Foreclosure and Tunneling with Partial Vertical Ownership

Matthias Hunold* and Vasilisa Petrishcheva†

November 8, 2021

Abstract

We study the incentives of firms that hold partial vertical ownership to foreclose rivals. Compared to a full vertical merger, with partial ownership, a firm may obtain only part of the target's profit but may nevertheless be able to influence the target's strategy significantly. Levy et al. (2018) argue that this makes foreclosure more likely than a full merger. The target may be either a supplier or a customer, which opens the scope for either input foreclosure or customer foreclosure. We show that the incentives to foreclose can be higher, equal, or even lower with partial ownership than with a vertical merger, depending on how the protection of minority shareholders and transfer price regulations are specified.

JEL classification: G34, L22, L40

Keywords: Backward ownership; Entry deterrence; Foreclosure; Minority shareholdings; Partial ownership; Uniform pricing; Vertical integration

*Universität Siegen, Unteres Schloß 3, 57068 Siegen, Germany; E-mail: matthias.hunold@uni-siegen.de.

†Heinrich-Heine-Universität Düsseldorf, Düsseldorf Institute for Competition Economics (DICE), Universitätsstr. 1, 40225 Düsseldorf, Germany; E-mail: petrishcheva@dice.hhu.de.

1 Introduction

Foreclosure is a major policy concern related to vertical mergers. A vertically integrated entity may not be willing to supply rivals of its downstream unit (input foreclosure), or may not be willing to on-sell the products of a competing upstream firm (customer foreclosure). The Chicago School has argued that an integrated entity that can write efficient contracts does not foreclose other vertically related firms if there are gains from trade. Meanwhile, economists have formally shown that this argument may not apply in certain situations and foreclosure can occur as a result of vertical mergers.

Baumol and Ordover (1994), Spiegel (2013), and Levy et al. (2018) argue that the foreclosure incentives may be even stronger with partial vertical ownership that involves control. For example, if there are voting and non-voting shares of an upstream firm, a downstream firm may own all voting shares and have full control. These articles emphasize that with controlling partial acquisitions, a firm only internalizes parts of another firm's profits and losses, although it can fully distort its strategy to increase its own profit. Consequently, dedicated foreclosure strategies (such as a refusal to supply) can be more attractive when compared to full integration.

In this article, we add to this literature by studying the contracting and corporate governance of partially integrated firms. When a partial owner has control over a target firm, but only obtains part of the dividends, the questions arise whether, how, and to what extent the controlling owner can extract profits from the target firm (*tunneling*). Whereas minority shareholder protection aims at limiting such tunneling, it does take place in practice (our literature review provides details).

We show that different restrictions on profit shifting lead to distinctively different incentives to foreclose rivals. Certain restrictions indeed cause more incentives to foreclose with partial ownership than in the case of a full vertical merger, as shown by Baumol and Ordover (1994), Spiegel (2013), and Levy et al. (2018). However, with other restrictions on tunneling, there are the same or fewer incentives to foreclose in case of partial vertical ownership.

For competition policy, it is important to understand under what conditions partial ownership tends to create high foreclosure incentives. We complement the existing literature in this respect.

We focus on studying the restriction on the amount that can be taken out of the target firm (Restriction 1) and the restriction on the amount that must be left in the target firm (Restriction 2). At first sight, it might seem that the restrictions are equivalent. For instance, if the target's profit is 100, one can either specify that at most 20 can be taken out ($t \leq 20$)

or that 80 need to be left ($\pi^U \geq 80$). However, we will show below that the foreclosure incentives differ substantially. We show that, for different tunneling restrictions, a partial owner's optimal strategy may vary between higher incentives to foreclose than under vertical integration (as discussed in Levy et al. (2018)), the same incentives (because of fully taking into account the target firm's residual profit) and no incentives at all (if the transfer of money into the target firm is sufficiently restricted). We analyze the partial owner's foreclosure incentives for different market environments. In particular, we distinguish between the case where an upstream firm holds shares of a customer (partial forward ownership) and the case where a customer holds shares of its supplier (partial backward ownership).

Under a partial backward ownership structure, we find, in line with Levy et al. (2018), that the restriction on maximal tunneling amount indeed increases partial owner's incentives to foreclose its downstream rivals (input foreclosure) and decreases the foreclosure incentives of its upstream target's rivals (customer foreclosure). However, the alternative restriction on the minimal profit that needs to be left in the target firm yields the same customer and input foreclosure incentives as in full integration. Additionally, the restriction on the minimal profit might necessitate propping money into the target firm in order foreclose. If propping is not feasible at all, or not to a required extent, the partial backward owner faces lower incentives for input foreclosure and higher incentives for customer foreclosure compared to a full integration benchmark.

Under a partial forward ownership structure, the restriction on the tunneling amount decreases the incentives of the partial owner to foreclose its target's downstream rivals (input foreclosure) but increases the incentives to foreclose its own upstream rivals (customer foreclosure). This restriction follows the setup of Levy et al. (2018) and our results are in line with their findings as well. The minimal profit restriction, however, yields the same foreclosure incentives as full integration, provided that the partial owner can prop its target firm if the minimal profit level is relatively high. Additionally, if propping is not feasible at all, or not to a required extent, the partial forward owner has higher input foreclosure and lower customer foreclosure incentives in comparison to a fully integrated firm.

The structure of the remaining text is as follows. Section 2 contains the review of the related literature. Section 3 studies the input foreclosure incentives under partial backward ownership under different types of restrictions on profit shifting. Section 4 contains the analysis for customer foreclosure. We compare the different results in Section 5 and also relate them specifically to the article of Levy et al. (2018). Section 6 concludes with a discussion of implications for regulation and competition policy.

2 Related literature

We relate to and combine mainly two strands of literature, the one on vertical integration and foreclosure, and the other on profit shifting from and to a target firm (tunneling and propping).

Partial vertical ownership. There are crucial differences between a vertical merger and partial non-controlling backward ownership of the downstream incumbents. The direction of acquisition does typically not matter for the competitive effects if the result is a new entity. In particular, a merged entity cannot commit to an internal transfer price above costs (at least the literature on vertical mergers typically assumes this, such as Chen (2001)). This tends to reduce double marginalization within the integrated vertical chain – a pro-competitive effect. The literature has also pointed out the possible anti-competitive effects of vertical mergers. See Rey and Tirole (2007) for an overview.

Baumol and Ordover (1994), Spiegel (2013), and Levy et al. (2018) mainly consider the effects of controlling an upstream or downstream firm via partial ownership. They emphasize that, with controlling partial acquisitions, a firm only internalizes parts of another firm's profits and losses, although it can fully distort its strategy to increase its own profit. Consequently, dedicated foreclosure strategies (such as a refusal to supply) can be more attractive when compared to full integration. A crucial assumption for these results on controlling partial ownership is how the controlling owner can extract profits from the partially owned target firm (tunneling). Our main contribution is to show that the effects of foreclosure depend on the type of tunneling that is feasible in surprising and policy-relevant ways.

Other articles on partial vertical ownership focus more on the case of no or limited control, such that tunneling is less of an issue (Flath, 1989; Fiocco, 2016; Greenlee and Raskovich, 2006; Hunold and Stahl, 2016; Hunold, 2020).

Empirical evidence on tunneling. The second strand of literature deals with tunneling but does not consider partial ownership and foreclosure. Tunneling can take a variety of different forms.[1] The simplest form is shifting profits to the benefit of the controlling shareholder through self-dealing transactions. These may include the sale of over-priced output to

[1]See Atanasov et al. (2014) for a detailed discussion of three main types of tunneling: cash flow tunneling, asset tunneling, and equity tunneling. Cash flow tunneling is shifting a part of the target firm's current profits (e.g. through transfer pricing, excessive salaries, etc). Asset tunneling is buying the firm's major assets for a price above the market value or selling them for a price below the market value, and thereby influencing the firm's long-term profitability. Equity tunneling is increasing the controller's share at the expense of minority shareholders.

the target firm, the purchase of under-priced input from the target firm, excessive salaries, and bonuses for top managers and executives, and even using a corporate jet for private reasons. According to Johnson et al. (2000), this form of tunneling is illegal everywhere if it includes theft or fraudulent behavior. However, the controlling shareholders may legally shift profits through asset sales or excessive pricing agreements, or exploit corporate monetary and non-monetary opportunities, or use more complex instruments for profit-shifting.

Especially in countries with weaker investor protection, firms are able to tunnel resources in ways that cannot be prevented by outside investors. A number of studies document empirical evidence for tunneling in various countries like India, China, South Korea, Hong Kong, and Bulgaria. We briefly introduce these studies in turn.

- Bertrand et al. (2002) use the Prowess database to analyze Indian business groups from 1989 to 1999. They compare low-cash-flow to high-cash-flow firms and firms that are a part of a business group to stand-alone firms. They regress a firm's actual reported performance on its predicted performance and the predicted performance of other firms in the same group. They find evidence that tunneling occurs mainly through the firm's non-operating profits and is partly incorporated into the stock market prices.

- Jiang et al. (2010) document the nature and severity of tunneling in China. They analyze 1377 listed companies throughout 1996-2004 and find that controlling shareholders widely use corporate loans to shift profits from listed Chinese companies. They also show that the tunneling problem is most severe if the control right is significantly larger than the profit right.

- Baek et al. (2006) analyze private placements of firms listed on the Korean Stock Exchange in 1989-2000 and focus on business groups. They compare intragroup deals (deals within one business group) with other deals and provide evidence for tunneling activities within business groups: the firms with favorable past performance sell their securities at a discount to other group members.

- Cheung et al. (2006) analyze transactions between partial owners and target firms of Hong Kong listed companies in 1998-2000. They find that excess returns from those transactions are significantly negative, and negatively related to the percentage ownership of a controlling shareholder. Additionally, they find that the connected party transactions are more likely to be undertaken if the controlling shareholder can be traced to the mainland of China. They explain that those firms find it is easier to expropriate their minority shareholders because rulings by courts in Hong Kong are

not enforceable in China and thus Hong Kong investors have little chance to recover shifted assets.

- Atanasov (2005) conducts an econometric analysis of mass privatization in Bulgaria as an extreme case of a lack of mechanisms that can protect minority shareholders.[2] He finds that the absence of regulation allows majority shareholders to extract up to 85% of the target's firm value to its private benefit. Atanasov provides several examples supporting his evidence: in the year 2000, the national oil refinery Neftochim's stock was only valued at 24% of the price paid by Lukoil for the majority block; Balkanfarma, a holding of three pharmaceutical companies, had a ratio of 21%; and Sodi, the second-largest producer of soda ash in the world, had a ratio of 10.8%. Atanasov argues that controlling shareholders have a strong preference for expropriating minority shareholders rather than adding value through monitoring.

Tunneling also occurs in the context of profit shifting across countries due to tax differences. In their seminal study, Grubert et al. (1991) focus on the ability of firms to shift profits from high-tax to low-tax countries through their foreign affiliates. They use data from 1982 from 33 countriesand find that the US-based multinational enterprises shift disproportionally much income to the countries with low statutory tax rates. Moreover, they export more to their foreign affiliates in low-tax countries. More recent examples include Microsoft allegedly shifting profits to its foreign affiliates in Ireland, Puerto Rico, and Singapore to reduce its tax burden in Europe and avoid the US corporate income tax.[3]Another recent example is as well as Apple allegedly using offshore structures to shift billions of dollars out of the United States.[4]

Propping. Opposite to shifting profits from the target firm to the partial owner (tunneling), firms might also shift profits from the owner to the target firm (propping). Partial owners might use it to avoid a potential bankruptcy of the target firm.[5] Friedman et al. (2003) show theoretically that, in case of a moderate negative shock in the market, a partial

[2]He constructs a two-stage estimator which controls for a selection bias. The first stage estimates whether an investor places a small or a large bid or abstains from bidding at all. The second stage estimates the bid price conditional on bidding.

[3]See United States Congress Senate Committee on Homeland Security and Government Affairs. 2012. Offshore Profit Shifting and the U.S. Tax Code - Part 1 (Microsoft and Hewlett Packard), Hearings, September 20, 2012. 112th Cong. 2nd sess. Washington: GPO.

[4]See United States Congress Senate Committee on Homeland Security and Government Affairs. 2013. Offshore Profit Shifting and the U.S. Tax Code - Part 2 (Apple). Hearings, May 21, 2013. 113th Cong. 1st sess. Washington: GPO.

[5]Similarly, the partial owner might engage in tunneling to protect itself from bankruptcy.

owner may find it optimal to prop the target firm to prevent its bankruptcy. They also analyze firms hit by an Asian crisis 1997-1998 and provide empirical evidence of propping. Friedman et al. (2003) focus on the Asian crisis 1997-1998, a quasi-natural experiment and a shock large and unexpected enough to induce propping. They analyze the effect of debt and corporate governance on firm-level performance by applying difference-in-difference analysis and find evidence for propping, especially pronounced in specific ownership structures, such as pyramids.[6]

Our analysis shows that propping might also facilitate customer foreclosure in the case of partial backward ownership.

3 Input foreclosure incentives with partial ownership

3.1 Model framework

In this section, we consider a setting with one upstream firm U and two symmetric downstream firms, D_1 and D_2, as shown in Figure 1. The upstream firm can sell each downstream firm one unit of the input at prices f_1 and f_2.

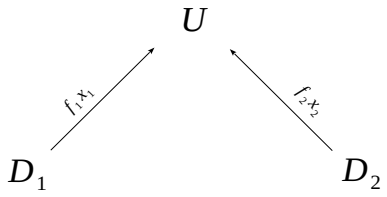

Figure 1: Market structure – input foreclosure setup.

The profit of U is

$$\pi^U = f_1 x_1 + f_2 x_2,$$

where $x_i \in \{0, 1\}$ denotes the input sales to firm i. One can interpret an input sale ($x_i = 1$) in several ways. First, one can think of a machine that the downstream firm can use to produce the output. Second, one can think of a per-unit input sold at marginal costs and

[6] In a pyramidal ownership structure, several firms form a business group. This business group is a top-down chain of companies usually controlled by the ultimate shareholder who may only owe a small part of firms located in the lower levels of the pyramidal structure but can control it fully (Riyanto and Toolsema (2008)).

an upfront fee (as may be the case with secret contracting, see Hart and Tirole (1990)). We follow Levy et al. (2018) and denote the profit of the downstream firm i as

$$\pi_i = \pi(x_i, x_{-i}) - f_i x_i,$$

where $\pi(x_i, x_{-i})$ is the downstream flow profit before input costs. The downstream firm's flow profit increases if it has the input. We allow for the case that a firm cannot make a positive profit without the input and that a firm can produce the output in more competitively way with the input from U (cheaper or at a higher quality):

Assumption 1. $\pi(1, x_{-i}) > \pi(0, x_{-i})$,

Moreover, a firm's profit decreases if its rival has obtained a unit of input because this intensifies competition:

Assumption 2. $\pi(x_i, 1) \leq \pi(x_i, 0)$, *with the latter holding strictly at least for* $x_i = 1$.

We study the cases of vertical separation, a full merger between U and D_1, and partial vertical ownership where D_1 owns a share $\alpha \in (0; 1)$ of U and can influence the strategy of U to some degree (we explain the restrictions below). For a given ownership structure:

1. Upstream firm U sets input prices f_1 and f_2.
2. Each downstream firm $D_i, i \in \{1; 2\}$, chooses whether to purchase the input ($x_i \in \{0; 1\}$) and then sells its output.

For the following analysis of tunneling, we use as a reference a *"market price"* f^*. To allow for different levels of bargaining power, we let the market price have any level in the interval $[\underline{f}, \overline{f}]$. The lower bound $\underline{f}$ is the reservation value of U, which equals its marginal costs of 0, and the upper bound equals the willingness-to-pay of each D_i under vertical separation. It is defined as the maximal price that U can charge each firm, which is equal to the incremental profit from the input, given the other downstream firm also uses the input:

$$\overline{f} = \pi(1, 1) - \pi(0, 1). \quad \textit{(take-it-or-leave-it price)} \tag{1}$$

Benchmark: full vertical integration. Full integration between U and D_1 is our benchmark in the subsequent sections where we show that the foreclosure incentives of partial

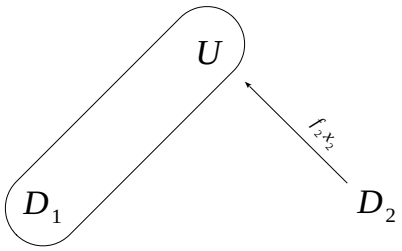

Figure 2: Full integration: input foreclosure setup

ownership depend crucially on how we model the restrictions on tunneling and transfer prices (see Figure 2). The joint profit of U and D_1 is

$$\pi_{D1}^{U} = \pi(x_1, x_2) + f_2 x_2. \tag{2}$$

To start, let us establish

Lemma 1. *It is always optimal for the integrated unit of U and D_1 to supply its downstream business with the input.*

Proof. See Appendix. □

It is optimal for the integrated entity to supply both downstream firms if the joint profit when doing so exceeds the joint profits under foreclosure:

$$\pi(1,1) + f^* \geq \pi(1,0) \tag{3}$$

$$\implies f^* \geq \pi(1,0) - \pi(1,1). \tag{4}$$

We refer to (4) as *"non-foreclosure condition under vertical integration"*.

3.2 Partial backward ownership

This section focuses on the case that D_1 has partial ownership of U, as shown in Figure 3. This partial ownership entitles D_1 to a share $\alpha \in (0,1)$ of U's profits, which yields for D_1 a total profit of

$$\pi_{D1} = \pi(x_1, x_2) - f_1 x_1 + \alpha(\underbrace{f_1 x_1 + f_2 x_2}_{\pi^U}). \tag{5}$$

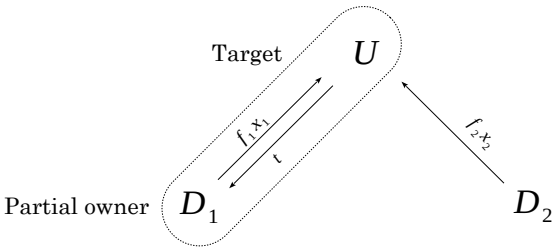

Figure 3: Partial backward ownership: D_1 owns stake of U

In line with Levy et al. (2018), we assume that the ownership arrangement allows D_1 to exert control over the strategy of U, subject to different restrictions, which we introduce below. The strategy of U essentially consists of setting the input prices f_1 and f_2 for the two downstream firms.

Firm D_1 can, if the restrictions allow so, use its control to require such a high input price from D_2 that D_2 does not buy the input (input foreclosure). Any price above $\overline{f}$ achieves this, for instance, $f_2 \to \infty$.

As regards the own input price f_1, the partial owner D_1 can generally demand a price that differs from the market price f^*. We speak of *tunneling* in the case of a lower input price ($f_1 < f^*$), whereas we speak of *negative tunneling* or *propping* in the case of a higher input price ($f_1 > f^*$). We denote by t the amount that D_1 tunnels out of U:

$$t = f^* - f_1. \tag{6}$$

The profit of supplier U is

$$\pi^U = f_1 x_1 + f_2 x_2 = (f^* - t)\, x_1 + f_2 x_2.$$

In what follows, we focus on the natural case that D_1 never forecloses itself, which means $x_1 = 1$. We can write the profit of D_1 as

$$\pi_{D1} = \pi(1, x_2) - f^* + t + \alpha(\underbrace{f^* - t + f_2 x_2}_{\pi^U}). \tag{7}$$

We now present alternative restrictions on tunneling and compare how these restrictions affect the foreclosure incentives. We focus on studying restrictions on the minimal upstream profit, on the amount to tunnel, and a combination of both. Both types of restrictions can naturally result from rules that aim at protecting minority shareholders of the upstream firm.

This protection might require profits to reach at least the minimum threshold to be satisfied or restrict the amount of money to be transferred downstream. In some cases, however, it might be optimal for the partial owner D_1 to prop U, i.e., to transfer profits upstream. In this case, the minority shareholder protection of the downstream firm can play a role. They can also either restrict the minimal amount of D_1's profits to be left in the firm or the amount of money that can be transferred upstream.

Remark. Although we model tunneling as an adjustment of the input price of D_1, our results also extend to the case that tunneling does not take place through the input price. In general, tunneling could take other forms than through a reduced input price for D_1. For instance, transfer price regulations may put limits on the deviations of the input price for D_1 from the market price that would prevail absent ownership (e.g. "the input price cannot differ more than 5% from f^*"). It might necessitate other forms of tunneling. A very crude way of tunneling would be that the partial owner D_1 physically takes cash out of U.

Tunneling Restriction 1: exogenous limit on the tunneling amount: $t \leq \bar{t}$ (as in Levy et al. (2018)). Following Levy et al. (2018), we assume that tunneling from U to D_1 is limited to an exogenous amount of $\bar{t}$, which yields the restriction $t \leq \bar{t}$. Intuitively, we expect the limit $\bar{t}$ to be higher if the protection of minority shareholders is weaker: the less the minority shareholders are protected, the easier it should get for the controlling shareholder to shift the profits out of the firm. Similarly, $\bar{t}$ should be higher if the transfer price regulation is weaker.

Lemma 2. *Under the restriction on the absolute tunneling amount, the partial owner D_1 has strictly higher incentives to foreclose its rival than in the case of full integration.*

Proof. The partial owner D_1 is not able to tunnel all profits, neither with nor without foreclosure. This means that D_1 can shift up to $\bar{t}$ out of the upstream firm independent of whether it supplies D_2 or not. Substituting $t = \bar{t}$ in the profit of D_1 yields

$$\pi_{D1}^{F} = \pi(1,0) - f^* + \bar{t} + \alpha\left(f^* - \bar{t}\right) \tag{8}$$

in the case of foreclosure, and

$$\pi_{D1}^{S} = \pi(1,1) - f^* + \bar{t} + \alpha\left(2f^* - \bar{t}\right) \tag{9}$$

when supplying D_2. Supplying is weakly more profitable than foreclosure if $\pi_{D1}^{S} \geq \pi_{D1}^{F}$, which

implies

$$f^* \geq {}^1\!/\!_\alpha \left[\pi(1,0) - \pi(1,1)\right]. \tag{10}$$

Condition (10) implies that foreclosure is more profitable for D_1 than in the case of a vertical merger because $\alpha < 1$. □

For a given tunneling restriction, foreclosure is more profitable when the profit share α from partial ownership is smaller. This condition is similar to the foreclosure incentive condition in Levy et al. (2018) as they assume an exogenous limit on tunneling and restrict the amount of tunneling to be smaller than the downstream gains and upstream losses from not supplying to D_2.[7]

Tunneling Restriction 2: minimal upstream profit ($\pi^U \geq \underline{\pi}^U$). Instead of restricting the amount that the downstream firm can tunnel ($t \leq \bar{t}$), one can impose a lower limit $\underline{\pi}^U$ on the profits that need to be left in the upstream firm. Intuitively, the supplier must have at least a certain profit level ($\underline{\pi}^U$), such that the other shareholders (or stakeholders) of the upstream firms do not become suspicious or too unsatisfied. For instance, one can imagine that, in case of a profit level below $\underline{\pi}^U$, these other parties would be able to sue D_1 successfully. So, D_1 needs to leave at least this amount of profit with U. The amount $\underline{\pi}^U$ could be an industry benchmark that provides an indication of what profit to expect under normal circumstances. We restrict $\underline{\pi}^U$ to the natural upper bound of $2f^*$ because $\underline{\pi}^U > 2f^*$ would mean that $U's$ profits need to be higher than the highest profit achievable at market prices absent vertical ownership.

Assumption 3. $\underline{\pi}^U \leq 2f^*$.

At first sight, it might seem that the restriction on the amount that can be taken out of the target firm (Restriction 1) and the restriction on the amount that must be left in the target firm (Restriction 2) are equivalent. For instance, if the target's profit is 100, one can either specify that at most 20 can be taken out ($t \leq 20$) or that 80 need to be left ($\pi^U \geq 80$). However, we will show below that the foreclosure incentives differ substantially.

[7] Their assumption A5 reads $t \leq min\{G, L\}$. The assumption implies that the amount to tunnel should not exceed the minimum of downstream gains and upstream losses from foreclosure: authors define the difference between downstream profits with and without foreclosure as G (gains) and the respective difference between upstream profits as L (losses).

In the present case, the tunneling restriction

$$\pi^U \geq \underline{\pi}^U$$

can be written as

$$f^* - t + f_2 x_2 \geq \underline{\pi}^U. \tag{11}$$

The restriction implies a maximal tunneling amount of

$$t = f^* + f^* x_2 - \underline{\pi}^U.$$

Lemma 3. *Under the tunneling restriction of a minimal profit that needs to be left in the upstream firm, the partial owner D_1 has the same incentive to foreclose its downstream rival as under vertical integration.*

Proof. Substituting for t in the profit of D_1 yields

$$\pi_{D1} = \pi(1, x_2) - f^* + \underbrace{\left(f^* + f^* x_2 - \underline{\pi}^U\right)}_{t} + \alpha \underline{\pi}^U, \tag{12}$$

and equivalently

$$\pi_{D1} = \pi(1, x_2) + f^* x_2 - (1 - \alpha)\underline{\pi}^U. \tag{13}$$

D_1 prefers to supply D_2 if the resulting profits are higher than the profits in the case of foreclosure:

$$\pi(1, 1) + f^* - (1 - \alpha)\underline{\pi}^U \geq \pi(1, 0) - (1 - \alpha)\underline{\pi}^U,$$

Adding $(1 - \alpha)\underline{\pi}^U$ on both sides yields

$$f^* \geq \pi(1, 0) - \pi(1, 1). \tag{14}$$

This is the same condition as under full vertical integration (Equation (4)). Firm D_1 has the same foreclosure incentives as when U and D_1 are fully integrated. □

Note that the profits do not depend on the degree of minority shareholder protection and the share α. This is different from the foreclosure condition (10) that we obtained when restricting the amount that D_1 can tunnel with the condition $t \leq \bar{t}$. The latter condition is also the relevant foreclosure condition of Levy et al. (2018) for their partial (backward)

ownership case.

Propping and foreclosure. Without profit shifting ($t = 0$), the minimum profit condition (11) in the case of foreclosure ($x_2 = 0$) becomes $\underline{\pi}^U > f^*$. To ensure the minimum profit of U, D_1 would need to engage in negative tunneling ($t < 0$, "*propping*") in the case of foreclosure. Therefore, we specifically analyze the case when $\underline{\pi}^U$ is in the interval $(f^*; 2f^*]$. It is a subset of the cases considered under Lemma 3.

Lemma 4. *If foreclosure is more profitable than supplying D_2 (Condition 14 does not hold) and the minimal profit that needs to be left in the upstream firm is relatively large ($\underline{\pi}^U > f^*$), the partial owner D_1 optimally props U to foreclose D_2 by shifting an amount of $\underline{\pi}^U - f^*$ to the target firm.*

Proof. We have shown in the proof of Lemma that foreclosure is profitable in case of the minimal profit restriction under the same condition as under vertical integration (see Equation (4)), that is:

$$\pi(1, 0) > \pi(1, 1) + f^*.$$

Propping is equivalent to $t < 0$ and occurs as part of the foreclosure strategy when the above condition holds and, in addition, $\underline{\pi}^U > f^*$.

To see this, note that in the absence of profit shifting and thus propping ($t = 0$), U supplying both downstream firms at market prices fulfills the restriction $\pi^U \geq \underline{\pi}^U$ as $\underline{\pi}^U \in (f^*; 2f^*]$ and the profit π^U then equals $2f^*$.

Instead, foreclosure of D_2 does not satisfy $\pi^U \geq \underline{\pi}^U$ as the profit π^U then equals f^* and $\underline{\pi}^U > f^*$ by construction of this case. In order so satisfy the minimal profit restriction of U, D_1 must shift profits to U, such that $\pi^U = f^* + t \geq \underline{\pi}^U$. The lowest transfer which satisfies this is given by $\underline{\pi}^U - f^*$, which implies

$$t = f^* - \underline{\pi}^U < 0.$$

which is negative by construction as $\underline{\pi}^U > f^*$.

Therefore, if foreclosure is profitable for D_1, the partial owner will prop U to ensure that its profit level is not below $\underline{\pi}^U$. □

If propping is restricted or not possible, foreclosure may not be feasible with partial ownership, although it would be profitable. For example, suppose that $f^* = 50$, $\underline{\pi}^U = 60$,

$\pi(1,1) = 100$, $\pi(1,0) = 200$. Hence, $D_1's$ profit absent foreclosure is and $U's$ profit equals

$$2f^* - t = 100 - t \geq \underline{\pi}^U = 60,$$

which implies that D_1 optimally tunnels an amount of $t = 40$ in this case and obtains a profit of

$$\pi(1,1) - f^* + t = 100 - 50 + 40 = 90.$$

With a foreclosure, the profit of U becomes

$$f^* - t = 50 - t \geq \underline{\pi}^U = 60,$$

which implies an optimal amount of profit shifting of $t = -10$ and yields a profit for D_1 of

$$\pi(1,0) - f^* + t = 200 - 50 - 10 = 140.$$

Foreclosure is only feasible with propping ($t \leq -10$) and turns out to be profitable for D_1 at $t = -10$ because its foreclosure profit is 140 and thus larger than the profit of 90 absent foreclosure. See Table 1 for a summary.

	Profit of target firm U	Profit of partial owner D_1
No foreclosure	$\pi^U = 2f^* - t = 100 - t = 60$ $\implies t = 40$	$\pi_{D1} = 100 - f^* + t = 90$
Foreclosure with propping	$\pi^U = f^* - t = 50 - t \geq \underline{\pi}^U = 60$ $\implies t = -10$	$\pi_{D1} = 200 - f^* + t = 140$

Table 1: Example with propping in the case of foreclosure where $f^* = 50$, $\underline{\pi}^U = 60$, $\pi(1,1) = 100$, $\pi(1,0) = 200$.

Note that if propping were not possible (which corresponds to $t \geq 0$), then there would not be foreclosure, and D_1 would earn the profit of 90.

Corollary 1. *Foreclosure does not occur with partial backward ownership in situations where it would occur with a full vertical merger if the target firm's minimum profit level is above the*

profit obtainable with foreclosure ($\underline{\pi}^U > f^*$) and profit shifting into the target firm (propping) is not feasible at all, or not to the required extent (this corresponds to the restriction $t > \underline{\pi}^U - f^*$).

This corollary sheds new light on the foreclosure effects of partial vertical ownership: Restrictions on the money a partial owner can prop into the target firm as part of a foreclosure strategy may render foreclosure impossible. Even if the vertically related partial owner has full control over the target firm and seemingly more incentives to foreclosure than in the case of a full vertical merger (as argued by Levy et al. (2018)), foreclosure may nevertheless not occur, although it would have occurred with a merger. As propping is a form of expropriation, strong enough minority shareholder protection might assure it is not unlimited. Additionally, transfer price regulations may also limit the scope for propping.

The next proposition summarizes the results on the input foreclosure incentives with partial backward ownership of the Lemmas 2, 3, and 4.

Proposition 1. *Relative to full vertical integration, partial backward ownership (PBO) tends to affect the incentives for input foreclosure in the following ways:*

1. *PBO increases the foreclosure incentives if the absolute amount of tunneling is effectively restricted (Lemma 2);*

2. *PBO has the same effect as full vertical integration if tunneling is restricted by a minimum profit that needs to be left in the target firm, provided that propping is unrestricted (Lemma 3);*

3. *The foreclosure incentives tend to be lower with PBO if tunneling is restricted by a minimum profit that needs to be left in the target firm and if propping is restricted as well (Lemma 4).*

3.3 Partial forward ownership

For the industry structure with one upstream and two downstream firms, we now consider the case where U owns a share $\alpha \in (0, 1)$ of $D_1's$ profits. The market structure is shown in Figure 4. The partial owner U can exert full control over its target's strategy, subject to tunneling restrictions.

As the derivations are similar to the case of partial backward ownership in the previous section, we present the detailed analysis in the Appendix and only summarize and discuss the result in this section.

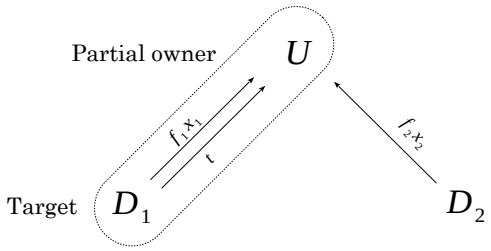

Figure 4: Partial forward ownership: U owns stake of D_1

For this analysis, we make the natural assumption that the minimal profits, which the non-controlling shareholders of D_1 might request, are lower than $D_1's$ monopoly profit $\pi(1,0) - f^*$, i.e. D_1's minority shareholders cannot demand the minimal profit to be larger than the market "best case scenario":

Assumption 4. $\underline{\pi}_{D1} \leq \pi(1,0) - f^*$.

This assumption implies that the tunneling amount in the case of foreclosure is weakly positive ($t^F \geq 0$) and hence propping is not needed in this case.

Proposition 2. *Relative to full vertical integration, partial forward ownership (PFO) tends to affect the incentives for input foreclosure in the following ways:*

1. *PFO decreases the foreclosure incentives if the absolute amount of tunneling is effectively restricted (Lemma 7);*

2. *PFO has the same effect as full vertical integration if tunneling is restricted by a minimum profit that needs to be left in the target firm, provided that propping is unrestricted (Lemma 8);*

3. *The foreclosure incentives tend to be higher with PFO if tunneling is restricted by a minimum profit that needs to be left in the target firm and if propping is restricted as well (Lemma 9).*

Proof. See the Appendix for the lemmas and their proofs. □

The intuition for result 1 of the proposition is that when the partial owner U internalizes additional upstream profits more than additional downstream profits of D_1, it has fewer incentives to foreclose than under full integration where both profits have the same value. The intuition behind result 3 of the proposition is the following. If propping is limited or not possible, U will always foreclose D_2 because supplying to both downstream firms lowers D_1's

profits cannot satisfy its target's restriction on minimal profits without a sufficient amount of propping.

4 Customer foreclosure with partial ownership

4.1 Model framework

We now study the case of customer foreclosure: An upstream firm being prevented from selling its products. For this, we consider a setting with two symmetric upstream firms U_1 and U_2 and a downstream monopolist D, as shown in Figure 5. We assume that the upstream

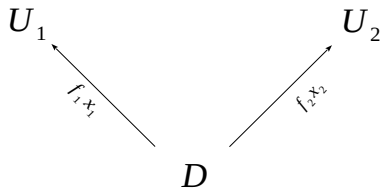

Figure 5: Market structure: customer foreclosure setup

firms produce differentiated input goods, and D can use at most two units of input: Those two units can be purchased from a single upstream firm or each input unit from each firm. The downstream firm's flow profits before input costs are higher when the input units are differentiated:

$$\Pi(1,1) > \Pi(2,0),$$

where $\Pi(x_1, x_2)$ is the downstream flow profit as a function of the input quantities x_1 and x_2 from U_1 and U_2, respectively.[8] We assume that the upstream firm $j \in \{1,2\}$sells at a unit price of f_j. We further assume that both upstream firms produce at zero costs.[9] The profit of upstream firm j is thus $x_j \cdot f_j$.

We focus on the case where, under vertical separation, D finds it optimal to buy the input

[8]For homogeneous products (and no non-linear transaction costs, etc.), the condition would hold with equality.

[9]We consider zero production costs for the sake of simplicity and comparability to the setup of Section 3.1. Our model yields conceptually identical predictions if a firm's production costs are non-decreasing in the number of units produced.

from both upstream firms. The profit of an upstream firm is

$$\pi^{Uj} = x_j \cdot f_j = 1 \cdot f_j. \tag{15}$$

In this case, the minimal price at which a supplier could could without making a loss is equal to the cost of producing the input:

$$\underline{f} = 0. \quad \textit{(take-it-or-leave-it price)} \tag{16}$$

The maximal price equals the incremental profit of D, that is its maximal flow profits $\Pi(1,1)$ minus its second-best profit from buying both input units at one upstream provider:

$$\overline{f} = \Pi(1,1) - \Pi(2,0). \tag{17}$$

However, we stay more general in the analysis in that we use a *"market price"* f^*, which we restrict to be in the interval $[\underline{f}, \overline{f}]$.

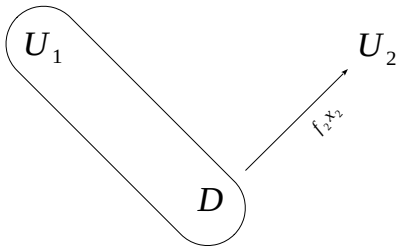

Figure 6: Full integration: customer foreclosure setup

Definition 1. In the present setting, customer foreclosure refers to a situation where U_2 does not sell an input to D while D sources two units of input from U_1.

Benchmark: full vertical integration. Full integration between U_1 and D is our benchmark in the subsequent sections where we show that the customer foreclosure incentives of partial ownership depend crucially on how we model the restrictions on tunneling and transfer prices (see Figure 6).

The joint profit of U and D_1 is

$$\pi_I^S = \Pi(1,1) - f^*$$

when the inputs of both upstream firms are used, and

$$\pi_I^F = \Pi(2,0)$$

in the case where upstream firm 2 is foreclosed. The integrated entity decides to source from U_2 if $\pi_I^S \geq \pi_I^F$,which is equivalent to

$$\Pi(1,1) - f^* \geq \Pi(2,0)$$

$$\implies f^* \leq \Pi(1,1) - \Pi(2,0) \tag{18}$$

We refer to equation (18) as *the "foreclosure condition under vertical integration"*. In Conditions 16 and 17, we have established that $f^* \in [0; \Pi(1,1) - \Pi(2,0)]$. Hence, in the current setting, D always buys input from both upstream suppliers.

4.2 Partial backward ownership

Downstream firm D owns a share $\alpha \in (0,1)$ of $U_1's$ profits. The partial owner D can exert full control over its target's strategy, subject to tunneling restrictions (see details on the market structure in Figure 7).

Absent foreclosure and absent tunneling ($t = 0$), the profit of each upstream firm equals f^*. With customer foreclosure of U_2 and absent tunneling ($t = 0$), the profit of U_1 equals $2f^*$ whereas the profit of U_2 equals 0.

We summarize D's incentives to foreclose U_2 subject to different tunneling restrictions in Proposition 3.

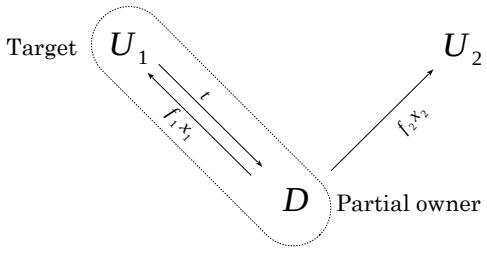

Figure 7: Partial backward ownership: D owns stake of U_1

Proposition 3. *Relative to full vertical integration, partial backward ownership (PBO) tends to affect the incentives for customer foreclosure in the following ways:*

1. *PBO decreases the foreclosure incentives if the absolute amount of tunneling is effectively restricted (Lemma 5);*

2. *PBO has the same effect as full vertical integration if tunneling is restricted by a minimum profit that needs to be left in the target firm, provided that propping is unrestricted (Lemma 6);*

3. *The foreclosure incentives tend to be higher with PBO if tunneling is restricted by a minimum profit that needs to be left in the target firm and if propping is restricted as well (Lemma 4.2).*

The intuition for result 1 of the proposition is that when the partial owner D internalizes additional downstream profits more than additional upstream profits of U_1, there is less incentive than under full integration to sacrifice downstream profits to the benefit of upstream profits. If minimal profits that have to be left in the upstream target are higher than in the case of supplying only one unit of input to its partial owner, D has to engage in propping to meet this restriction. However, as described in result 3, if the partial owner cannot prop the target firm sufficiently due to additional propping restrictions, it necessarily forecloses the upstream rival to source both input units from its target supplier.

Tunneling Restriction 1: exogenous limit on the tunneling amount: $t \leq \bar{t}$ (as in Levy et al. (2018)).

Lemma 5. *Under the restriction on the absolute tunneling amount, the partial owner D has strictly lower incentives to foreclose its target's rival than in the case of full integration.*

Proof. The partial owner D can choose to source from both upstream firms and obtain the following profits:

$$\pi_D^S = \Pi(1,1) - 2f^* + \bar{t} + \alpha\left(f^* - \bar{t}\right).$$

Alternatively, D may only obtain input from its target firm and get:

$$\pi_D^F = \Pi(2,0) - 2f^* + \bar{t} + \alpha\left(2f^* - \bar{t}\right).$$

The partial owner D sources from both upstream firms if

$$\pi_D^S \geq \pi_D^F$$

$$\implies f^* \leq 1/\alpha \left[\Pi(1,1) - \Pi(2,0)\right]$$

The foreclosure condition is stricter than under full integration: The partial owner D is more affected from a downstream loss of customer foreclosure relative to the upstream gains and thus has fewer incentives to foreclose U_2 than under full integration. □

However, the foreclosure condition under full integration (Condition 18) is sufficient to ensure D sources from both upstream suppliers. Tunneling Restriction 1 has hence an effect on the foreclosure incentives but not on the overall market outcome.

Tunneling Restriction 2: minimal downstream profit ($\pi_{U1} \geq \underline{\pi}_{U1}$).

Lemma 6. *Under the tunneling restriction of a minimal profit that needs to be left in the upstream firm, the partial owner D has the same incentive to foreclose its target's downstream rival as under vertical integration.*

Proof. The downstream firm's profits when sourcing from either both or only one upstream firm are given by

$$\pi_D^S = \Pi(1,1) - 2f^* + \underbrace{(f^* - \underline{\pi}_{U1})}_{t^S} + \alpha\underline{\pi}_{U1},$$

$$\pi_D^F = \Pi(2,0) - 2f^* + \underbrace{(2f^* - \underline{\pi}_{U1})}_{t^F} + \alpha\underline{\pi}_{U1}.$$

Partial owner D sources from both upstream firms if

$$\pi_D^S \geq \pi_D^F$$

$$\implies f^* \leq \left[\Pi(1,1) - \Pi(2,0)\right]. \tag{19}$$

The foreclosure incentives are the same as in the full integration case. □

Analog to Assumption 3, we assume that the minimal profit $\underline{\pi}_{U1}$ should not be larger than the equilibrium profit of the upstream firm under vertical separation (see Equation (15)).

Assumption 5. $\underline{\pi}_{U1} \leq f^*$.

As the profit of the target firm in the case of customer foreclosure equals $2 \cdot f^* - t$, there is no need to prop the target firm to enable customer foreclosure. If the minimal profit that needs to be left in the upstream firm is relatively large ($\underline{\pi}^{U1} > f^*$), the partial owner D optimally props U_1 to source from U_2.

Proof. Propping is needed whenever the minimal profit that needs to be left in the target firm $\underline{\pi}^{U1}$ is larger than the profit U_1 can make from selling one unit of input. It happens if

$$\underline{\pi}^{U1} > f^*.$$

If propping is limited or not possible, D will always foreclose U_2 because sourcing from both upstream firms will not satisfy its target's restriction on minimal profits. □

4.3 Partial forward ownership

We continue with the structure of two upstream firms and one downstream firm (Figure 8). We now consider the case where U_1 owns a share $\alpha \in (0, 1)$ of D's profits. The partial owner U_1 can exert full control over its target's strategy, subject to tunneling restrictions.

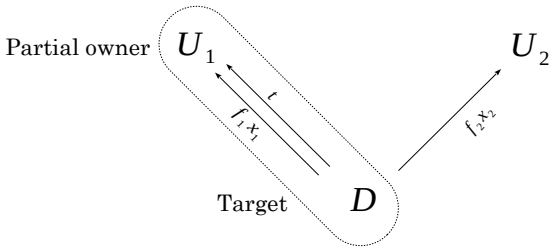

Figure 8: Partial forward ownership: U_1 owns a stake of D

Our results under these assumptions are summarized in Proposition (4).

Proposition 4. *Relative to full vertical integration, partial forward ownership (PFO) tends to affect the incentives for customer foreclosure in the following ways:*

1. *PFO increases the foreclosure incentives if the absolute amount of tunneling is effectively restricted (Lemma 10);*

2. *PFO has the same effect as full vertical integration if tunneling is restricted by a minimum profit that needs to be left in the target firm, provided that propping is unrestricted (Lemma 11);*

3. *The foreclosure incentives tend to be lower with PFO if tunneling is restricted by a minimum profit that needs to be left in the target firm and if propping is restricted as well (Lemma 12).*

Proof. See the Appendix for the lemmas and their proofs. □

The mechanism for result 1 of the proposition is analog to the case of input foreclosure and PBO in Section 1. When the partial ownership values own profits more than the target's profits, then commanding a foreclosure action that hurts the target is more profitable than under full integration where both profits have the same value. Moreover, as regards result 2, as before the partial owner becomes the claimant of the full incremental profits of the target with the minimal profit restriction and thus has the same foreclosure incentives as under full integration. However, when the partial owner has to ensure a higher profit of the target D when D does not buy from D_2 but propping is not possible, foreclosure is harder than under full integration (result 3).

5 Discussion

5.1 Overview of results

For Restriction 1 on the amount that a partial owner can tunnel, our results are in line with the existing literature (Baumol and Ordover, 1994; Spiegel, 2013; Levy et al., 2018). Compared to full integration, partial backward ownership leads to higher input foreclosure incentives than full integration but lower customer foreclosure incentives. Analogously, partial forward ownership has the opposite effects. See Table 2 for an overview of our main results.

We add to this the insight that the restriction on the minimal profit leads to the same foreclosure incentives as full integration. The reason is that the partial owner becomes a residual claimant of the joint profits – which implies the same incentives as full integration.

When the minimal profit that needs to be left in the target firm is relatively high, the latter equivalence result relies on the assumption that propping is feasible. Propping means that the partial owner can shift funds into the target firm. The partial owner may need to prop to induce the target firm to foreclosure a rival of the owner. A foreclosure action, which may be profitable for the partial owner, can reduce the target's profit below the critical level, such that propping may be necessary for foreclosure to be feasible. When propping

is not feasible, the foreclosure incentives are eliminated under the minimal profit restriction and,thus, can be lower than with full integration.

A key distinction between Restriction 1 on the tunneling amount and Restriction 2 on the minimal profit of the target firm is whether or not propping might occur. Intuitively, Restriction 2 sets a target profit level that the partial owner has to assure, which means that if this target profit level is high enough, the partial owner cannot satisfy the restriction without additional transfers to the target firm. Under Restriction 1, the mechanism is different: The non-controlling shareholders of the target firm can only impose restrictions on how much value is tunneled out of the firm. Profit shifting into the target firm is thus not an issue when there is solely a restriction on the amount that can be tunneled out of the target firm. Of course, in a real-world case, several restrictions on tunneling can be in place simultaneously, including the Restrictions 1 and 2 that we study. Indeed, a restriction on propping is essentially a restriction on negative tunneling.

Table 2: Overview of results

Input foreclosure (not serving downstream rival)

Benchmark – non-foreclosure condition with full integration: $f^* \geq \pi(1,0) - \pi(1,1)$

	Partial backward ownership	Partial forward ownership
Restriction 1: tunneling amount	$f^* \geq 1/\alpha \left[\pi(1,0) - \pi(1,1)\right]$ Higher incentives to foreclose than with full integration; Propping never needed.	$f^* \geq \alpha \left[\pi(1,0) - \pi(1,1)\right]$ Lower incentives to foreclose than with full integration Propping never needed.
Restriction 2: minimal profit	$f^* \geq \pi(1,0) - \pi(1,1)$ Same incentives to foreclose as with full integration; Propping needed if $\underline{\pi}^U > f^*$.	$f^* \geq \pi(1,0) - \pi(1,1)$ Same incentives to foreclose as with full integration; Propping needed if $\underline{\pi}_{D1} > \pi(1,1) - f^*$.

Customer foreclosure (not buying rival's input)

Benchmark – foreclosure condition with full integration: $f^* \leq [\Pi(1,1) - \Pi(2,0)]$

	Partial backward ownership	Partial forward ownership
Restriction 1: tunneling amount	$f^* \leq 1/\alpha \left[\Pi(1,1) - \Pi(2,0)\right]$ Less incentives to foreclose than with full integration; Propping never needed.	$f^* \leq \alpha \left[\Pi(1,1) - \Pi(2,0)\right]$ More incentives to foreclose than with full integration; Propping never needed.
Restriction 2: minimal profit	$f^* \leq [\Pi(1,1) - \Pi(2,0)]$ Same incentives to foreclose as with full integration; Propping needed if $\underline{\pi}_{U1} > f^*$.	$f^* \leq [\Pi(1,1) - \Pi(2,0)]$ Same incentives to foreclose as with full integration; Propping needed if $\underline{\pi}_D > \Pi(2,0) - 2f^*$.

5.2 A review of the results in Levy et al. (2018)

Levy et al. (2018) base their analysis on comparing the downstream gains (G in their notation) and upstream losses (L) of foreclosing D_2. Our model is sufficient to replicate their findings and can naturally extend to their setting with N upstream suppliers. We can rearrange Condition (3) to show that the fully integrated entity chooses to supply D_2 if the downstream gains of foreclosure (G) do not exceed the foregone upstream profits from supplying an additional retailer (L):

$$\underbrace{\pi(1,0) - \pi(1,1)}_{G} \leq \underbrace{\pi(1,1) - \pi(0,1)}_{L}.$$

What we call exogenous restriction on the tunneling amount, $t \leq \bar{t} < f^*$, corresponds to the case considered in Levy et al. (2018). Their Assumption 5 requires that the effect of tunneling on D_1's and U's payoffs is smaller than the effect of foreclosure, i.e., $t \leq \min\{G, L\}$. The partial owner has stronger incentives to foreclose its rival in comparison to the full integration case, namely, D_1 chooses to supply D_2 with an input if

$$\underbrace{\pi(1,0) - \pi(1,1)}_{G} \leq \underbrace{\alpha\left[\pi(1,1) - \pi(0,1)\right]}_{\alpha L}.$$

We argue that the way one specifies the restriction on tunneling plays a crucial role in shaping the incentives of the partial owner to foreclose its rival. By restricting the minimal profit which has to stay in the upstream firm (what we call Restriction 2) instead of imposing an exogenous limit on tunneling (what we call Restriction 1), the foreclosure condition becomes

$$\underbrace{\pi(1,0) - \pi(1,1)}_{G} \leq \underbrace{\pi(1,1) - \pi(0,1)}_{L}.$$

This condition is the same as it would have been for the full merger with U and is strictly lower than under an exogenous tunneling restriction.

Levy et al. (2018) implicitly assume that the tunneling amount t is non-negative.[10] We show in Corollary 1 that propping restrictions may eliminate the incentives to foreclose D_2 completely. If the minimal profit which has to stay in the upstream firm is large enough, i.e. $\underline{\pi}^U$ is in the interval $(\pi(1,1) - \pi(0,1); 2(\pi(1,1) - \pi(0,1))]$, and tunneling is restricted to be non-negative, it becomes impossible for the partial owner to foreclose its rival. Foreclosure is not feasible, although it could be profitable for the partial owner.

Therefore, the ability and incentives to foreclose depend crucially on the assumptions on the minority shareholder protection structure and the types of tunneling restrictions minority shareholders may impose. As Levy et al. (2018) show, restrictions on the tunneling amount in partial backward ownership may increase foreclosure incentives compared to the full integration case. In this article, we show that other tunneling restrictions may leave the foreclosure incentives of partial vertical owners unchanged or even eliminate them.

[10] "D_1 pays for [U's] input the same amount it pays under non-integration, but minus a discount t if D_1 controls [U]" (Levy et al. (2018), p. 14)

6 Conclusion

This article reviews the incentives of a firm that holds partial vertical ownership to foreclose rivals. The partial owner only obtains the part of its target's profits but it may substantially change its strategy and foreclosure incentives. We focus on the phenomena of tunneling and propping, that is shifting profits out of and into the target firm, and demonstrate how the different restrictions imposed on these activities alter the downstream firm's incentives to foreclose a rival. This phenomenon has, to our knowledge, so far received only limited and, arguably, insufficient attention in theoretical competition policy analyses.

We show that, depending on the type of tunneling, a partial owner's optimal strategy may vary between higher incentives to foreclose than under vertical integration (as discussed in Levy et al. (2018)), the same incentives (because of fully taking into account the target firm's residual profit) and no incentives at all (if propping is sufficiently restricted). We analyze the partial owner's foreclosure incentives for a variety of market environments.

For partial backward ownership, we find that the restriction on the maximal tunneling amount indeed increases the partial owner's incentives to foreclose its downstream rivals (input foreclosure) and decreases the incentives to foreclosure the rivals of the upstream target (customer foreclosure). This is in line with Levy et al. (2018) who exclusively use this kind of tunneling restriction. However, the alternative restriction on the minimal profit that needs to be left in the target firm yields the same customer and input foreclosure incentives as full integration. Additionally, the restriction on the minimal profit might necessitate propping money into the target firm in order to foreclose. If propping is not feasible at all, or not to a required extent, the partial backward owner faces lower incentives for input foreclosure and higher incentives for customer foreclosure compared to a full integration benchmark.

For partial forward ownership, the restriction on the tunneling amount decreases the incentives of the partial owner to foreclose its target's downstream rivals (input foreclosure) but increases the incentives to foreclose its own upstream rivals (customer foreclosure). This restriction follows the setup of Levy et al. (2018) and our results are in line with their findings as well. The minimal profit restriction, however, yields the same foreclosure incentives as full integration, provided that the partial owner can prop its target firm if the minimal profit level is relatively high. Additionally, if propping is not feasible at all, or not to a required extent, the partial forward owner has higher input foreclosure and lower customer foreclosure incentives in comparison to a fully integrated firm.

In summary, our article shows that the way tunneling is modeled can substantially affect the results on foreclosure analyzes of partial vertical ownership. It, therefore, complements

the analyses of Levy et al. (2018) and should be taken into consideration for future analyses in this field.

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Appendix: Additional lemmas and proofs

Proof of Lemma 1. Suppose that the integrated entity can commit to not supplying itself (for instance, by setting a fee of $f_1 = \infty$ if that is public). The integrated entity's profit when not supplying itself becomes

$$\pi^U_{D1}(x_1 = 0, x_2 = 1) = \pi(0, 1) + f^*.$$

If the entity does not supply D_2, but only D_1, its joint profits are

$$\pi^U_{D1}(x_1 = 1, x_2 = 0) = \pi(1, 0).$$

It is weakly more profitable for the integrated unit to supply itself than only D_2 because

$$\begin{aligned}
&\pi^U_{D1}(x_1 = 0, x_2 = 1) \leq \pi^U_{D1}(x_1 = 1, x_2 = 0) \\
\iff &\pi(1, 0) \geq \pi(0, 1) + f^* \\
\iff &f^* \leq \pi(1, 0) - \pi(0, 1).
\end{aligned}$$

The latter condition holds due to Assumption (2) and Condition 1.

Moreover, if f_1 and f_2 are set secretly (downstream firm 1 does not see f_2 when accepting the contract and vice versa), the integrated unit simply cannot commit to not supplying itself. Thus, it cannot charge D_2 a transfer price above f^* in equilibrium as it would do better with charging a price at which the downstream firm buys the input. □

Input foreclosure with partial forward ownership: lemmas for Proposition (2) and their proofs.

Lemma 7. *Under the restriction on the absolute tunneling amount, the partial owner U has strictly lower incentives to foreclose its target's rival D_2 than in the case of a full integration.*

Proof. The upstream profits without and with foreclosure are

$$\pi^S_U = 2f^* + \bar{t} + \alpha\left(\pi(1, 1) - f^* - \bar{t}\right),$$

$$\pi^F_U = f^* + \bar{t} + \alpha\left(\pi(1, 0) - f^* - \bar{t}\right).$$

The upstream owner is better off when supplying D_2 if

$$\pi_U^S \geq \pi_U^F$$

$$\implies f^* \geq \alpha \left[\pi(1,0) - \pi(1,1)\right].$$

The foreclosure incentives for the upstream firm are lower than in the case of full integration (condition (3)). □

Lemma 8. *Under the tunneling restriction of a minimal profit that needs to be left in the upstream firm, the partial owner U has the same incentive to foreclose its target's downstream rival D_2 as under vertical integration.*

Proof. If both tunneling and propping are feasible, the downstream firm D_1 ends up with the profit of $\underline{\pi}_{D1}$ in any case, but the amount of tunneling , t^S and t^F, differ in general. The upstream profits are

$$\pi_U^S = 2f^* + \underbrace{\left(\pi(1,1) - f^* - \underline{\pi}_{D1}\right)}_{\mathrm{t}^S} + \alpha\underline{\pi}_{D1},$$

$$\pi_U^F = f^* + \underbrace{\left(\pi(1,0) - f^* - \underline{\pi}_{D1}\right)}_{\mathrm{t}^F} + \alpha\underline{\pi}_{D1}.$$

The upstream owner is better off when supplying D_2 if

$$\pi_U^S \geq \pi_U^F$$

$$\implies f^* \geq \pi(1,0) - \pi(1,1). \tag{20}$$

The foreclosure incentives are the same as in the full integration case. □

Lemma 9. *If supplying D_2 is more profitable than foreclosing it (Condition 20 holds) and the minimal profit that needs to be left in the downstream firm is relatively large ($\underline{\pi}_{D1} > \pi(1,1) - f^*$), the partial owner U optimally props D_1 in order to supply D_2.*

Proof. Propping could be needed absent foreclosure if

$$t^S = \pi(1,1) - f^* - \underline{\pi}_{D1} < 0.$$

Rearranging of the above condition yields

$$\underline{\pi}_{D1} > \pi(1,1) - f^*$$

If propping is limited or not possible, U will always foreclose D_2 because supplying to both downstream firms lowers D_1's profits cannot satisfy its target's restriction on minimal profits without a sufficient amount of propping. □

Customer foreclosure with partial forward ownership: lemmas for Proposition (4) and their proofs.

Lemma 10. *Under the restriction on the absolute tunneling amount ($t \leq \bar{t}$), the partial owner U_1 has strictly higher incentives to foreclose its rival than in the case of a full integration.*

Proof. Partial owner U_1which owns a share α of its target's profits, may want D to source from both upstream competitors and get:

$$\pi_{U1}^S = f^* + \bar{t} + \alpha\left(\Pi(1,1) - 2f^* - \bar{t}\right),$$

or, alternatively, supply input to its downstream firm only by itself and obtain:

$$\pi_{U1}^F = 2f^* + \bar{t} + \alpha\left(\Pi(2,0) - 2f^* - \bar{t}\right).$$

D gets input from both downstream firms if

$$\pi_{U1}^S \geq \pi_{U1}^F$$

$$\implies f^* \leq \alpha\left[\Pi(1,1) - \Pi(2,0)\right].$$

Foreclosure is more likely than under full integration because the partial owner U_1 puts relatively less weight on the downstream losses from foreclosure. □

Lemma 11. *Under the tunneling restriction of a minimal profit that needs to be left in the downstream firm ($\pi_D \geq \underline{\pi}_D$), the partial owner U_1 has the same incentive to foreclose its rival as under vertical integration.*

Proof. When minimal profit which has to be left in the downstream firms is restricted, U_1 gets the following profits if D sources from both upstream firms:

$$\pi_{U1}^{S} = f^* + \alpha\underline{\pi}_D + \underbrace{(\Pi(1,1) - 2f^* - \underline{\pi}_D)}_{t_{U1}^{S}},$$

or only from its partial owner:

$$\pi_{U1}^{F} = 2f^* + \alpha\underline{\pi}_D + \underbrace{(\Pi(2,0) - 2f^* - \underline{\pi}_D)}_{t_{U1}^{F}}.$$

D gets input from both downstream firms if

$$\pi_{U1}^{S} \geq \pi_{U1}^{F}$$

$$\implies f^* \leq [\Pi(1,1) - \Pi(2,0)]. \tag{21}$$

The condition is the same as in the full integration case. □

Lemma 12. *If sourcing from U_2 is less profitable than foreclosing it (condition 21 does not hold) and the minimal profit that needs to be left in the downstream firm is relatively large ($\underline{\pi}_D > \Pi(2,0) - 2f^*$), the partial owner U_1 optimally props D in order to foreclose U_2. If propping is not feasible, no foreclosure takes place in this case.*

Proof. Propping is needed if it is more profitable for the partial owner to foreclose its upstream rival but the target's firm minimal profit restriction can only be met if input comes from both suppliers, i.e.,

$$\min(t_{U1}^{S}, t_{U1}^{F}) < 0.$$

As $\Pi(1,1) > \Pi(2,0)$,using the definitions in Lemma 11, the above condition can be reduced to

$$\underline{\pi}_D > \Pi(2,0) - 2f^*.$$

Conversely, if propping is limited or impossible, the partial owner U_1 would want to foreclose U_2 but has to source from it if $\underline{\pi}_D > \Pi(2,0) - 2f^*$. □