Other,t}/K_{DE,t}$	-0.0001	-0.0001^{*}	-0.0002^{**}
		(0.0001)	(0.0001)	(0.0001)
Constant		0.197^{***}	0.262^{***}	0.199^{***}
		(0.023)	(0.035)	(0.036)
Observations		3,068	3,068	3,068
R^2		0.131	0.155	0.473
Adjusted R^2		0.126	0.149	0.429
AT firms		218	218	218
DE firms		386	386	386
Year fixed effects		Yes	Yes	Yes
DE affiliate sector fixed effects		No	Yes	No
AT parent firm fixed effects		No	No	Yes

Notes: Unbalanced panel for the years 2007–2022. R^k_{jt}, $j \in \{DE, Other\}$, defined as revenues over total assets. I_{jt} denotes (net) internal borrowing and N_{jt} denotes FDI net worth as a fraction of DE affiliate total assets. AT parent firms with FDI ownership share(s) in DE $> 75\%$. Outlier correction for ratios above/below $+/-1.5$. Standard errors are HAC robust [Newey and West, 1987] with 2 lags in annual panel data. $^{*}/^{**}/^{***}$ indicates $p < 0.1/p < 0.05/p < 0.01$.

we obtained the same qualitative results (available upon request) when clustering standard errors at the Austrian parent level to account for potential correlation in the regression residuals between German affiliates of the same MNE.

Table 3 reports the coefficient estimates based on the regression in Equation (24) with only year fixed effects (column 1) and adding either sector fixed effects (column 2) or parent fixed effects (column 3). While all observations are at the relationship-year level, sector and parent fixed effects eliminate any time-constant heterogeneity in internal borrowing patterns across sectors and parents, respectively. Consequently, identification of the coefficient estimates in the rightmost column is exclusively based on variation over time and between affiliates of the same Austrian parent firm. At the same time, we find that the share of the explained variance in internal borrowing increases when including sector fixed effects and, even more, when including parent fixed effects.

We are mainly interested in the coefficient β, which captures the relationship between an affiliate's return on total assets R^k_{jt} — our empirical measure of the affiliate's productivity — and its (net) internal borrowing in year t. Across all specifications, the coefficient estimates in the first line of Table 3 are negative and of similar magnitude. We find that an affiliate's internal borrowing over total assets *decreases* with its return on capital, R^k_{jt}. Given that we control for the ratio of net worth, N_{jt}/K_{jt}, this implies that the share of external borrowing *increases* in the affiliate's return on capital, in line with the theoretical result of Proposition 1. As predicted by our theoretical model, more profitable German affiliates of Austrian MNEs borrow a smaller share of their total assets internally and a greater share externally. This holds over time, across sectors and for affiliates of the same Austrian parent firm.

Note that, in line with our theoretical model, internal borrowing is lower for relationship-year observations with a higher share of FDI net worth over total assets, which is an effective substitute for inter-company loans.[30] The estimate of the corresponding coefficient, γ, is statistically significant throughout. Finally, the coefficient estimates in Table 3 suggest that a similar theoretical mechanism is at work for affiliates in *countries other than Germany*, where a higher (average) return on capital, $R^k_{Other,t}$, increases the net internal borrowing of German affiliates from their Austrian parents, albeit with mixed statistical significance.

4.2 External and internal financing of Austrian parents

As a second empirical exercise, we test our theoretical predictions for the optimal net internal borrowing (Corollary 2) and external borrowing (Corollary 3) of Austrian parent firms. Using the same sample of FDI relationships between German affiliates and Austrian parents as in Section 4.1, we estimate the following regression equation at the affiliate level:

[30] This holds true also for German affiliates' external borrowing share. Results are available upon request.

$$\frac{X_{j't}}{K_{jt}} = \alpha + \beta \cdot R^k_{jt} + \gamma \cdot \frac{N_{jt}}{K_{jt}} + \beta' \cdot R^k_{Other,t} + \gamma' \cdot \frac{N_{Other,t}}{K_{jt}} + \gamma'' \cdot \frac{N_{j't}}{K_{jt}} + \delta_t + \mu_{s'} + \phi_{p'} + \epsilon_{j't}, \quad (25)$$

for $X_{j't} = \{I_{j't}, B_{j't}\}$, where $I_{j't}$ denotes net internal borrowing of Austrian parent j' from German affiliate j (from the OeNB's FDI dataset) and $B_{j't}$ external borrowing (i.e. domestic bank credit from the Austrian credit register) of parent j' in year t. All other variables and parameters are as defined in Equation (24), and we again control for the average return on capital and net worth of affiliates located in *countries other than Germany*, $R^k_{Other,t}$ and $N_{Other,t}$, respectively.

It is important to note, first, that we estimate both the regression for internal borrowing, $I_{j't}$, and for external borrowing, $B_{j't}$, at the relationship level. While we observe internal borrowing between Austrian parent j' and German affiliate j, domestic bank credit is observed only at the level of the Austrian parent and cannot be assigned to a specific FDI relationship. However, since we scale domestic bank credit by affiliate total assets and regress it on the productivity measure of German affiliate j, the unit of observation in this regression is also at the level of the affiliate. Second, in line with our theoretical results in Corollaries 2–3, we scale $I_{j't}$, $B_{j't}$, N_{jt}, $N_{Other,t}$, and $N_{j't}$ in (25) by the *affiliate's* rather than the *parent's* total assets. Another reason is that affiliate total assets are subject to mandatory reporting in the Austrian FDI data, whereas parent total assets are not measured consistently in either of the data sets discussed in Section 3.[31]

Tables 4 and 5 report the regression results for net internal and external borrowing of Austrian parent firms. In either table, the coefficient estimates in column (1) include year fixed effects, δ_t, while column (2) and column (3) adds sector fixed effects, $\mu_{s'}$ and firm fixed effects, $\phi_{p'}$, for Austrian parent j', respectively. Recall that our theoretical model in Section 2 predicts that a higher return on capital of foreign affiliate j, R^k_{jt}, is associated with *higher* net internal borrowing of the Austrian parent from the foreign affiliate, $I_{j't}/K_{jt}$, and *lower* external borrowing of the Austrian parent from domestic banks, $B_{j't}/K_{jt}$, both expressed as a fraction of the affiliate's total assets.

Table 4 confirms our theoretical prediction for net internal borrowing between Austrian parents and their German affiliates. The higher the return on capital of a German affiliate – measured by the firm's FDI revenue over total assets (scaled by the parent's FDI ownership share) – the *higher* is the Austrian parent's net internal borrowing from this German affiliate. Austrian parents borrow more from productive German affiliates via their internal capital

[31] The resulting ratios $I_{j't}/K_{jt}$, $B_{j't}/K_{jt}$, $N_{Other,t}/K_{jt}$, and $N_{j't}/K_{jt}$ do not have a straightforward interpretation and may take on extreme values, if K_{jt} is small relative to parent j'. Nevertheless, we abstain from correcting for outliers and use the same sample of FDI relationships as in the regression equation (24).

Table 4: Internal borrowing of Austrian parents

		Dependent variable:		
		Net internal borrowing $I_{AT,t}/K_{DE,t}$		
		(1)	(2)	(3)
DE affiliates return on capital	$R^k_{DE,t}$	0.121^{***}	0.099^{**}	0.165^{***}
		(0.041)	(0.039)	(0.042)
DE affiliates net worth	$N_{DE,t}/K_{DE,t}$	0.285^{***}	0.285^{***}	0.246^{***}
		(0.019)	(0.020)	(0.024)
Other affiliates return on capital	$R^k_{Other,t}$	-0.108^{***}	-0.062	-0.057
		(0.056)	(0.054)	(0.049)
Other affiliates net worth	$N_{Other,t}/K_{DE,t}$	0.0001	0.0001	0.0002^{**}
		(0.0001)	(0.0001)	(0.0001)
Parent net worth	$N_{AT,t}/K_{DE,t}$	-0.00001	-0.00000	-0.00000
		((0.0000))	(0.0000)	(0.0000)
Constant		-0.197^{***}	-0.147^{***}	-0.200^{***}
		(0.023)	(0.035)	(0.036)
Observations		3,068	3,068	3,068
R^2		0.131	0.194	0.473
Adjusted R^2		0.125	0.183	0.429
AT firms		218	218	218
DE firms		386	386	386
Year fixed effects		Yes	Yes	Yes
AT parent sector fixed effects		No	Yes	No
AT parent firm fixed effects		No	No	Yes

Notes: Unbalanced panel for the years 2007–2022. R^k_{jt}, $j \in \{DE, Other\}$, defined as revenues over total assets. I_{jt} denotes (net) internal borrowing and N_{jt}, $j \in \{DE, Other, AT\}$ denotes parent and affiliate net worth, all as a fraction of DE affiliate total assets. AT parent firms with FDI ownership share(s) in DE > 75%. Standard errors are HAC robust [Newey and West, 1987] with 2 lags in annual panel data. $^*/^{**}/^{***}$ indicates $p < 0.1/p < 0.05/p < 0.01$.

Table 5: External borrowing of Austrian parents

		Dependent variable:		
		Domestic bank credit $B_{AT,t}/K_{DE,t}$		
		(1)	(2)	(3)
DE affiliates return on capital	$R^k_{DE,t}$	-27.788^{***}	-26.638^{**}	-32.071^{***}
		(10.596)	(10.629)	(11.006)
DE affiliates net worth	$N_{DE,t}/K_{DE,t}$	14.268^{***}	16.155^{***}	26.360^{***}
		(4.509)	(5.146)	(6.603)
Other affiliates return on capital	$R^k_{Other,t}$	-20.273^{***}	-19.263^{***}	-11.193^{**}
		(6.344)	(5.600)	(5.271)
Other affiliates net worth	$N_{Other,t}/K_{DE,t}$	0.553^{***}	0.561^{***}	0.660^{***}
		(0.108)	(0.104)	(0.088)
Parent net worth	$N_{AT,t}/K_{DE,t}$	0.015^{***}	0.015^{***}	0.014^{***}
		(0.002)	(0.002)	(0.002)
Constant		0.764	2.664	-52.688^{***}
		(2.329)	(2.606)	(10.915)
Observations		2,355	2,355	2,355
R^2		0.462	0.487	0.656
Adjusted R^2		0.458	0.480	0.622
AT firms		194	194	194
DE firms		320	320	320
Year fixed effects		Yes	Yes	Yes
AT parent sector fixed effects		No	Yes	No
AT parent firm fixed effects		No	No	Yes

Notes: Unbalanced panel for the years 2007–2019. R^k_{jt}, $j \in \{DE, Other\}$, defined as revenues over total assets. N_{jt}, $j \in \{DE, Other, AT\}$ denotes parent and affiliate net worth as a fraction of DE affiliate total assets. AT parent firms with FDI ownership share(s) in DE $> 75\%$. Standard errors are HAC robust [Newey and West, 1987] with 2 lags in annual panel data. $^{*}/^{**}/^{***}$ indicates $p < 0.1/p < 0.05/p < 0.01$.

market. Columns (2) and (3) illustrate that this relationship is statistically and quantitatively robust to adding sector fixed effects or firm fixed effects at the Austrian parent level. Note further that, in line with our mechanism, net internal borrowing between an Austrian parent and its German affiliate is negatively associated with the (average) return on capital of its affiliates in countries other than Germany.

Table 5 confirms our theoretical prediction for the MNE's optimal use of external funding. The higher the return on capital of the German affiliate, the *lower* is the Austrian parent's stock of domestic bank credit as a fraction of the affiliate's total assets. The negative and highly significant coefficient on $R^k_{DE,t}$ with year fixed effects in column (1) is robust to adding either sector fixed effects or firm fixed effects for the Austrian parent in columns (2) and (3). Intuitively, this relationship should also hold for the return on capital of affiliates in other countries. In line with this intuition, the external borrowing of the Austrian parent in relation to the total assets of the German affiliate also decreases with the average return on capital of affiliates in countries other than Germany, $R^k_{Other,t}$. The corresponding coefficient estimate in Table 5 is negative and statistically significant for all three specifications.

Finally, the financial accelerator model of Bernanke et al. [1999] implies that higher net worth, which serves as collateral in the optimal debt contract with the financial intermediary, facilitates a higher leverage ratio and, ceteris paribus, more external borrowing. In our model, the same logic should hold for the net worth of the MNE parent as well as the FDI net worth of affiliates in Germany and other countries. Consistently, we find that the Austrian parent's domestic bank credit *increases* in its own net worth, $N_{AT,t}$, as well as in the net worth of its foreign affiliates, $N_{DE,t}$ and $N_{Other,t}$, where all variables are expressed as a fraction of the German affiliate's total assets.

4.3 Interpretation and quantitative effects

Our coefficient estimates of interest are highly statistically significant and consistent with our theoretical predictions in Section 2. This is remarkable especially in light of the fact that we obtain the data on internal and external borrowing of Austrian parents from different datasets — the OeNB's foreign direct investment survey of Austrian MNEs for internal borrowing on the one hand, and the Austrian credit register for external borrowing on the other hand. The estimates are qualitatively and quantitatively robust to using different combinations of fixed effects, where identification rests on different dimensions of variation at the FDI relationship level. In our preferred specification with year and parent fixed effects in column (3), the coefficient estimates in Tables 3, 4, and 5 are identified merely by variation between German affiliates of the same Austrian parent firm and by idiosyncratic variation over time. Accordingly, our empirical results are driven neither by economy-wide fluctuations in the supply or demand for financial funds nor by time-constant observable or unobservable differences between Austrian parents.

In order to interpret the coefficient estimates quantitatively, consider the effect of moving from the first to the third quartile of the return-on-capital distribution of German affiliates, i.e. the distribution of FDI revenues relative to affiliate total assets both across affiliate firms and over time. This amounts to comparing a return on capital of 8.3% for the third quartile with a zero return for the first quartile. From column (3) of Table 3, the German affiliate's net internal borrowing relative to affiliate total assets is .0139 ($= -.168 \times .083$) lower relative to a sample mean ratio of .1076, corresponding to a 13% lower net internal borrowing ratio of the German affiliate. Vice versa, net internal borrowing by the Austrian parent is higher by about the same amount (see column (3) of Table 4). From Table 5, the Austrian parent's domestic bank credit relative to affiliate total assets is 2.66 ($= -32.07 \times .083$) lower relative to a sample mean ratio of 11.23, corresponding to a 23.7% lower domestic bank credit ratio.

5 Conclusion

This paper extends the costly-state-verification model of Bernanke et al. [1999] and derives theoretical predictions for the optimal use of internal and external capital markets by a multinational enterprise (MNE). We first show theoretically that internal capital markets interact with external borrowing conditions and induce spill-over effects to the external borrowing and capital investment decisions of foreign affiliates in the MNE network. In our model, more productive foreign affiliates finance a greater share of their total assets externally, while their domestic parents borrow more internally and less externally relative to the affiliate's total assets. Productive capital is reallocated to more productive affiliates, while firm leverage – external debt over total assets – is higher for these affiliates as well as their parents.

Previous work has focused on internal capital markets as a channel to reallocate funds in response to cross-country differences in tax rates and financial institutions. We contribute to this literature by showing that, while internal borrowing may depend on external financing conditions, external financing conditions are, vice versa, affected by internal capital markets. In our model, access to external funds varies between firms due to differences in their return on capital, even if they operate in the same host country. In the case of an MNE, this implies differences in the optimal external borrowing share both at home and abroad. Parent firms of more productive foreign affiliates also benefit from better external financing conditions. They borrow more internally and less externally, while their leverage increases due to reduced capital investment at home.[32]

[32]Moreover, we find that the optimal response of the MNE's parent and affiliate firms to a domestic credit

We then confirm our theoretical predictions empirically by using a unique combination of FDI and credit register data provided by the Oesterreichische Nationalbank, which covers all Austrian MNEs and their foreign affiliates, as well as all Austrian firm-bank relationships with outstanding loans above a minimum reporting threshold of EUR 350,000. Matching these data allows us to uncover the interaction of external and internal capital markets at the FDI-relationship level and to identify cross-border effects of differences in capital returns on the borrowing and investment decisions of Austrian MNEs. Consistent with the predictions of our extended Bernanke et al. [1999] model, we show that German affiliates with a higher return on capital borrow less internally from their Austrian parents, while the latter borrow more internally and less externally from domestic banks relative to affiliate total assets.

Accordingly, our findings provide empirical support for the relevance of financial frictions and their transmission across borders via the internal capital market of an MNE, suggesting that, through a bank's participation constraint and opportunity cost, internal capital markets may also affect the external funding conditions of firms operating only domestically. We leave the investigation of a further propagation of foreign productivity and credit supply shocks to domestic bank lending for future research.

supply shock depends on how this affects the tightness of the bank's participation constraint, qualifying thus the theoretical predictions in Bernanke et al. [1999] and Biermann and Huber [2024].

References

L. Alfaro and M.X. Chen. Surviving the global financial crisis: Foreign ownership and establishment performance. *American Economic Journal: Economic Policy*, 4, 2012.

P. Antràs, M.A. Desai, and C.F. Foley. Multinational firms, FDI flows, and imperfect capital markets. *The Quarterly Journal of Economics*, 124(3):1171–1219, 08 2009. ISSN 0033-5533. doi: 10.1162/qjec.2009.124.3.1171. URL https://doi.org/10.1162/qjec.2009.124.3.1171.

B.S. Bernanke, M. Gertler, and S. Gilchrist. The financial accelerator in a quantitative business cycle framework. In *Handbook of Macroeconomics*, volume 1C, pages 1341–1393. Elsevier, New York, 1999.

M. Biermann and K. Huber. Tracing the international transmission of a crisis through multinational firms. *The Journal of Finance*, 79(3), 2024.

O.J. Blanchard, F. López de Silanes, and A. Shleifer. What do firms do with cash windfalls? *Journal of Financial Economics*, 36, 1994.

T. Buettner, M. Overesch, U. Schreiber, and G. Wamser. Taxation and capital structure choice – Evidence from a panel of German multinationals. *Economics Letters*, 105, 2009.

M.A. Desai, C.F. Foley, and J.R. Hines. A multinational perspective on capital structure choice and internal capital markets. *The Journal of Finance*, 59, 2004.

M.A. Desai, C.F. Foley, and K.J. Forbes. Financial constraints and growth: Multinational and local firm responses to currency depreciations. *Review of Financial Studies*, 21, 2008.

M.A. Desai, C.F. Foley, and J. Hines. Domestic effects of the foreign activities of US multinationals. *American Economic Journal: Economic Policy*, 1, 2009.

P. Egger, C. Keuschnigg, V. Merlo, and G. Wamser. Corporate taxes and internal borrowing within multinational firms. *American Economic Journal: Economic Policy*, 6, 2014.

M.S. Feldstein. *The effects of taxation on multinational corporations*, chapter 'The effects of outbound foreign direct investment on the domestic capital stock'. University of Chicago Press, 1995.

S. Goldbach, A.J. Nagengast, E. Steinmüller, and G. Wamser. The effect of investing abroad on investment at home: On the role of technology, tax savings, and internal capital markets. *Journal of International Economics*, 116, 2019.

B.J. Henderson, N. Jegadeesh, and M.S. Weisbach. World markets for raising new capital. *Journal of Financial Economics*, 82, 2006.

D. Herzer and M. Schrooten. Outward FDI and domestic investment in two industrialized countries. *Economics Letters*, 99, 2008.

B. Imbierowicz, A. Nagengast, E. Prieto, and U. Vogel. Bank lending and firm internal capital markets following a deglobalization shock. *Journal of International Economics*, 157, 2025.

S. Kalemli-Özcan, H. Kamil, and C. Villegas-Sanchez. What hinders investment in the aftermath of financial crises: Insolvent firms or illiquid banks? *The Review of Economics and Statistics*, 98(4), 2016.

R. La Porta, F. López de Silanes, and A. Shleifer. The economic consequences of legal origins. *Journal of Economic Literature*, 52, 2008.

O. Lamont. Cash flow and investment: Evidence from internal capital markets. *The Journal of Finance*, 46, 1997.

R. Levine. Finance and growth: Theory and evidence. In *Handbook of Economic Growth*, volume 1, pages 865–934. North Holland, Amsterdam, 2005.

C. Lian and Y. Ma. Anatomy of corporate borrowing constraints. *The Quarterly Journal of Economics*, 136(1), 2021.

K. Manova, S.J. Wei, and Z. Zhang. Firm exports and multinational activity under credit constraints. *The Review of Economics and Statistics*, 97, 2015.

J.R. Meyer and E. Kuh. *The investment decision: An empirical study.* Harvard University Press, Cambridge, MA, 1957.

W. K. Newey and K. D. West. A simple, positive semi-definite, heteroskedasticity and autocorrelation consistent covariance matrix. *Econometrica*, 55(3):703–708, 1987.

Oesterreichische Nationalbank. Foreign direct investment — Standardized tables, 2025. URL `https://www.oenb.at/en/Statistics/Standardized-Tables/external-sector/foreign-direct-investment.html`.

P. Ottonello and T. Winberry. Financial heterogeneity and the investment channel of monetary policy. *Econometrica*, 88(6), 2020.

A Theoretical Appendix

A.1 Equilibrium effects of total factor productivity (A_j)

This appendix provides supplementary derivations and results underlying the formal proofs in the main text. In what follows, we totally differentiate with respect to total factor productivity, A_j, the system of FOCs in (11'), (12), (13), (14) and (15), which are restated here for convenience for j':

$$\begin{aligned}
K_{j'}: \quad & \{[1-\Gamma(\bar{\omega}_{j'})] + \lambda_{1j'} \cdot [\Gamma(\bar{\omega}_{j'}) - \mu G(\bar{\omega}_{j'})]\} \cdot \alpha^2 A_{j'} K_{j'}^{\alpha-1} L_{j'}^{1-\alpha} \\
& -\lambda_{1j'} R_{j'} = 0 \quad \forall\ j', && \text{(A.1)} \\
B_{j'}: \quad & \lambda_{1j'} R_{j'} = \lambda_{1j} R_j \quad \forall\ j', && \text{(A.2)} \\
\bar{\omega}_j: \quad & \Gamma'(\bar{\omega}_{j'}) - \lambda_{1j'} \cdot [\Gamma'(\bar{\omega}_{j'}) - \mu G'(\bar{\omega}_{j'})] = 0 \quad \forall\ j', && \text{(A.3)} \\
\lambda_{1j'}: \quad & [\Gamma(\bar{\omega}_{j'}) - \mu G(\bar{\omega}_{j'})] \cdot R_{j'}^k K_{j'} - R_{j'} B_{j'} = 0 \quad \forall\ j', && \text{(A.4)} \\
\lambda_2: \quad & \sum_{j'=1}^{n} (K_{j'} - B_{j'} - N_{j'}) = 0. && \text{(A.5)}
\end{aligned}$$

First, we totally differentiate Equation (A.1) in order to obtain

$$\begin{aligned}
& \{-\Gamma'[\bar{\omega}_{j'}) + \lambda_{1j'} \cdot [\Gamma'(\bar{\omega}_{j'}) - \mu G'(\bar{\omega}_{j'})]\} \cdot \alpha^2 A_{j'} K_{j'}^{\alpha-1} L_{j'}^{1-\alpha} \cdot \frac{d\bar{\omega}_{j'}}{dA_j} + \\
& \{[1-\Gamma(\bar{\omega}_{j'})] + \lambda_{1j'} \cdot [\Gamma(\bar{\omega}_{j'}) - \mu G(\bar{\omega}_{j'})]\} \cdot \alpha^2 (\alpha-1) A_{j'} K_{j'}^{\alpha-2} L_{j'}^{1-\alpha} \cdot \frac{dK_{j'}}{dA_j} + \\
& \left\{[\Gamma(\bar{\omega}_{j'}) - \mu G(\bar{\omega}_{j'})] \cdot \alpha^2 A_{j'} K_{j'}^{\alpha-1} L_{j'}^{1-\alpha} - R_{j'}\right\} \cdot \frac{d\lambda_{1j'}}{dA_j} + \\
& \{[1-\Gamma(\bar{\omega}_{j'})] + \lambda_{1j'} \cdot [\Gamma(\bar{\omega}_{j'}) - \mu G(\bar{\omega}_{j'})]\} \cdot \alpha^2 K_{j'}^{\alpha-1} L_{j'}^{1-\alpha} \cdot \frac{dA_{j'}}{dA_j} = 0,
\end{aligned}$$

or, using Equation (A.3) to substitute for $\lambda_{1j'}$:

$$\begin{aligned}
& \{[1-\Gamma(\bar{\omega}_{j'})] + \lambda_{1j'} \cdot [\Gamma(\bar{\omega}_{j'}) - \mu G(\bar{\omega}_{j'})]\} \cdot \alpha^2 (\alpha-1) A_{j'} K_{j'}^{\alpha-2} L_{j'}^{1-\alpha} \cdot \frac{dK_{j'}}{dA_j} + \\
& \left\{[(\Gamma(\bar{\omega}_{j'}) - \mu G(\bar{\omega}_{j'})] \cdot \alpha^2 A_{j'} K_{j'}^{\alpha-1} L_{j'}^{1-\alpha} - R_{j'}\right\} \cdot \frac{d\lambda_{1j'}}{dA_j} + \\
& \{[1-\Gamma(\bar{\omega}_{j'})] + \lambda_{1j'} \cdot [\Gamma(\bar{\omega}_{j'}) - \mu G(\bar{\omega}_{j'})]\} \cdot \alpha^2 K_{j'}^{\alpha-1} L_{j'}^{1-\alpha} \cdot \frac{dA_{j'}}{dA_j} = 0. && \text{(A.6)}
\end{aligned}$$

Second, we totally differentiate Equation (A.2):

$$\frac{d\lambda_{1j'}}{dA_j} = \frac{R_j}{R_{j'}} \cdot \frac{d\lambda_{1j}}{dA_j}, \tag{A.7}$$

which implies that, in response to an increase in productivity in any location j, the shadow cost of capital increases or decreases simultaneously for the parent and its affiliates in all locations j'.

Third, we totally differentiate Equation (A.3) to obtain

$$\frac{d\lambda_{1j'}}{dA_j} = \frac{\partial \lambda_{1j'}}{\partial \bar{\omega}_{j'}} \cdot \frac{d\bar{\omega}_{j'}}{dA_j}, \tag{A.8}$$

where $\partial\lambda_{1j'}/\partial\bar{\omega}_{j'} > 0$ (see footnote 15).

Fourth, we totally differentiate Equation (A.4), which yields

$$\begin{aligned} &[\Gamma'(\bar{\omega}_{j'}) - \mu G'(\bar{\omega}_{j'})] \cdot \alpha A_{j'} K_{j'}^{\alpha} L_{j'}^{1-\alpha} \cdot \frac{d\bar{\omega}_{j'}}{dA_j} + [\Gamma(\bar{\omega}_{j'}) - \mu G(\bar{\omega}_{j'})] \cdot \alpha^2 A_{j'} K_{j'}^{\alpha-1} L_{j'}^{1-\alpha} \cdot \frac{dK_{j'}}{dA_j} \\ &+ [\Gamma(\bar{\omega}_{j'}) - \mu G(\bar{\omega}_{j'})] \cdot \alpha K_{j'}^{\alpha} L_{j'}^{1-\alpha} \cdot \frac{dA_{j'}}{dA_j} - R_{j'} \cdot \frac{dB_{j'}}{dA_j} = 0. \end{aligned} \tag{A.9}$$

Fifth, we totally differentiate Equation (A.5) to obtain

$$\sum_{j'} \frac{dB_{j'}}{dA_j} = \sum_{j'} \frac{dK_{j'}}{dA_j}. \tag{A.10}$$

A.1.1 Spill-over effects in capital returns

The return on capital in each location j' is given by Equation (6) in the main text:

$$R_{j'}^{k} = \alpha A_{j'} K_{j'}^{\alpha-1} L_{j'}^{1-\alpha}.$$

Totally differentiating $R_{j'}^{k}$ with respect to total factor productivity in location j, A_j, we get

$$\frac{dR_{j'}^{k}}{dA_j} = \alpha K_{j'}^{\alpha-1} L_{j'}^{1-\alpha} \cdot \frac{dA_{j'}}{dA_j} - \alpha\,(1-\alpha)\, A_{j'} L_{j'}^{1-\alpha} K_{j'}^{\alpha-2} \cdot \frac{dK_{j'}}{dA_j}.$$

Consider first the case $j' \neq j$, where $dA_{j'}/dA_j = 0$ by assumption. Consequently,

$$\frac{dR_{j'}^{k}}{dA_j} = -\alpha\,(1-\alpha)\, A_{j'} L_{j'}^{1-\alpha} K_{j'}^{\alpha-2} \underbrace{\frac{dK_{j'}}{dA_j}}_{<0} > 0,$$

where $dK_{j'}/dA_j < 0$ from Proposition 2.

Now consider the case $j' = j$, where $dA_j/dA_j = 1$ yields

$$\frac{dR_j^k}{dA_j} = \alpha K_j^{\alpha-1} L_j^{1-\alpha} - \alpha\left(1-\alpha\right) A_j L_j^{1-\alpha} K_j^{\alpha-2} \cdot \underbrace{\frac{dK_j}{dA_j}}_{>0} > 0,$$

because

$$\frac{\alpha K_j^{\alpha-1} L_j^{1-\alpha}}{\alpha(1-\alpha) A_j L_j^{1-\alpha} K_j^{\alpha-2}} = \frac{K_j}{(1-\alpha)A_j} > \frac{dK_j}{dA_j} > 0,$$

where the first inequality follows from our proof of Proposition 2, which implies that $dK_j/dA_j = K_j/\left[(1-\alpha)A_j\right] - (1-\alpha B_j/K_j)R_j \cdot d\lambda_{1j}/dA_j < K_j/\left[(1-\alpha)A_j\right]$ due to $1-\alpha B_j/K_j > 0$ and $d\lambda_{1j}/dA_j > 0$, and the second inequality follows directly from Proposition 3.

A.1.2 Symmetry

Since $dA_{j'}/dA_j = 0$ for $j' \neq j$ and $dA_j/dA_j = 1$, given symmetry, it follows from Equation (A.6) that

$$\frac{dK_j}{dA_j} > \frac{dK_{j'}}{dA_j} \quad \text{for} \quad j' \neq j.$$

Moreover, it follows from Equation (A.9) that

$$\frac{dB_j}{dA_j} > \frac{dB_{j'}}{dA_j} \quad \text{for} \quad j' \neq j.$$

A.2 Equilibrium effects of the risk-free rate

The costly-state-verification framework of Bernanke et al. [1999] relates the optimal external borrowing of firms to the so-called external finance premium (EFP), defined as the return on capital investment, R_j^k, relative to the risk-free interest rate, R_j, where the latter corresponds to the interest rate set by the central bank. Appendix A.1 investigates the equilibrium effects of a change in the *numerator* of the EFP in our model, $R_j^k = \alpha A_j K_j^{\alpha-1} L_j^{1-\alpha}$, due to a change in total factor productivity, A_j. In contrast to Bernanke et al. [1999], the MNE in our model chooses separately its optimal level of capital investment, K_j, and external borrowing, B_j, across n different locations, as its external borrowing depends also on its internal borrowing. In response to an exogenous change in R_j^k, e.g. due to a change in total factor productivity, A_j, productive capital is reallocated to equalize its marginal returns in all n locations.

In this section, we complement the previous analysis by investigating the equilibrium effects of a change in the *denominator* of the EFP, R_j. This allows us to compare the effects of a change in the financial intermediary's funding costs in our model with effects described in the existing literature, in particular in Bernanke et al. [1999] and Biermann and Huber [2024]. For this purpose, we totally differentiate the system of FOCs in (A.1)–(A.5) with respect to R_j.

Totally differentiating Equation (A.1), we obtain

$$\begin{aligned}&\{[1-\Gamma(\bar{\omega}_{j'})]+\lambda_{1j'}\cdot[\Gamma(\bar{\omega}_{j'})-\mu G(\bar{\omega}_{j'})]\}\cdot\alpha^2(\alpha-1)A_{j'}K_{j'}^{\alpha-2}L_{j'}^{1-\alpha}\cdot\frac{dK_{j'}}{dR_j}\\&+\left\{[\Gamma(\bar{\omega}_{j'})-\mu G(\bar{\omega}_{j'})]\cdot\alpha^2A_{j'}K_{j'}^{\alpha-1}L_{j'}^{1-\alpha}-R_{j'}\right\}\cdot\frac{d\lambda_{1j'}}{dR_j}-\lambda_{1j'}\cdot\frac{dR_{j'}}{dR_j}=0.\end{aligned}\tag{A.11}$$

Second, we totally differentiate Equation (A.2) with respect to R_j:

$$R_{j'}\cdot\frac{d\lambda_{1j'}}{dR_j}=R_j\cdot\frac{d\lambda_{1j}}{dR_j}+\lambda_{1j}.\tag{A.12}$$

Third, we totally differentiate Equation (A.3) with respect to R_j:

$$\frac{d\lambda_{1j'}}{dR_j}=\frac{\partial\lambda_{1j'}}{\partial\bar{\omega}_{j'}}\cdot\frac{d\bar{\omega}_{j'}}{dR_j},\tag{A.13}$$

where $\partial\lambda_{1j'}/\partial\bar{\omega}_{j'}>0$ (see footnote 15).

Fourth, we totally differentiate Equation (A.4) with respect to R_j:

$$\begin{aligned}&[\Gamma'(\bar{\omega}_{j'})-\mu G'(\bar{\omega}_{j'})]\cdot\alpha A_{j'}K_{j'}^{\alpha}L_{j'}^{1-\alpha}\cdot\frac{d\bar{\omega}_{j'}}{dR_j}+[\Gamma(\bar{\omega}_{j'})-\mu G(\bar{\omega}_{j'})]\cdot\alpha^2A_{j'}K_{j'}^{\alpha-1}L_{j'}^{1-\alpha}\cdot\frac{dK_{j'}}{dR_j}\\&-B_{j'}\cdot\frac{dR_{j'}}{dR_j}-R_{j'}\cdot\frac{dB_{j'}}{dR_j}=0.\end{aligned}\tag{A.14}$$

Fifth, we totally differentiate Equation (A.5) with respect to R_j:

$$\sum_{j'}\frac{dB_{j'}}{dR_j}=\sum_{j'}\frac{dK_{j'}}{dR_j}.\tag{A.15}$$

Setting $dR_{j'}/dR_j=0$ for $j'\neq j$ and substituting R_j^k for $\alpha A_jK_j^{\alpha-1}L_j^{1-\alpha}$ from Equation (6) as well as B_j/K_j for $[\Gamma(\bar{\omega}_j)-\mu G(\bar{\omega}_j)]\cdot\left(R_j^k/R_j\right)$ from Equations (18)–(19), we re-write (A.11) as

$$\begin{aligned}&\{[1-\Gamma(\bar{\omega}_{j'})]+\lambda_{1j'}\cdot[\Gamma(\bar{\omega}_{j'})-\mu G(\bar{\omega}_{j'})]\}\cdot\alpha^2(1-\alpha)A_{j'}K_{j'}^{\alpha-2}L_{j'}^{1-\alpha}\cdot\frac{dK_{j'}}{dR_j}\\&+\left[1-\alpha\cdot\frac{B_{j'}}{K_{j'}}\right]\cdot R_{j'}\cdot\frac{d\lambda_{1j'}}{dR_j}=0,\quad\text{for } j'\neq j,\end{aligned}$$

which implies that

$$\frac{dK_{j'}}{dR_j} \gtrless 0 \quad \text{if} \quad \frac{d\lambda_{1j'}}{dR_j} \lessgtr 0, \quad \text{for } j' \neq j.$$

To determine the sign of $d\lambda_{1j'}/dR_j$, we re-write Equation (A.12) as

$$R_{j'} \cdot \frac{d\lambda_{1j'}}{dR_j} = \lambda_{1j} \cdot \left(1 + \epsilon_{\lambda_{1j},R_j}\right), \quad j' \neq j,$$

where $\epsilon_{\lambda_{1j},R_j} \equiv (d\lambda_{1j}/dR_j) \,/\, (\lambda_{1j}/R_j) < 0$ denotes the elasticity of the shadow cost of external borrowing with respect to the financial intermediary's funding costs in j.[33] It follows that

$$\frac{dK_{j'}}{dR_j} \lesseqgtr 0, \quad \text{for } j' \neq j, \tag{A.16}$$

if (and only if)

$$\epsilon_{\lambda_{1j},R_j} \gtreqless -1. \tag{A.17}$$

As a result, optimal capital investment in country j' decreases in response to an increase in the cost of capital in country j, *unless* the shadow cost of external borrowing falls sufficiently strongly in response to $dR_j > 0$ (and vice versa).

For $j' = j$, $dR_j/dR_j = 1$, and we can use Equations (6) and (18)–(19) to write (A.11) as

$$\begin{aligned} &\{[1 - \Gamma(\bar{\omega}_j)] + \lambda_{1j} \cdot [\Gamma(\bar{\omega}_j) - \mu G(\bar{\omega}_j)]\} \cdot \alpha^2 (1-\alpha) A_j K_j^{\alpha-2} L_j^{1-\alpha} \cdot \frac{dK_j}{dR_j} \\ &+ \left[1 - \alpha \cdot \frac{B_j}{K_j}\right] \cdot R_j \cdot \frac{d\lambda_{1j}}{dR_j} + \lambda_{1j} = 0. \end{aligned} \tag{A.18}$$

The sum of the last two terms in Equation (A.18) is positive, if (and only if)

$$\epsilon_{\lambda_{1j},R_j} > -\frac{1}{1 - \alpha \cdot \frac{B_j}{K_j}}.$$

Consequently, optimal capital investment in country j decreases, *unless* the shadow cost of external debt falls sufficiently strongly in response to $dR_j > 0$ (and vice versa), that is

$$\frac{dK_j}{dR_j} \lesseqgtr 0, \tag{A.19}$$

[33] This is negative, as the shadow cost of external borrowing, λ_{1j}, increases in the EFP and decreases thus in the risk-free interest rate, R_j.

if (and only if)

$$\epsilon_{\lambda_{1j},R_j} \gtreqless -\frac{1}{1-\alpha \cdot \frac{B_j}{K_j}}. \tag{A.20}$$

Since $1/\left(1-\alpha \cdot \frac{B_j}{K_j}\right) < -1$, the condition for a decrease of capital investment in location j (see Equations (A.16)-(A.17)) is more likely satisfied than the condition for a decrease of capital investment in location j' (see Equations (A.19)-(A.20)).

In sum, an increase in the risk-free interest rate in country j, $dR_j > 0$, decreases the MNE's optimal capital investment in all locations j', unless the shadow cost of capital, λ_{1j}, is sufficiently responsive.[34] For intermediate values of the elasticity of λ_{1j} with respect to R_j, $1/\left(1-\alpha \cdot \frac{B_j}{K_j}\right) < \epsilon_{\lambda_{1j},R_j} < -1$, investment decreases in location j but increases in location j'. If the shadow cost of capital is sufficiently responsive, such that $\epsilon_{\lambda_{1j},R_j} < 1/\left(1-\alpha \cdot \frac{B_j}{K_j}\right) < -1$, investment increases in all locations j'.

This implies that the optimal leverage ratio, $B_{j'}/K_{j'}$, and, in turn, optimal external borrowing, $B_{j'}$, may increase or decrease in the interest rate, R_j. To see this, we can totally differentiate Equations (18)–(19), which gives:

$$\begin{aligned}\frac{d(B_{j'}/K_{j'})}{dR_j} = & \underbrace{[\Gamma'(\bar{\omega}_{j'}) - \mu G'(\bar{\omega}_{j'})] \cdot \frac{R^k_{j'}}{R_{j'}}}_{>0} \cdot \underbrace{\frac{d\bar{\omega}_{j'}}{dR_j}}_{<0} - \underbrace{[\Gamma(\bar{\omega}_{j'}) - \mu G(\bar{\omega}_{j'})] \cdot \frac{R^k_{j'}}{R^2_{j'}}}_{>0} \cdot \underbrace{\frac{dR_{j'}}{dR_j}}_{\substack{=1 \text{ for } j'=j \\ =0 \text{ for } j\neq j}} \\ & + \underbrace{\frac{[\Gamma(\bar{\omega}_{j'}) - \mu G(\bar{\omega}_{j'})]}{R_{j'}}}_{>0} \cdot \underbrace{\frac{dR^k_{j'}}{dK_{j'}}}_{<0} \cdot \underbrace{\frac{dK_{j'}}{dR_j}}_{\gtreqless 0}.\end{aligned} \tag{A.21}$$

In comparison, in Bernanke et al. [1999], domestic firms unambiguously decrease their optimal external borrowing and capital investment in response to an increase in the financial intermediary's cost of funding. In Biermann and Huber [2024], multinational firms respond by increasing their external borrowing abroad, unless the marginal cost of borrowing increases too strongly. MNEs also decrease their optimal capital investment both at home and abroad (see their Appendix B). In contrast, our model features explicit borrowing constraints of the MNE's entities that arise from the collateral requirements set by domestic banks. We show that the optimal adjustment of borrowing and investment depends on the extent to which the borrowing constraint responds to changes in the financial intermediary's cost of funding (i.e., the size of $\epsilon_{\lambda_{1j},R_j}$).

[34] If $\epsilon_{\lambda_{1j},R_j} > -1$, a decrease in the risk-free interest rate in location j raises the optimal capital investment in all locations. This is in line with empirical evidence for a positive relationship between foreign and domestic investment of MNEs in response to improved access to external financing in Goldbach et al. [2019].

A.3 Alternative MNE legal structure

In the main text, we assume that a multinational enterprise (MNE) has *separate legal entities* – the parent and its affiliate firms – that raise external funds independently to finance their capital investments in locations $j = 1, \ldots, n$. As a result, the parent and each affiliate firm repays its debt, if its productivity realization ω_j is equal to or greater than the firm-specific default threshold $\bar{\omega}_j$ defined in Equation (2), and defaults otherwise. In the event of default, an entity in location j guarantees its external debt using only its collateral, whereas all other entities of the MNE are unaffected.

In this appendix, we explore an alternative legal structure of the MNE that allows pooling risks and cross-financing external debt within the MNE's affiliate network. In this case, after the realization of productivity draws, all entities of an MNE may borrow (lend) funds internally to repay their own (other entities') external debt.[35] With this legal structure, the MNE collectively repays the external debt of all of its entities, if (and only if) the *sum of their returns to capital* is at least as large as the *sum of their outstanding debt*. Otherwise, the entire MNE defaults and is liquidated subject to a state-verification cost, which reduces the residual value of its collateral. As a consequence, the default threshold $\bar{\omega}$ applies to the MNE as a whole rather than to each entity separately. Formally,

$$\bar{\omega} \cdot \sum_{j=1}^{n} R_j^k K_j = \sum_{j=1}^{n} Z_j B_j \quad \Longleftrightarrow \quad \bar{\omega} \equiv \frac{\sum_{j=1}^{n} Z_j B_j}{\sum_{j=1}^{n} R_j^k K_j} \tag{A.22}$$

Note that the capital returns of all entities are pooled in the case of repayment, whereas the collateral of all entities is pooled in the case of default.

With a single default threshold $\bar{\omega}$, the expected return to the MNE corresponds to

$$\sum_{j=1}^{n} \int_{\bar{\omega}}^{\infty} \omega R_j^k K_j dF(\bar{\omega}) - [1 - F(\bar{\omega})] \cdot \sum_{i=1}^{\infty} Z_j B_j, \tag{A.23}$$

while the accounting identity and the internal budget constraint in Equations (1) and (4) remain unchanged.

Each bank is now concerned only with the repayment or default of the MNE as a whole. Consequently, the bank's participation constraint in each location j becomes

$$[1 - F(\bar{\omega})] \cdot Z_j B_j + (1 - \mu) \int_{0}^{\bar{\omega}} \omega R_j^k K_j dF(\omega) = R_j B_j.$$

Aggregating the participation constraint over all j locations and substituting for the sum of

[35] The MNE's legal structure in this appendix might also be interpreted as a holding company.

non-default repayments, $\sum_{j=1}^{n} Z_j B_j$, from Equation (A.22), we get

$$\left\{[1-F(\bar{\omega})]\,\bar{\omega}+(1-\mu)\int_0^{\bar{\omega}}\omega dF\left(\bar{\omega}\right)\right\}\cdot\sum_{j=1}^{n}R_j^k K_j=\sum_{j=1}^{n}R_j B_j. \tag{A.24}$$

Using short-hand notation $\Gamma(\bar{\omega}) \equiv \int_0^{\bar{\omega}} \omega f(\omega)d\omega + \bar{\omega}\int_{\bar{\omega}}^{\infty} f(\omega)d\omega$ and $\mu G(\bar{\omega}) \equiv \mu \int_0^{\bar{\omega}} \omega f(\omega)d\omega$, the MNE's constrained profit-maximization problem *with cross-financing* can be written as

$$\begin{aligned}\max_{K_j,B_j,\bar{\omega}}\ [1-\Gamma(\bar{\omega})]\cdot\sum_{j=1}^{n}R_j^k K_j + \lambda_1\cdot\left\{[\Gamma(\bar{\omega})-\mu G(\bar{\omega})]\cdot\sum_{j=1}^{n}R_j^k K_j-\sum_{j=1}^{n}R_j B_j\right\}\\ -\lambda_2\cdot\sum_{j=1}^{n}\left(K_j-B_j-N_j\right),\end{aligned} \tag{A.25}$$

which differs from the corresponding Equation (10) in the main text only in the position of the terms of summation and the MNE's single default threshold $\bar{\omega}$.

The first-order conditions characterizing an interior solution to the above problem are

$$K_j: \quad [1-\Gamma(\bar{\omega})]\cdot R_j^k + \lambda_1\cdot[\Gamma(\bar{\omega})-\mu G(\bar{\omega})]\cdot R_j^k - \lambda_2 = 0 \quad \forall\ j \tag{A.26}$$

$$B_j: \quad \lambda_1\cdot R_j + \lambda_2 = 0 \quad \forall\ j \tag{A.27}$$

$$\begin{aligned}\bar{\omega}: \quad & -\Gamma'(\bar{\omega})\cdot\sum_{j=1}^{n}R_j^k K_j + \lambda_1\cdot[\Gamma'(\bar{\omega})-\mu G'(\bar{\omega})]\cdot\sum_{j=1}^{n}R_j^k K_j = 0\\ & \iff \quad \Gamma'(\bar{\omega}) - \lambda_1\cdot[\Gamma'(\bar{\omega})-\mu G'(\bar{\omega})] = 0\end{aligned} \tag{A.28}$$

$$\lambda_1: \quad [\Gamma(\bar{\omega})-\mu G(\bar{\omega})]\cdot\sum_{j=1}^{n}R_j^k K_j - \sum_{j=1}^{n}R_j B_j = 0 \tag{A.29}$$

$$\lambda_2: \quad \sum_{j=1}^{n}(K_j - B_j - N_j) = 0, \tag{A.30}$$

which differ from the equilibrium conditions in Equations (A.1)–(A.5) merely in two respects:

1. The bank's participation constraint must now hold in the aggregate, i.e. as a sum over $j = 1, \ldots, n$.

2. There is only one aggregate participation constraint to be satisfied by the MNE and thus only one λ_1.

Importantly, Equation (A.27) implies that R_j is the same across all locations j. In this case, the MNE's optimal external borrowing across affiliates is indeterminate. Else, the MNE optimally borrows all external funds in the location j_0, where $R_{j_0} < R_j$ and the opportunity cost of the domestic bank is lowest, and zero external funds in all other locations $j \neq j_0$.

Following Bernanke et al. [1999], we assume that the parent and each affiliate firm invest weakly more than their net worth, i.e., $K_j \geq N_j \; \forall j$. Moreover, the results from Propositions 2 and 3 remain unchanged, such that a higher total factor productivity in location j implies a higher optimal capital stock in j and a lower optimal capital stock in all other locations $j' \neq j$, ceteris paribus.[36] In what follows, we distinguish between two scenarios.

Suppose first that $j_0 = j$, and the MNE's external borrowing is non-zero only in the location where total factor productivity increases. In this case, net internal borrowing by the affiliate in j is initially *negative*, as the affiliate lends to its parent and affiliates in other locations $j' \neq j$, or zero, if (and only if) the latter invest exactly their net worth. A higher productivity of the affiliate in j implies that productive capital is optimally shifted from locations $j' \neq j$ to location j in order to equate the marginal product of capital $\forall j$. Thus, net internal borrowing as a fraction of affiliate total assets will be less negative, if the affiliate initially lends to its parent and other affiliates, or becomes positive, if net internal borrowing was initially zero. In either case, the ratio of net internal borrowing over affiliate total assets, N_j/K_j, unambiguously *increases*. Formally,

$$\frac{d\left(I_j/K_j\right)}{dA_j} = \underbrace{\frac{1}{K_j}}_{>0} \cdot \underbrace{\frac{dI_j}{dA_j}}_{>0} - \underbrace{\frac{I_j}{\left(K_j\right)^2}}_{\leq 0} \cdot \underbrace{\frac{dK_j}{dA_j}}_{>0} > 0. \tag{A.31}$$

Suppose instead that $j_0 = j' \neq j$. Hence, the bank's opportunity cost is lowest, and the MNE's external borrowing is non-zero, only in a location other than j. Following a higher total factor productivity in j, the MNE extends its external borrowing in location $j' \neq j$. Given that every additional unit of external funds (and, possibly, some productive capital initially installed in locations $j' \neq j$) is now transferred to j, the ratio of net internal borrowing over affiliate total assets increases, ceteris paribus. Formally,

$$\frac{d\left(I_j/K_j\right)}{dA_j} = \underbrace{\frac{1}{K_j}}_{>0} \cdot \underbrace{\frac{dI_j}{dA_j}}_{=\frac{dK_j}{dA_j}>0} - \underbrace{\frac{I_j}{\left(K_j\right)^2}}_{0<\ldots<\frac{1}{K_j}} \cdot \underbrace{\frac{dK_j}{dA_j}}_{>0} > 0. \tag{A.32}$$

■

Regardless of the location j_0, where $R_{j_0} < R_j \; \forall j \neq j_0$, an alternative MNE legal structure with risk pooling implies that a higher total factor productivity of the affiliate in location j is associated with *higher* net internal borrowing by the affiliate relative to its total assets. This is the opposite of our theoretical prediction in Corollary 1 based on an MNE structure

[36] The formal proofs are available upon request.

with separate legal entities. More importantly, it is also at odds with our empirical finding in Table 3, which shows that a higher return on capital of an Austrian parent's German affiliate is associated with a *lower* ratio of affiliate net internal borrowing.