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Working Paper

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IFN Working Paper, No. 841

Provided in Cooperation with:
Research Institute of Industrial Economics (IFN), Stockholm

Suggested Citation: Norbäck, Pehr-Johan; Persson, Lars; Tåg, Joacim (2010) : Ownership Efficiency and Tax Advantages: The Case of Private Equity Buyouts, IFN Working Paper, No. 841, Research Institute of Industrial Economics (IFN), Stockholm

This Version is available at:
https://hdl.handle.net/10419/81463

IFN Working Paper No. 841, 2010

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Ownership Efficiency and Tax Advantages: The Case of Private Equity Buyouts*

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May 4, 2011

Abstract

Private equity firms are drivers of the ongoing international restructuring process. Extensive use of leverage gives private equity firms a tax advantage in the market for corporate control. We show that with limited deductibility of acquisition costs, these tax advantages will affect the efficiency of the market for corporate control: a private equity firm can outbid more efficient incumbent bidders. These inefficiencies can be substantial if bidding competition or competition in the product market is limited. We also show that there are too many buyouts and acquisitions in a double taxation system because acquisitions create deductions for buyers.

Keywords: Capital Gains Tax, Corporate Tax, Ownership Efficiency, Private Equity, Buyouts, LBOs, M&As.

JEL classification: D20, G30, H20, H30, L10, L20

*We thank Andreas Haufler, Roger Gordon, Magnus Henrekson, Christian Keuschnigg, Mikko Mustonen, Gordon Phillips, and participants at the FDPE Workshop on Microeconomics and Industrial Organization in Helsinki, SIFR (The Institute for Financial Research), 9th Journées Louis-André Gérard-Varet Conference in Public Economics (Marseille), and Copenhagen University for great comments and suggestions. Financial support from Tom Hedelius' and Jan Wallander's Research Foundations and the NASDAQ OMX Nordic Foundation is gratefully acknowledged. This paper was written within the Gustaf Douglas Research Program on Entrepreneurship. E-mail: firstname.lastname@ifn.se

1 Introduction

Private equity firms are increasingly important owners of corporate assets. During the period 1985 to 2006 they have bought corporate assets in the U.S. yearly at an average value of approximately 1% of the total U.S. stock market value, with a top value of 3% in 2006 (Kaplan and Strömberg (2009)). Moreover, in 2005 around 2% of US non-farm employees worked in a private equity backed firm (Davis et al. (2009)). The growth in the number of buyouts worldwide has been staggering: Strömberg (2008) estimates that the value of all transactions between 1970 and 2000 was $0.9 trillion, while the value of transactions between 2000 and 2007 was close to $2.7 trillion (in 2007 US dollars). Consequently, private equity firms are important drivers of the ongoing international restructuring process.

However, there is a concern that these private equity buyouts are mainly driven by tax advantages and not efficiency advantages.[1] In particular, commentators argue that favorable tax treatment gives private equity firms advantages over other bidders in the market for corporate control. The fear is that private equity buyouts take place simply for tax reasons, thus resulting in inefficient asset ownership and a reduction in government tax revenues.

Policy responses range from attempts to ensure tax neutrality and transparency, to a more direct intervention in capital structure, competition policy, and corporate governance (Walker (2007); PSE (2007)). For example, several countries have already taken some steps to reduce the deductibility of interest payments and goodwill: Denmark has passed a law that limits deductions and Germany has enacted a law limiting the deductibility of net interest expenses to below 30% of EBITA, which is similar to laws adopted in Italy (Thomsen (2009)).

The starting point of this paper is that tax advantages for private equity firms stem from their business model: to acquire firms using heavy leverage, restructure them and then resell them. This implies that they can take on higher debt levels, thereby benefitting to a greater extent than incumbent firms from the tax shield of debt. It has been acknowledged in the empirical literature that private equity backed firms indeed have a tax advantage created by extensive use of debt. Badertscher et al. (2009) empirically document that majority owned private equity backed firms face lower marginal tax rates as a result of the tax shield of debt. Kaplan (1989) has also shown empirically that interest deductibility benefits equal 21% of the premium paid in leveraged buyout transactions.[2]

This raises the issue of why other firms do not use leverage to the same extent to

[1] See, for instance, "Testing the Model: Private Equity Faces a More Hostile World" (Jul 9 2009, *The Economist*), "Editorial, New Rules for Private Equity" (August 30 2009, *New York Times*) or "Private Equity Fights Tax Plan" (February 27 2009, *Financial Times*).

[2] See also Schipper and Smith (1991), Landsman and Shackelford (1995) and Newbould et al. (1992). The data is on leveraged management buyouts 1979-1985 in the US.

benefit from the tax shield of debt. One explanation proposed in the literature is that private equity backed firms have more concentrated ownership than publicly traded firms, thus giving the owners stronger incentives to reduce agency problems in the firm. One way of achieving this is to increase leverage in order to force the firm to pay out free cash flow (Jensen (1986)). A second explanation is that private equity firms are temporary owners of assets. Private equity firms therefore have stronger incentives to restructure target firms and also stronger incentives to take on debt to give management incentives to undertake restructuring activities (Norbäck et al. (2010)).

Apart from these explanations, private equity backed firms can have a tax advantage compared to publicly traded firms due to less reporting requirements as private equity backed firms are not listed on a stock exchange. Publicly traded firms are subject to tighter bookkeeping, accounting and reporting standards which imposes a restriction on tax planing. Furthermore, private equity firms are repeat borrowers in the capital market allowing them to use leverage to a greater extent to finance an acquisition. Indeed, Axelson et al. (2010) find that the leverage in private equity backed firms cannot be explained by the same factors that explain leverage in non-private equity backed firms. Instead, debt market conditions seem to entirely determine the leverage in private equity backed firms.

Given that the behavior of private equity firms gives them tax advantages, the purpose of this paper is to study how these tax advantages (i) affect the efficiency of the market for corporate control, (ii) affect tax revenues, and (iii) how these effects depend on acquisition cost deduction rules and the intensity of competition.

To this end, we develop an endogenous asset ownership model with taxation. Our formalization of the tax system corresponds to a double taxation system. In many countries, among these the United States and many European countries, income from corporate investment is taxed twice: at the corporate level a corporate tax is levied on profits, and at the investor level realized capital gains are subject to capital gains taxes.[3]

Our model has three types of agents that are subject to taxation: a target firm, incumbents competing in the market, and private equity firms. A private equity backed firm has the ability to benefit from increased deductions at the corporate level due to the tax shield of debt. The target firm is up for sale through a first price perfect information auction. If a sale takes place, capital gains taxes are paid on the sales price by the target's owners. On the other side of the deal, an acquiring firm pays corporate level taxes on profits and capital gains taxes are paid on profits net corporate taxes. If no sale takes place, corporate taxes are paid on the target's profits and capital gains taxes are paid by the target's owners on profits net of corporate taxes.

Within this setting, the extent to which tax advantages affect ownership efficiency and tax revenues depends on acquisition cost deduction rules and the intensity of competition

[3]See Sørensen (1995). For a discussion of the Swedish system, see Lodin et al. (2001).

in the market. Tax advantages do not affect asset ownership efficiency or tax revenues if acquisition costs are fully deductible. Thus, if private equity firms are less efficient owners of assets, they are not able to acquire them in equilibrium as more efficient incumbents can outbid them. This occurs despite tax advantages for private equity firms, since under full deductibility of acquisition costs, incumbents and private equity firms have a maximum willingness to pay for the target equal to the profits net of taxes. At this price, they make zero profits and thus pay no taxes. If bidding competition makes them pay their full valuation, no taxes are paid and thus, the acquisition price and the equilibrium allocation of the assets do not depend on taxes or tax advantages!

But when will tax advantages affect ownership efficiency and tax revenues? We identify three situations: (i) limited competition among private equity firms, (ii) limited deduction of acquisition costs, and (iii) the presence of oligopolistic externalities in the product market.

Limited competition among private equity firms means that tax advantages affect tax revenues, but not ownership efficiency. A tax advantaged inefficient private equity firm can still not overbid a more efficient incumbent, but a more efficient private equity firm can now make a net gain from the buyout. The reason is that the acquisition price is below the maximum willingness to pay of the private equity firm. Consequently, tax advantages reduce tax payments and thereby tax revenues.

The goodwill associated with the acquisition is typically not fully deductible from corporate taxes in most jurisdictions (where goodwill is defined as the part of the acquisition price above the value of deductible assets in the acquired firm[4]). Limited deductibility of acquisition costs means that tax advantages will not only affect tax revenues, but also ownership efficiency. The reason is that the seller's reservation price depends on corporate taxes, since corporate taxes are paid if the assets are not sold. A private equity firm's willingness to pay for the target now also depends on corporate taxes since the acquisition costs are not fully deductible. Consequently, a less efficient private equity firm with favorable tax treatment can thereby acquire the assets from a more efficient original owner and also outbid other (more efficient) incumbents.

Finally, the presence of oligopolistic externalities in the product market (and limited deductibility) means that tax advantages are of importance for ownership efficiency. Private equity buyouts often take place in concentrated markets. A potential problem with incumbent acquisitions in these types of industries is that they could increase the market power. This market power motive for acquisitions means that incumbent acquisitions can take place even though a private equity firm would run the business more efficiently. Tax advantages for private equity backed firms could then help prevent market power driven mergers. However, there is also a friction against incumbent acquisitions in oligopolies

[4]Dunne and Ndubizu (1995) report that acquisitions are associated with different international accounting and tax treatments for goodwill and that these have changed over time.

since incumbent acquisitions are associated with a replacement effect. Hence, less efficient private equity firms with tax advantages can also outbid both the target and more efficient incumbents.

The large literature on corporate taxation and firm investment does typically not study the effects of taxes on ownership efficiency. However, an emerging literature on international taxation acknowledges the importance of tax effects on ownership efficiency. This literature proposes the concept of Capital Ownership Neutrality (CON) to ensure that taxes do not distort ownership efficiency.[5] Desai and Hines (2004) point out that in a perfect competition framework with ownership asymmetries, CON requires that tax rules do not distort ownership patterns, which is equivalent to the ownership of an asset residing with the potential buyer who has the highest reservation price in the absence of tax differences. Devereux (2008) extends the definition by proposing that global neutrality requires two principles: (i) Direct "CEN": that taxes should not distort the location of corporate activity, and (ii) Market neutrality: that taxes should not distort competition between any companies operating in the same market. Becker and Fuest (2010) combine an optimal tax model with a non-strategic acquisition model and study when international exemption is an appropriate policy choice. Becker and Fuest (2009) use a similar framework to analyze tax competition and tax coordination when both source and residence based taxation are available.

However, these studies abstract from how potential buyers' valuations of target firms and potential sellers' reservation prices depend on the tax system. Our approach explicitly allows for firms to be acquired through auctions, and accounts for deductions related to both tax shields of debt and acquisition costs. By incorporating these features into an acquisition model with asymmetric buyers, we are able to show that taxes affect ownership efficiency also in domestic settings where different types of owners of corporate assets are able to utilize deductions to different degrees. In particular, private equity firms enjoying tax advantages from the ability to use greater leverage can affect ownership efficiency despite tax rates and the ability to make deductions being equal in the tax code for all types of owners! Moreover, we show that in a system of double taxation, if the goodwill associated with acquisitions is deductible, too many acquisitions will occur from an efficiency perspective even though tax rates are equalized since acquisitions create deductions for buyers that are not available to sellers. Then, we show that a single taxation system with full goodwill deductibility would be CON (abstracting from intertemporal effects of taxes).

Our paper is also a contribution to the theoretical merger literature, which typically

[5] Musgrave (1969) introduced the terms "capital export neutrality (CEN)" and "capital import neutrality (CIN)", which are now in common use. CEN holds if any individual investor faces the same effective tax rate on her investments, wherever those investments are located. CIN holds if all investments undertaken in the same jurisdiction face the same effective tax rate.

treats taxes as cursory.[6] An exception is Auerbach and Reishus (1998) who use a marriage market model of mergers to show that tax savings can trigger mergers.[7] Norbäck et al. (2009) use a more detailed acquisition model with double taxation and allow for an imperfectly competitive product market. They find that reductions in foreign profit taxes tend to trigger inefficient foreign acquisitions, while reductions in foreign capital gains taxes could trigger efficient foreign acquisitions.[8] We add to this literature by analyzing how details of the tax system (the level of deductions of goodwill and tax shields) affect the merger pattern and ownership efficiency. In particular, we show that in a double taxation system, too many acquisitions take place (from an efficiency perspective) if the goodwill associated with acquisitions is deductible. The reason is that acquisitions create deductions for buyers that are not available to sellers.

Finally, while there is no formal work on private equity buyouts and taxes of which we are aware, there is a small emerging public economics literature on venture capital, firm development, and taxes. Keuschnigg and Nielsen (2002) and Keuschnigg and Nielsen (2004) focus on the effects of various tax policies when entrepreneurs face financial constraints and set up a contract with a venture capitalist under conditions of one-sided or two-sided moral hazard. Our focus differs as we study when taxes and details of the tax system matter for the efficient allocation of assets, specifically accounting for tax advantages for private equity backed firms arising as a result of them using a higher leverage in the firms they acquire.

Our paper consists of four parts. In Section 2, we start out by providing a brief overview of private equity buyouts, the private equity business model, and from where private equity tax advantages may stem. Then, in Section 3, we set up a benchmark endogenous asset ownership model with taxation and full deductibility of acquisition costs. We show how tax advantages for private equity firms have no effect on ownership efficiency and tax revenues. Then, we move on to study limited bidding competition (Section 4.1) and limited deductibility (Section 4.2). We show that under each of these modifications, tax advantages can affect ownership efficiency and/or tax revenues. Finally, we take a more general perspective in Section 5 and ask what type of tax system is consistent with

[6] There is a small literature on cross-border acquisitions and taxes that abstracts from ownership efficiency asymmetries. Gordon and Bovenberg (1996) propose a model with asymmetric information between foreign and domestic owners to explain why capital is so immobile internationally. Becker and Fuest (2008) analyze tax competition in a model where M&A and greenfield investment are alternative modes of entry and show that the existence of M&A investment intensifies tax competition. Haufler and Schulte (2007) consider tax incentives in a model where M&A can take place within and across borders. They show that ownership patterns are highly important for the welfare implications of tax policy choices.

[7] However, using a sample of 318 mergers in the US in the period 1968-1983, they find no strong evidence of tax savings to be influential for merger decisions, but only for a small subset of mergers.

[8] Empirically, Hayn (1989) examines a sample of 640 acquisitions during 1970–1985 and finds that the announcement period for abnormal returns is positively associated with the tax attributes of the target firm. Devos et al. (2009) find empirically that a merger contributes 1.64% in additional value due to tax savings, while efficiency improvements contribute 8.38%.

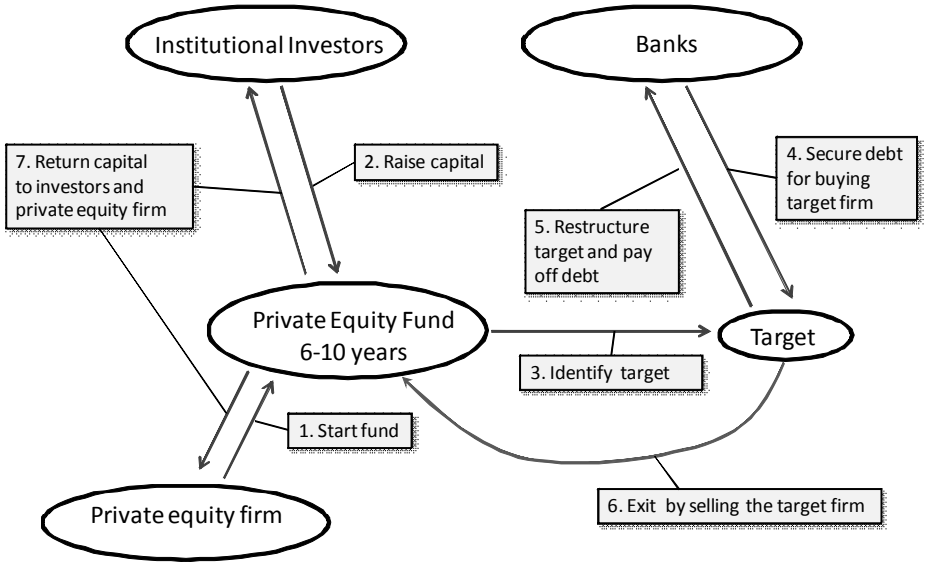

Figure 1: The private equity business model. (1) Private equity firms set up a private equity fund with a predetermined life span. (2) The general partners raise capital from institutional investors. (3) Private equity firms start looking for target firms to acquire. (4) When a target is identified, debt is raised from banks to finance the acquisition. (5) The target firm is restructured and the cash flows from the firm are used to pay off part of the debt. (6) After the firm has been restructured, the private equity firm sells the target firm. (7) The proceeds from the sale are returned to investors and the private equity firm.

CON absent any tax advantages and show that a single taxation system with full goodwill deductibility would be CON. In Section 5, we also show that with limited product market competition (Section 5.1.2), tax advantages can affect ownership efficiency and tax revenues. We provide a discussion of possible extensions to our framework in Section 6, and end with some concluding remarks in Section 7.

2 Private equity buyouts

2.1 The business model

We start out with a brief primer on the private equity business model. Private equity buyouts, or leveraged buyouts, are acquisitions of established companies with stable cash flows, usually with the help of substantial amounts of leverage. These acquisitions are sponsored by private equity firms (often organized as partnerships) that raise money from institutional investors for private equity funds with a predetermined life span.

The private equity business model works as follows (see Figure 1 for an illustration):

1. Private equity firms set up a private equity fund with a predetermined life span.

2. The partners in the private equity firm go out and raise capital from institutional investors and wealthy individuals.

3. After the target amount of capital has been raised, the fund is closed and the private equity partners start looking for firms to acquire and restructure.

4. Once a firm has been identified, debt is raised from banks in order to finance the acquisition. Private equity firms usually acquire multiple firms in each fund, and each acquisition is financed with 60%-90% debt.

5. The target firm is acquired and restructured. Cash flows from the firm are used to pay off part of the debt.

6. After the firm has been restructured, the private equity firm sells the firm it acquired.

7. The returns from cash flow during the restructuring period and from the sale of the firms in the fund are split on a 80/20 basis with 80% going back to the investors in the private equity fund and 20% going to the private equity firm.

The private equity buyout industry took off during the 1980s. As a large wave of takeovers swept across the U.S., leveraged buyouts became a new phenomenon much talked about and scrutinized. When the takeover wave receded at the end of the 1980s, so did a large part of leveraged buyout activities. They did not, however, vanish completely but instead spread out from the U.S. to other countries. Towards the end of the 1990s and during the first decade of the 21st century, the private equity buyout industry once more emerged and this time on a global scale and with full force. Strömberg (2008) estimates that between 1970 and 2007, the total value of all firms subject to a buyout (worldwide) was $3.6 trillion in 2007 U.S. dollars. At the end of 2007, around 14 000 companies worldwide were owned by private equity funds.

2.2 Tax advantages

The starting point of this paper is that private equity firms have a tax advantage arising from the way they do business (and not because they have an advantage in the tax code). Their business model of temporary ownership of assets and close connections to banks implies that they can take on higher debt levels and thereby benefit from the tax shield of debt. It has been acknowledged in the empirical literature that private equity backed firms indeed have a tax advantage arising from the extensive use of debt. Badertscher et al. (2009) empirically document that majority owned private equity backed firms face lower marginal tax rates as a result of the tax shield of debt. Kaplan (1989) has also

shown empirically that interest deductibility benefits equal 21% of the premium paid in leveraged buyout transactions.[9]

This raises the issue of why other firms do not use the same leverage to benefit from the tax shield of debt? There are several different explanations.

1. Private equity backed firms have more concentrated ownership than publicly traded firms, which implies that the private equity firms have stronger incentives to run the private equity backed firm efficiently. One way of increasing efficiency is to reduce agency problems in the firm by increasing leverage leading to a reduction of the free cash flow available to managers (Jensen (1986)).

2. Private equity firms are repeated borrowers in the capital market which has given them advantages in the financial market as compared to regular firms. This allows them to use leverage to a greater extent. Axelson et al. (2010) find that the leverage in private equity backed firms cannot be explained by the same factors that explain leverage in non-private equity backed firms. Instead, debt market conditions seem to entirely determine leverage in private equity backed firms.

3. Private equity firms are temporary owners of the target firm. Private equity firms therefore have stronger incentives to restructure target firms and also stronger incentives to take on debt to give management incentives to undertake restructuring activities (Norbäck et al. (2010)).

4. Private equity backed firms can have a tax advantage as compared to publicly traded firms due to less stringent reporting requirements as private equity backed firms are not listed on a stock exchange. Publicly traded firms are subject to tighter bookkeeping, accounting and reporting standards which imposes a restriction on tax planing.

The tax advantages we analyze do not stem from specific tax advantages in the tax law, but rather they are consequences of the equilibrium behavior of private equity firms in comparison to other firms resulting in the use of more leverage and thus greater benefits from the tax shield of debt. To our knowledge, the only direct advantage in the tax code for private equity firms is related to personal taxation: carried interest (the payment the private equity partners who run the private equity firm receive as incentive compensation) is taxed as capital gains instead of labor income. We discuss this advantage further in section 6.3.

[9] See also Schipper and Smith (1991), Landsman and Shackelford (1995) and Newbould et al. (1992). The data is on leveraged management buyouts 1979-1985 in the US.

3 Baseline model

Having described the private equity business model, we will now present our baseline model and argue that ownership efficiency and tax revenues are unaffected by the tax advantage created by the tax shield of debt for private equity firms if acquisition costs are fully deductible from corporate taxes.

3.1 Setup

Consider an industry consisting of several incumbent firms owning assets necessary for production. To underscore how tax advantages affect ownership efficiency and tax revenues, we initially make the simplifying assumption of no interaction between firms in the product market. All incumbents can be viewed as local monopolists active in a segmented market (we relax this assumption in Section 5.1.2). One incumbent, the target, is up for sale. In stage one, the target arranges an auction to sell its assets. The bidders are the other incumbents and several private equity firms which do not have assets in the market. Given the outcome of the auction in stage one, in stage two the firms with assets produce, profits are realized, and taxes are paid.

3.2 Stage 2: Profits and tax payments

The set of potentially producing firms in the industry is $\mathcal{J} = \{t, i_1, i_2, .., i_n, p_1, p_2, .., p_m\}$, where $j \in \mathcal{J}$ is an element. The first entry refers to the target (t). The second n entries refer to the n number of incumbents (i) and the final m entries to the m number of private equity firms (p). The set of (potential) owners of the target firm's assets is $\mathcal{L} = \mathcal{J}$, where $l \in \mathcal{L}$ is an element. Let $\pi(x, l)$ denote the pre-tax product market profit of the target firm given a product market action (x) and the ownership of the target firm (l).

Taxes are paid as follows. A corporate tax τ_c is paid on net profits, and a capital gains tax τ_g is paid on profits net corporate taxes. In particular:

- If the target's assets are sold, its owners pay capital gains taxes at the rate τ_g on the acquisition price S, i.e. the target's tax payment is $\tau_g S$. Thus, we normalize such that the target's owners initially acquired the target at zero price.

- If the target's assets are not sold, the target pays corporate level taxes τ_c on net profits and capital gains taxes are paid on net profits at the rate τ_g, net corporate level taxes, i.e. the target's tax payment is $\tau_c \pi(t) + \tau_g(1 - \tau_c)\pi(t)$. Thus, we treat the firm as having been closed down when the game ends and therefore, the owner of the target pays capital tax on the capital gains. Alternatively, we could interpret the payment as dividends to the owner and then τ_g would be a dividend tax.

- If the target's assets are sold to an incumbent, the incumbent pays corporate taxes at the rate τ_c on total net profits. The owners of the incumbent firm pay capital gains taxes at the rate τ_g on the profits net corporate taxes and deductions. An incumbent acquiring the assets results in tax payments of

$$\tau_c[\pi(i) - S] + \tau_g(1 - \tau_c)[\pi(i) - S]. \tag{1}$$

- If the target's assets are bought by a private equity firm, the private equity backed firm pays a corporate tax of τ_c and the firm's investors pay capital gains taxes of τ_g on profits net of corporate taxes and deductions. We model tax advantages for private equity firms in a reduced-form, such that we assume that they can make an additional deduction D before paying corporate taxes. With full deductibility of the acquisition cost, if a private equity firm acquires the assets, the tax payments are

$$\tau_c[\pi(p) - D - S] + \tau_g(1 - \tau_c)[\pi(p) - D - S]. \tag{2}$$

These deductions D, with $D \leq \pi_P(p)$, can come from multiple sources (in general, the way in which private equity funds are taxed varies between jurisdictions and between investors, limited partners and general partners). The main advantage, however, comes from the tax shield of debt created by extensive use of leverage in private equity buyouts. Note that this setup is identical to a setup in which both private equity firms and incumbents benefit from the tax shield of debt, but D is the additional advantage of private equity backed firms due to their ability to utilize a higher debt level. [10]

Let us now turn to the product market behavior. Given ownership l, the target firm chooses an action x (a price or a quantity) to maximize its product market profit $(1-\tau_c)(1-\tau_g)[\pi(x,l) - S_l]$, where $S_l = S$ if firm l acquired the target, otherwise $S_l = 0$. The optimal action $x^*(l)$ is defined from

$$(1 - \tau_c)(1 - \tau_g)(\pi(x^*, l) - S_l) > (1 - \tau_c)(1 - \tau_g)(\pi(x, l) - S_l) \ \forall x. \tag{3}$$

Thus, taxes do not distort the product market actions.

Since taxes do not affect the optimal action $x^*(l)$, we can define a reduced-form product market profit, $\pi(l) = \pi(x^*(l), l)$. With symmetry within firm types, we need only distinguish between three types of reduced-form profits. The profit for an incumbent

[10] Since we want to focus on tax advantages for one type of actor in the economy, the additional deductions D will be exogenous to the model. D could be considered to be endogenous, since leverage is a factor the private equity firm could affect. However, Axelson et al. (2010) have shown empirically that private equity firms tend to lever up as much as possible: the amount of leverage in private equity buyout transactions is mainly driven by debt market conditions and not by firm-specific factors. This suggests that we can take D to be exogenously given as a result of the private equity business model and that the extent of D would be driven by debt market conditions.

acquirer ($l = i$), $\pi(i)$, the profit for the target firm under no sale ($l = t$), $\pi(t)$, and the profit for a private equity firm ($l = p$), $\pi(p)$. For completeness, let us also define $\bar{\pi}(i)$ as the profit for an incumbent $i_1, i_2, .., i_n$ in its own (monopoly) market. To underscore the effect of tax advantages of private equity firms, we assume that $\bar{\pi}(i)$ is independent of the ownership of the target firm l and normalize such that $\bar{\pi}(i) = 0$ (we relax this assumption in section 5.1.2).

Our measure of ownership efficiency is denoted by $\gamma_l > 0$. This parameter corresponds to how efficiently an owner of type l can use the target's assets. We make the following assumption:

Assumption 1 $\frac{d\pi(l)}{d\gamma_l} > 0$.

Thus, Assumption 1 implies that the profits increase due to a more efficient use of the target firm's assets. We then normalize as follows:

Assumption 2 *(i)* $\gamma_t = 1$, *(ii)* $\gamma_l \in [0, \gamma^{\max}]$ *for* $\gamma^{\max} > 1$ *and* $l \neq t$.

We can then define ownership efficiency as follows:

Definition 1 *Let* $l^{Eff} = \arg\max_l \pi(l)$ *and let* l^* *denote the equilibrium ownership of the target firm. Under ownership efficiency,* $l^* = l^{Eff}$.

Assumption 1 implies that under ownership efficiency, the target's assets will be possessed by the owner with the highest efficiency parameter, γ_l. Assuming simple monopoly pricing, ownership efficiency will also maximize welfare, since consumers will benefit from higher efficiency through lower prices. This is shown by the following simple example.

Example 1 *Let the inverse demand be* $P = a - \frac{q}{s}$, *where* a *is the consumer's willingness to pay for the first unit and* s *is the size of the market (the number of identical consumers). Let the marginal cost be* $c_l = c - \gamma_l$, *where measures* γ_l *constitute the efficiency associated with an owner of type* l. *Then,* $x^*(l) = s\frac{a+\gamma_l}{2}$, $\pi(l) = \frac{1}{s}[x^*(l)]^2$ *and* $CS(l) = \frac{1}{2}[x^*(l)]^2$, *where* $CS(l)$ *is the consumer surplus.*

We will now examine how the tax shield of debt in private equity firms affects ownership efficiency and tax revenues.

3.3 Stage 1: The acquisition auction

The acquisition process is depicted as an auction where all incumbents and private equity firms simultaneously post bids. Everyone announces a bid, b_i, which is either accepted or rejected by the target's owner. Following the announcement of bids, the target's assets

are either sold at the highest bid price or remain with the target. The acquisition is solved for Nash equilibria in undominated pure strategies.

To solve the acquisition auction and determine bids, we need to determine the valuations of the bidders for obtaining the assets and the target owner's reservation price for selling them. To aid in this, we introduce the net gain function $\Delta_l(S)$ which defines the net gain for a bidder/seller of type l if the acquisition price is S.

The net gain for the target's owner from selling the assets is thus

$$\begin{aligned}\Delta_t(S) &= \underbrace{S - \tau_g S}_{\text{Net profit from sale}} \underbrace{- [\pi(t) - \tau_c \pi(t) - \tau_g (1 - \tau_c) \pi(t)]}_{\text{Net profit from no sale}} \\ &= (1 - \tau_g) [S - (1 - \tau_c) \pi(t)] . \end{aligned} \tag{4}$$

The reservation price for the target's owners, v_t, can be determined as $v_t = \min S$, $s.t$ $\Delta_t(S) \geq 0$. Solving for $\Delta_t(S) = 0$, we have

$$v_t = (1 - \tau_c) \pi(t). \tag{5}$$

In equation (5), corporate taxes—but not capital gains taxes—affect the reservation value since capital gains taxes are paid both if a sale takes place and if the assets are kept.

Now turn to an incumbent's valuation. Suppose that the incumbent pays S to acquire the target's assets. Then, the net gain for an incumbent is

$$\begin{aligned}\Delta_i(S) &= \pi(i) - S - \tau_c[\pi(i) - S] - \tau_g (1 - \tau_c) [\pi(i) - S] \\ &= (1 - \tau_g) (1 - \tau_c) [\pi(i) - S]. \end{aligned} \tag{6}$$

An incumbent's maximum willingness to pay for the assets is thus given by $v_i \equiv \max S$, $s.t$ $\Delta_i(S) \geq 0$. Solving for $\Delta_i(S) = 0$, we have

$$v_i = \pi(i). \tag{7}$$

Thus, from equation (7), it follows that taxes do not affect the incumbents' maximum willingness to pay, v_i. The reason is that at an acquisition cost $S = \pi(i)$, no taxes are ever paid if the acquisition cost is fully deductible.

Using the same argument, we see that the net gain for a private equity firm of acquiring the assets equals

$$\Delta_p(S) = \pi(p) - S - \tau_c[\pi(p) - D - S] - \tau_g (1 - \tau_c) [\pi(p) - S - D]. \tag{8}$$

Based on this net gain, we can state a lemma showing that tax advantages do not affect the bidding behavior.

Lemma 1 *When the acquisition cost is fully deductible at the corporate level and private equity firms have tax advantages, $D > 0$, the maximum willingness to pay for a private equity firm bidding for the assets is $v_p = \pi(p)$.*

Proof. Initially, $\pi(p) - S - D \geq 0$ must hold, as total deductions $(S + D)$ cannot be larger than corporate income $\pi(p)$. Define $\Omega(S) = \pi(p) - S - D$ as net income after deductions, where the income after deductions must be non-negative ($\Omega(S) \geq 0$). Then, equation (8) can be re-written as

$$\Delta_p(S) = \begin{cases} \pi(p) - S - (\tau_c + \tau_g(1-\tau_c))[\pi(p) - D - S], \text{ if } \Omega(S) > 0 \\ \pi(p) - S, \text{ if } \Omega(S) \leq 0. \end{cases} \tag{9}$$

A private equity firm's maximum willingness to pay is $v_p \equiv \max S$, $s.t\ \Delta_p(S) \geq 0$. Solving the upper line in equation (9) gives $\tilde{v}_p = \pi(p) + \frac{\tau_c + \tau_g(1-\tau_c)}{(1-\tau_g)(1-\tau_c)} D$. However, if a private equity firm were to pay $S = \tilde{v}_p$, it directly follows that $\Omega(S) < 0$. Therefore, the maximum valuation for a private equity firm must be given solving the lower line in equation (9) to obtain

$$v_p = \pi(p), \tag{10}$$

where $\Omega(v_p) = 0$. ■

Since we have established that $v_p = \pi(p)$, a private equity firm's maximum willingness to pay is independent of taxes. Given the valuations v_t, v_i and v_p, defined in equations (5), (7) and (10), we can now solve the auction for the target's assets and determine the equilibrium ownership structure and the acquisition price.

Lemma 2 *The equilibrium owner of the target firm l^* and the acquisition price S^* are described in Table 1.*

Ineq:	Definition:	Equilibrium owner, l* :	Acquisition price, S*:
$I1:$	$v_p > v_i > v_t$	p	v_p
$I2:$	$v_p > v_t > v_i$	p	v_p
$I3:$	$v_i > v_p > v_t$	i	v_i
$I4:$	$v_i > v_t > v_p$	i	v_i
$I5:$	$v_t > v_i > v_p$	t	.
$I6:$	$v_t > v_p > v_i$	t	.

Table 1: The equilibrium ownership structure and the acquisition price.

Proof. First, $b_i \geq \max v_l$, $l = \{i,p\}$ is a weakly dominated strategy, since no owner will post a bid equal to or above its maximum valuation of obtaining the assets and firm t will accept a bid iff $b_i > v_t$. Then, competition within owner groups means that the equilibrium acquisition price must be $v_i - \epsilon$ and $v_p - \epsilon$ for an incumbent acquirer and a

private equity buyer, respectively. It then follows that a private equity acquisition takes place at the acquisition price $v_p - \epsilon$ iff $v_p > \max[v_t, v_i]$ and an incumbent acquisition takes place at the acquisition price $v_i - \epsilon$ iff $v_i > \max[v_t, v_p]$. Otherwise, no acquisition takes place. ■

3.3.1 Ownership efficiency and tax advantages

Let us now examine how tax advantages D affect ownership efficiency. Competition between incumbents means that incumbents will always bid v_i and competition between private equity firms means that a private equity firm will always bid v_p. Lemma 2 then states that the assets of the target end up with the owner that has the highest valuation, and that this owner pays his full valuation. Since all valuations v_j are independent of tax advantages, D, we can then state our first proposition.

Proposition 1 *Suppose that the acquisition cost is fully deductible at the corporate level, then the equilibrium ownership pattern, l^*, is independent of tax advantages, D.*

Tax advantages for private equity firms arising from the tax shield of debt are of no importance for ownership efficiency since additional deductions are meaningless when the acquisition cost is so high that there remain no profits from which to make deductions. The reason is that all possible deductions are "used up" by deducting the acquisition cost, which is as high as the maximum valuation due to bidding competition between two private equity firms or more.

3.3.2 Tax revenues and tax advantages

Let us then examine how the tax shield of debt in private equity firms D affects tax revenues. From Proposition 1, it directly follows that the tax shield of debt in private equity firms has no effect on tax revenues denoted by $\Gamma(l)$.

Proposition 2 *Suppose that the acquisition cost is fully deductible at the corporate level, then the equilibrium tax revenues $\Gamma(l^*)$ are independent of tax advantages, D.*

To see this, denote $\Gamma(t)$ as the tax revenues under no sale, $\Gamma(i)$ as the tax revenues under an incumbent acquisition, and $\Gamma(p)$ as the tax revenues if a buyout takes place.

Given Lemma 2, we then have

$$\Gamma(t) = [\tau_c + \tau_g (1 - \tau_c)] \pi(t), \tag{11}$$

$$\begin{aligned} \Gamma(i) &= \tau_g S(i) + [\tau_c + \tau_g (1 - \tau_c)] [\pi(i) - S(i)] \\ &= \tau_g \pi(i), \end{aligned} \tag{12}$$

$$\begin{aligned} \Gamma(p) &= \tau_g S(p) + [\tau_c + \tau_g (1 - \tau_c)] [\pi(p) - D - S(p)] \\ &= \tau_g \pi(p). \end{aligned} \tag{13}$$

If an acquisition takes place, taxes are only collected from the target as the acquisition price always equals the maximum valuation of the winning owner type. But since tax advantages do not affect the valuations, they do not affect the tax revenues either.

Summing up, we have shown that in our benchmark model, tax advantages for private equity firms have no effect on ownership efficiency and tax revenues if the acquisition costs are fully deductible. The intuition for this result is that tax advantages in the form of additional deductions are meaningless when the acquisition cost is so high that no profits remain from which to make deductions. Essentially, all possible deductions are "used up" by deducting the acquisition cost, which is as high as the maximum valuation due to intense bidding competition.

4 When do tax advantages for private equity firms matter?

We will now make two modifications to the benchmark model in Section 3: allowing for limited bidding competition (subsection 4.1) and for limited deductibility (subsection 4.2). These modifications imply that tax advantages for private equity firms can affect ownership efficiency and/or tax revenues.

4.1 Limited bidding competition

An assumption behind Proposition 1 is a sufficiently strong bidding competition between incumbents and private equity firms (such that they are forced to pay their maximum valuation for obtaining the target). Ownership efficiency is unaffected by the tax shield of debt even with limited bidding competition. However, tax revenues can be reduced due to tax advantages for private equity firms.

To introduce limited bidding competition, suppose that incumbents and private equity firms are asymmetric in the (deductible) fixed cost they face when running their

operations: $0 = f_{i_1} < f_{i_2} < ... < f_{i_n}$ and $0 = f_{p_1} < f_{p_2} < ... < f_{p_m}$. They are still symmetric in terms of their efficiency parameter so that $\gamma_i = \gamma_{i_1} = \gamma_{i_2} = ... = \gamma_{i_n}$ and $\gamma_p = \gamma_{p_1} = \gamma_{p_2} = ... = \gamma_{p_m}$. Introducing these fixed costs and applying Lemma 1 implies that the incumbents' maximum valuations are now

$$v_i \equiv v_{i_1} = \pi(i) > v_{i_2} = \pi(i) - f_{i_2} > ... > v_{i_m} = \pi(i) - f_{i_n}. \tag{14}$$

Similarly, private equity firms' maximum valuations are

$$v_p \equiv v_{p_1} = \pi(p) > v_{p_2} = \pi(p) - f_{p_2} > ... > v_{p_m} = \pi(p) - f_{p_m}. \tag{15}$$

The reservation price of the target firm is still given as $v_t = (1 - \tau_c)\,\pi(t)$ from equation (5). Given the valuations in equations (14) and (15), we can now solve the auction for the target's assets and determine the equilibrium ownership structure and the acquisition price.

Lemma 3 *The equilibrium ownership structure and the acquisition price with limited bidding competition are described in Table 2.*

Ineq:	Definition:	Owner:	Acquisition price S^*:
$I1:$	$v_p > v_i > v_t$	p	$\max\{v_{p_2}, v_i\}$,
$I2:$	$v_p > v_t > v_i$	p	$\max\{v_{p_2}, v_t\}$
$I3:$	$v_i > v_p > v_t$	i	$\max\{v_{i_2}, v_p\}$
$I4:$	$v_i > v_t > v_p$	i	$\max\{v_{i_2}, v_t\}$
$I5:$	$v_t > v_i > v_p$	t	.
$I6:$	$v_t > v_p > v_i$	t	.

Table 2: The equilibrium ownership structure and the acquisition price.

Proof. First, $b_i \geq \max v_l$, $l = \{i,p\}$ is a weakly dominated strategy, since no owner will post a bid equal to or above its maximum valuation of obtaining the assets and that firm t will accept a bid iff $b_i > v_t$. Then, competition within owner groups means that the equilibrium acquisition price must be $\max\{v_{i_2}, v_p, v_t\} - \epsilon$ and $\max\{v_{p_2}, v_t, v_i\} - \epsilon$ for an incumbent acquirer and a private equity buyer, respectively. It then follows that a private equity acquisition takes place at the acquisition price $\max\{v_{p_2}, v_t, v_i\}$ iff $v_p > \max[v_t, v_i]$, and an incumbent acquisition takes place at the acquisition price $\max\{v_{i_2}, v_p, v_t\}$ iff $v_i > \max[v_t, v_p]$. Otherwise, no acquisition takes place. ■

4.1.1 Ownership efficiency and tax advantages

We can now use Lemma 3 to examine the impact of the tax shield on debt in private equity firms on ownership efficiency. Lemma 3 shows that the target's assets will end up with

the owner with the highest valuation and if the target is sold, the price equals the second highest valuation. Basically, the same type of equilibria as in Lemma 2 then emerge. The difference is that the bidding competition between incumbents and private equity firms is weaker, implying that the acquisition price is lower. However, all valuations v_j in equations (5), (14) and (15) are still independent of the tax advantage of the private equity firm (D). Hence, even under limited bidding competition, tax advantages for private equity firms do not affect the equilibrium ownership structure.

4.1.2 Tax revenues and tax advantages

Let us now proceed to study the impact of the tax advantage on tax revenues. From Lemma 3

$$\Gamma(p) = \begin{cases} \tau_g S^* + [\tau_g (1-\tau_c)] [\pi_P(P) - D - S^*] & \text{for } \pi(p) - D - S^* \geq 0 \\ \tau_g S^*, & \text{for } \pi(p) - D - S^* < 0 \end{cases}, \tag{16}$$

where sufficient asymmetries could imply $\pi(p) - D - S^*$. It then follows that

$$\frac{\partial \Gamma(p)}{\partial D} = -\tau_g (1-\tau_c) < 0 \text{ for } \pi(p) - D - S^* \geq 0. \tag{17}$$

When the acquiring private equity firm has a positive net profit $\pi(p) - D - S^* \geq 0$, tax advantages for private equity firms reduce tax revenues as shown in (17).

The results in this subsection can be summarized in the following proposition.

Proposition 3 *With limited competition among private equity firms and incumbents, tax advantages (D) for private equity firms from the extensive use debt do not affect ownership efficiency l^*, but they can reduce tax revenues,* $\Gamma(p) < \Gamma(t)$.

4.2 Limited deductibility

Let us now consider limited deductibility, as opposed to full deductibility, of the acquisition cost. We retain our assumption of symmetric firms with each group of firms. Below, we will show that both ownership efficiency and tax revenues will be affected by tax advantages for private equity firms.

Let us first derive firms' valuation under limited deductibility. The net gain function for incumbents is now defined as

$$\begin{aligned} \Delta_i(S) &= \pi(i) - S - \tau_c \pi(i) - \tau_g [(1-\tau_c)\pi(i) - S] \\ &= (1-\tau_g)[(1-\tau_c)\pi(i) - S]. \end{aligned} \tag{18}$$

The maximum willingness to pay is then given as $v_i \equiv \max S$, $s.t\ \Delta_i(S) \geq 0$, or:

$$v_i = (1 - \tau_c)\,\pi(i). \tag{19}$$

The net gain for a private equity firm is now

$$\Delta_p(S) = \pi(p) - S - \tau_c\,[\pi(p) - D] - \tau_g[(1 - \tau_c)\,(\pi(p) - D) - S]. \tag{20}$$

From equation (20), we can state the following Lemma:

Lemma 4 *When the acquisition cost is not deductible at the corporate level and $D > 0$, the maximum willingness to pay for private equity firms is $v_p = (1 - \tau_c)\,\pi(p) + \tau_c D$ for $D < \pi(p)$.*

Proof. Since deductions D cannot be larger than corporate income $\pi(p)$, $\pi(p) - D \geq 0$ must hold. Moreover, $(1 - \tau_c)\,(\pi(p) - D) - S \geq 0$ holds as deductions S cannot be larger than the capital gains $(1 - \tau_c)\,(\pi(p) - D)$. Then, define $\Omega(S) = (1 - \tau_c)\,(\pi(p) - D) - S$. The net gain for private equity firms in (20) can then be written as:

$$\Delta_p(S) = \begin{cases} \pi(p) - S - \tau_c\,[\pi(p) - D] - \tau_g[(1 - \tau_c)\,(\pi(p) - D) - S] \text{ if } \Omega(S) > 0 \\ \pi(p) - S - \tau_c\,[\pi(p) - D] \text{ if } \Omega(S) < 0. \end{cases} \tag{21}$$

Solving for $v_p \equiv \max S$, $s.t\ \Delta_h(S) \geq 0$ in the upper line gives $v_p = (1 - \tau_c)\,\pi(p) + \left[\tau + \frac{\tau_g}{1-\tau_g}\right] D$. However, paying $S = v_p$ implies that $\Omega(S) < 0$. Solving $\Delta_p(S) = 0$ in the lower line of (21), we obtain:

$$v_p = \begin{cases} (1 - \tau_c)\,\pi(p) + \tau_c D,\ D < \pi(p) \\ (1 - \tau_c)\,\pi(p), \qquad D \geq \pi(p) \end{cases}. \tag{22}$$

■

The reservation price of the target firm is still given as $v_t = (1 - \tau_c)\,\pi(t)$ from equation (5). Using the valuations for v_p and v_i in (22) and (19), we can then state the following proposition:

Proposition 4 *When the acquisition cost is not deductible from corporate taxes, increased tax advantages for private equity firms D can trigger inefficient buyouts ($l^* = p \neq l^{eff}$) and decrease the tax revenues ($\Gamma(p) < \Gamma(t)$).*

If the acquisition cost is not deductible from corporate taxes, a buyout becomes more likely when the tax benefits for private equity firms increase. Equations (5), (22) and (19) imply $\frac{dv_p}{dD} = \tau_c > 0 = \frac{dv_t}{dD} = \frac{dv_i}{dD}$. Therefore, an inefficient private equity firm (with $\gamma_p < 1$) can outbid a more efficient incumbent (with $\gamma_i > \gamma_p$), since $v_p = (1 - \tau_c)\,\pi(p) + \tau_c D >$

$v_i = (1-\tau_c)\,\pi(i)$ if D and γ_p are sufficiently large. Moreover, $v_p = (1-\tau_c)\,\pi(p) + \tau_c D > v_t = (1-\tau_c)\,\pi(t)$ for $\gamma_p < 1$ if D is sufficiently large (and $\gamma_p < 1$ is not too small).

Tax revenues now become

$$\Gamma(t) = [\tau_c + \tau_g\,(1-\tau_c)]\,\pi(t), \tag{23}$$

$$\begin{aligned}\Gamma(i) &= \tau_g S^* + \tau_c \pi(i) + \tau_g[(1-\tau_c)\,\pi(i) - S^*] \\ &= [\tau_c + \tau_g\,(1-\tau_c)]\,\pi(i),\end{aligned} \tag{24}$$

$$\begin{aligned}\Gamma(p) &= \tau_g S^* + \tau_c\,[\pi(p) - D] + \tau_g[(1-\tau_c)\,(\pi(p) - D) - S^*] \\ &= -(1-\tau_g)\tau_c D + [\tau_c + \tau_g\,(1-\tau_c)]\,\pi(p),\end{aligned} \tag{25}$$

where bidding competition among ownership types implies that $S^* = v_l$ for $l = l^*$ and where we assume that $\pi(p) > D$.

We can infer that tax revenues are now affected by changes in tax advantages D since from (25) we have:

$$\frac{d\Gamma(p)}{dD} = -(1-\tau_c)\tau_g < 0. \tag{26}$$

Thus, tax revenues decrease as the tax advantages for private equity firms D increase. An increase in deductions D will increase capital gain tax revenues by increasing $S^* = v_p = (1-\tau_c)\,\pi(p) + \tau_c D$. But this positive effect on tax revenues is dominated by the negative effect on both corporate and capital gains through the lower profit of the private equity owned firm, $\pi(p) - D$.

On a final note, an increase in tax advantage D can also trigger a private equity buyout instead of an incumbent buyout. This will also decrease the tax revenues since if $D = 0$, a buyout takes place iff $\pi(p) > \pi(i)$. But then, increased tax advantages can only trigger an inefficient buyout, i.e. buyouts where $\pi(p) < \pi(i)$. It then follows from equations (24) and (25) that $\Gamma(p) < \Gamma(i)$.

5 The tax system and Capital Ownership Neutrality

Let us now take a more general perspective and ask what type of tax system would imply Capital Ownership Neutrality (CON), i.e. under which tax system would the ownership of the target firm be the same as in a tax-free system. We first show that a double taxation system is not Capital Ownership Neutral, since acquisitions create deductions that are not available to sellers. Then, we argue that a single taxation system with full deductibility of acquisition costs would fulfill this requirement.

In this section, we also show that the presence of oligopolistic externalities in the product market means that tax advantages are of importance for ownership efficiency. The market power motive of incumbent acquisitions means that incumbent acquisitions can take place even though a private equity firm would run the business more efficiently. However, incumbent acquisitions in oligopolies are associated with a friction due to a replacement effect which could allow less efficient private equity firms with tax advantages to outbid more efficient incumbents.

5.1 Double taxation and Capital Ownership Neutrality

Our analysis has shown that tax advantages have no impact on ownership efficiency when acquisition costs are fully deductible. Would then not a tax system with full deductibility of acquisition costs be superior to a tax system without full deductibility? The answer is no. The reason is that in a double taxation system, corporate taxes make too many acquisitions take place in equilibrium from an efficiency perspective.

5.1.1 The benchmark monopoly model

Let us illustrate this with our benchmark model with full deductibility. While private equity advantages D do not affect the equilibrium ownership l^* with full deductibility, this does not imply efficient ownership in equilibrium. Even in the absence of tax advantages, for $D = 0$, we could still have inefficient ownership $l^* \neq l^{eff}$ since the target's valuation $v_t = (1 - \tau_c)\,\pi(t)$ in equation (5) depends on corporate taxes τ_c while incumbent firms' and private equity firms' valuations $v_i = \pi(i)$ and $v_p = \pi(p)$ in equations (7) and (10) do not depend on taxes. Let $\tilde{\gamma}_h < \gamma_t \equiv 1$ be defined from $v_t = v_h$, $h = i, p$. Then, it directly follows that $l^* \neq l^{eff} = t$ holds for $\gamma \in (\tilde{\gamma}_h, 1)$. Hence, the incentive for the target to sell to avoid corporate taxes can lead to inefficient ownership. However, while this can lead to an inefficient transfer of ownership, private equity firms cannot be less efficient owners than incumbent firms. A buyout still requires that $\gamma_p > \gamma_i$.

Its easy to extend the argument to limited deductions. When $D > \pi(p)$, it can be shown that ownership efficiency prevails. However, whenever $D < \pi(p)$, we will once more find that capital ownership neutrality does not hold.

5.1.2 Oligopoly

The monopoly model rules out that buyout can occur when private equity firms are less efficient than incumbents. In this section, we will show that in an oligopoly setting, we can have truly inefficient buyouts where private equity firms are less efficient than both the target and incumbent firms. In the oligopoly model, it not straightforward to define efficient ownership since under oligopoly, this will depend on whether welfare, profits

and productive efficiency are measured. In this section, we will instead remark on how ownership directly affects the level of efficiency, γ_l.

Let $\pi_j(x, l)$ denote the pre-tax product market profit of firm j, net the investment costs for new assets. The vector of actions taken by firms in product market interaction is x and l once more denotes ownership of the target firm's assets from stage 1. The optimal behavior in the product market interaction is given as follows. Given the ownership of the target firm's assets from stage 1, l, firm j chooses an action x_j to maximize its net product market profit net taxes and deductions, denoted $(1-\tau_c)(1-\tau_g)\pi_j(x_j, x_{-j} : l)$ where x_{-j} is the set of actions taken by j's rivals. We assume there to exist a unique Nash-Equilibrium, $\mathbf{x}^*(l) = (x_j^*, x_{-j}^*)$, defined as

$$(1-\tau_c)(1-\tau_g)\pi_j(x_j^*, x_{-j}^* : l) \geq (1-\tau_c)(1-\tau_g)\pi_j(x_j, x_{-j}^* : l), \quad \forall x_j \in R^+. \tag{27}$$

Since neither capital gains taxes nor corporate taxes affect the firms' optimal actions $\mathbf{x}^*(l)$ in equation (27), we can define a reduced-form product market profit for a firm j, taking as given the ownership l of the target firm's assets, as $\pi_j(l) \equiv \pi_j(x_j^*(l), x_{-j}^*(l), l)$. The reduced-form product market profit net of taxes is then simply $(1-\tau_c)(1-\tau_g)\pi_j(l)$. With three different type of ownerships, the profits are denoted $\pi_h(l)$: the profit for an incumbent acquirer $(l = i)$, $\pi_A(i)$; the profit for the target firm with no sale $(l = t)$, $\pi_T(t)$; and the profit for a private equity firm $(l = p)$, $\pi_P(p)$. Non-acquiring incumbents also have three types of profits: $\pi_{NA}(l)$, where $l = \{t, p, i\}$ is the type of owner of the target firm.

Moreover, we assume that ownership efficiency, γ_l, affects the reduced form profit functions in the following way:

Assumption 3 $\frac{d\pi_A(i)}{d\gamma_i} > 0$, $\frac{d\pi_P(p)}{d\gamma_p} > 0$ *and* $\frac{d\pi_{NA}(l)}{d\gamma_l} < 0$.

This simply says that increased ownership efficiency benefits the owner of the target's assets, while it reduces the profits of non-acquiring incumbents producing in the industry. This holds, for example, in the Cournot model, where γ reduces the marginal costs.

Example 2 *Let demand be linear,* $P = a - \frac{Q}{s}$*, where* a *indicates consumer willingness to pay and* s *denotes market size. Direct product market profits are* $\Pi_h = (P - c_h)q_h$ *, where* q_h *is output for a firm of type* $h = \{A, NA\}$*. The marginal cost of an acquirer is* $c_A = c - \gamma_i$ *and the non-acquirer has the marginal cost* $c_{NA} = c$*. Reduced-form profits then take the form* $R_h(l) = \frac{1}{s}(q_h^*)^2$*, where* $q_A^*(i) = \frac{a-c+n\gamma_i}{n+1}$*,* $q_{NA}^*(i) = \frac{a-c-\gamma_i}{n+1}$*,* $q_T^*(t) = \frac{a-c+(n+1)\gamma_t}{n+2}$*,* $q_{NA}^*(t) = \frac{a-c-\gamma_t}{n+2}$*,* $q_P^*(p) = \frac{a-c+(n+1)\gamma_p}{n+2}$ *and* $q_{NA}^*(p) = \frac{a-c-\gamma_p}{n+2}$*. Hence,* $\frac{d\pi_A(i)}{d\gamma_i} > 0$*,* $\frac{d\pi_P(p)}{d\gamma_p} > 0$ *and* $\frac{d\pi_{NA}(l)}{d\gamma_l} < 0$*.*

Assumption 3 is also compatible with other oligopoly models (Farrell and Shapiro (1990)).

Let us first review the setting with full deductions. Proceeding as in Section 3.3, it follows that the valuation of a private equity firm is

$$v_p = \pi_P(p), \tag{28}$$

whereas the reservation price of the target firm is

$$v_t = (1 - \tau_c)\pi_T(t). \tag{29}$$

However, an incumbent will now have three net gain functions defined as

$$\Delta_{il}(S) = (1 - \tau_g)(1 - \tau)[\pi_A(i) - S] - (1 - \tau_g)(1 - \tau)\pi_{NA}(l) \quad \text{for } l \in \{i, p, t\}. \tag{30}$$

The reason is that an incumbent's maximum willingness to pay for the target's assets now depends on what happens if another incumbent obtains the target ($l = i$), if a private equity firm obtains the target ($l = p$), or if the target remains in the industry ($l = t$). Using the same procedure as above, we get the maximum willingness to pay for each of the three net gain functions as

$$v_{il} = \pi_A(i) - \pi_{NA}(l). \tag{31}$$

In Lemma 5, we make use of these maximum valuations to derive the equilibrium bidding behavior and the equilibrium ownership structures.

Lemma 5 *The equilibrium ownership (l^*) and the equilibrium acquisition price (S^*) for the case (i) $v_t > v_p$ and (i) $v_p > v_t$ are defined in Table 3.*

Case (i): $v_t > v_p$				Case (ii): $v_p > v_t$		
Ineq:	Definition:	Ownership l*	S^*	Definition:	Ownership l*	S^*
$I1:$	$v_{ii} > v_{it} > v_t$	i	v_{ii}	$v_{ii} > v_{ip} > v_p$	i	v_{ii}
$I2:$	$v_{ii} > v_t > v_{it}$	i or t	v_{ii}	$v_{ii} > v_p > v_{ip}$	i or p	v_{ii}
$I3:$	$v_{it} > v_{ii} > v_t$	i	v_{ii}	$v_{ip} > v_{ii} > v_p$		v_{ii}
$I4:$	$v_{it} > v_t > v_{ii}$	i	v_t	$v_{ip} > v_p > v_{ii}$		v_p
$I5:$	$v_t > v_{ii} > v_{it}$	t	.	$v_p > v_{ii} > v_{ip}$		.
$I6:$	$v_t > v_{it} > v_{ii}$	t	.	$v_p > v_{ip} > v_{ii}$		.

Table 3: The equilibrium ownership structure and the acquisition price.

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Proof. See the Appendix. ■

To solve for the equilibrium ownership structure, we distinguish between two cases: $v_t > v_p$ and $v_t < v_p$. When $v_t > v_p$, the private equity owner will not affect the equilibrium

ownership structure. Since incumbents are symmetric, valuations v_{ii}, v_{it} and v_t can be ordered in six different ways and the equilibrium ownership structure is solved for each inequality I1-I6 in Table 3. Three types of ownership structures arise in equilibrium: The structure where firm t keeps its assets is thus $l = t$ arising under I5 or I6; the structure where the target is obtained by one of the incumbents is thus $l = i$, where the acquisition price is $S^* = v_{ii}$ under inequalities $I1$, $I2$ or $I3$, and $S = v_t$ under inequality $I4$. When $I2$ holds, there exist multiple equilibria. In one equilibrium, firm t keeps the assets and no incumbent posts a bid above v_t. An equilibrium also exists where one of the incumbents obtains the assets at a price $v_{ii} - \varepsilon$ and another incumbent posts the second highest bid at $v_{ii} - 2\varepsilon$.

When $v_t < v_p$, the target owner will not affect the equilibrium ownership structure as shown in Table 3. Two types of ownership structures arise in equilibrium: The one where the firm P acquirer is thus $l = p$ arises under I4, I5 or I6; and the one where the target is obtained by one of the incumbents is thus $l = i$, where the acquisition price is $S^* = v_{ii}$ under inequalities $I1$, or $I3$, and $S = v_t$ or v_{ii} under inequality $I2$. In one equilibrium under $I2$, firm t posts the second highest bid, keeps the assets and no incumbent posts a bid above v_t. An equilibrium also exists where one of the incumbents obtains the assets at a price $v_{ii} - \varepsilon$ and another incumbent posts the second highest bid at $v_{ii} - 2\varepsilon$.

Since all valuations in (31), (28) and (29) are independent of the tax advantage of the private equity owner D, ownership efficiency and tax revenues are unaffected by tax advantages. Thus, we can state the following result:

Corollary 1 *Propositions 1 and 2 are valid also in an oligopolistic setting.*

However, ownership is not Capital Ownership Neutral (CON). Using Lemma 5, we can state the following proposition:

Proposition 5 *In the oligopoly model with full deductions: (i) a less efficient private equity firm can acquire the target's assets instead of the target's assets remaining in the hands of a more efficient original owner, (ii) a less efficient private equity firm can acquire the target's assets instead of a more efficient incumbent acquiring them.*

The proposition is illustrated in Figure 2, which is drawn for $\gamma_i = \gamma_t = 1$. First, note the locus of the "Buyout-condition" (BO-condition). This locus shows combinations of efficiency levels of private equity firms γ_p and corporate taxes τ_c such that $v_p = v_t$ holds. The BO-condition is downward-sloping in the $\gamma_p - \tau_c$ space. To see this, use (28) and (29) to solve for the corporate tax $\tau_c^{BO}(\gamma_p) = 1 - \frac{\pi_P(p)}{\pi_T(t)}$ which is decreasing in γ_p from Assumption 3. Below the BO-locus, the tax disadvantage of the target firm is not sufficiently large for private equity firms to overbid the target's reservation, $v_p < v_t$. Above the BO-locus, private equity firms can always induce the target to sell, $v_p > v_t$.

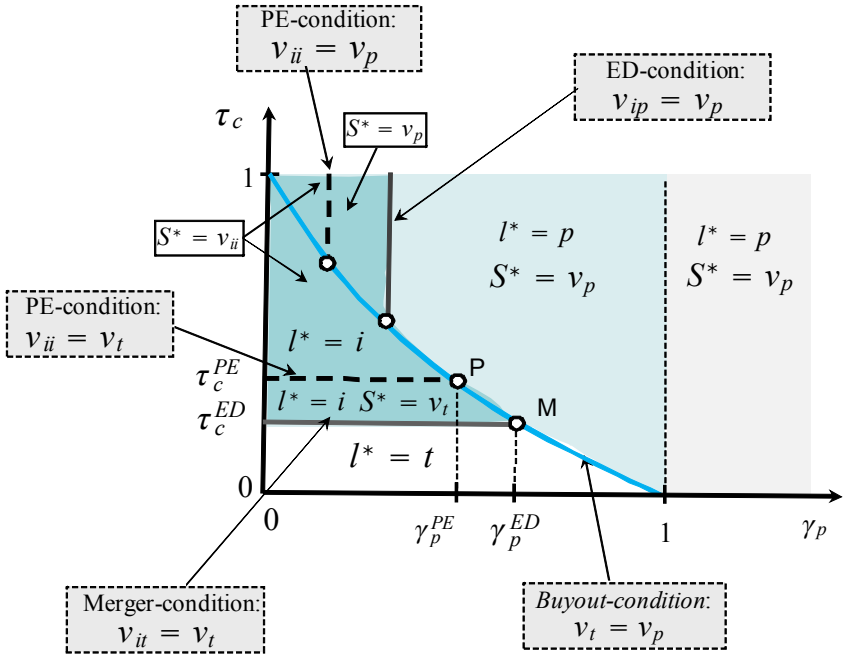

Figure 2: This figure illustrates the solution to the oligopoly model. In the oligopoly model with full deductions, a less efficient private equity firm can aquire the target instead of the target remaining in the hands of a previous more efficient owner; and a less efficient private equity firm can also acquire the target instead of a more efficient incumbent making the acquisition.

However, for low efficiency levels γ_p, private equity firms cannot outbid incumbents. This is shown by the Entry-deterrence condition (ED-condition) where an acquisition to deter private equity ownership is just profitable, $v_{ip} = v_p$ and the Preemption-condition (PE-condition) where an acquisition to preempt a rival incumbent is profitable, $v_{ip} = v_p$.

Consider combinations of τ_c and γ_p below the BO-condition where $v_p < v_t$. Then, assume that an incumbent acquisition is not profitable at a zero corporate tax rate, i.e. assume that $v_{ii} < v_{it} < v_t$ holds at $\tau_c = 0$. Increasing the corporate tax rate τ_c, when the efficiency level of private equity firms γ_p is not too high, it follows that $v_{it} = v_t$ holds at some tax rate τ_c^{ED} and that $v_{ii} = v_t$ holds at some tax rate τ_c^{PE}. These tax rates also mark out the loci for the Merger-condition at which an incumbent acquisition is just profitable and the Preemptive-condition (PE-condition) at which an acquisition to preempt rivals is just profitable. For low tax rates $\tau_c \in [0, \tau_c^{ED})$, the target firm will not sell, for medium tax rates $\tau_c \in [\tau_c^{ED}, \tau_c^{PE})$ there will be a sale at $S^* = v_t$, and for high tax rates $\tau_c \in [\tau_c^{PE}, 1]$, a preemptive acquisition takes place at $S^* = v_{ii}$. The latter follows since if $v_{ii} > v_t$, incumbents will always challenge an acquisition by rivals at the reservation price v_t. Bidding competition will then drive the price up to v_{ii}. It directly follows that due to the incentive for the target to evade the corporate tax rate, there

could also be an inefficient acquisition by the incumbent firm where $\gamma_i < 1$.

In this setting, private equity firms can acquire the target firm even when private equity firms are even less efficient than incumbents, $\gamma_p < \gamma_i = \gamma_t = 1$. This directly follows from Figure 2. Due to the tax disadvantage of the target, a private equity firm can acquire the target when $\gamma_p < 1$. For instance, as shown by point M in Figure 2, for $\tau_c = \tau_c^{ED}$, $v_p = v_t$ holds at $\hat{\gamma}_p < 1$. Increasing the γ_p slightly from point M (where $\gamma_p < 1$), we have $v_p > v_t = v_{it} > v_{ip}$. The latter inequality holds because it is better for an incumbent to have a less efficient private equity firm running the target firm, $\pi_{NA}(p) > \pi_{NA}(t)$, which in turn implies $v_{it} > v_{ip}$ from equation (31).

Thus, as opposed to the above monopoly setting, tax advantages can then decrease the ownership efficiency since incumbent acquisitions come with a replacement effect: an incumbent acquisition in an oligopolistic market means that the incumbent partly replaces its own profit when acquiring the target. This alone will imply that less efficient private equity firms can acquire assets through buyouts, even though an incumbent would be a more efficient owner.

However, an incumbent acquisition could increase the profits more than private equity buyouts since the product market becomes more concentrated under an incumbent acquisition. This monopolization motive of acquisitions means that welfare decreasing incumbent acquisitions can take place even though a private equity firm would run the business more efficiently. Tax advantages for private equity firms can then increase welfare if a buyout prevents an incumbent acquisition and the resulting concentration in the industry.[11]

It is easy to extend the argument that the tax system is not capital ownership neutral also with limited deductions. When $D > \pi_P(p)$, it can be shown that ownership efficiency prevails. However, whenever $D < \pi_P(p)$, we will once more find that capital ownership neutrality does not hold.

5.2 Single Taxation and Capital Ownership Neutrality

Given that a double taxation system is never Capital Ownership Neutral, what would such a system look like in the context of our model? A single taxation system with full deductibility of acquisition costs would fulfill such a requirement. Without loss of generality, we show this using the simpler monopoly model.

With such a single tax system, the net gain for the target's owner from selling the

[11] A caveat to these statements is that we have abstracted from the possibility of the private equity firm reselling the assets to an incumbent after the acquisition. For a detailed analysis of the strategic issues that arise in such a setting, we refer the reader to Norbäck et al. (2010).

assets is

$$\begin{aligned}\Delta_t(S) &= \underbrace{S - \tau S}_{\text{Net profit from sale}} - \underbrace{[\pi(t) - \tau\pi(t))]}_{\text{Net profit from no sale}} \\ &= (1-\tau)\left[S - \pi(t)\right]. \end{aligned} \tag{32}$$

The reservation price for the target's owners, v_t, can thus be determined as $v_t = \min S$, $s.t\ \ \Delta_t(S) \geq 0$. Solving for $\Delta_t(S) = 0$, we have

$$v_t = \pi(t). \tag{33}$$

Corporate taxes—but not capital gains taxes—affect the reservation value since capital gains taxes are paid both under a sale and if the assets are kept.

Now turn to an incumbent's valuation. Suppose that the incumbent pays S to acquire the target's assets. Then, the net gain for an incumbent is

$$\begin{aligned}\Delta_i(S) &= \pi_A(i) - S - \tau[\pi(i) - S] \\ &= (1-\tau)\left[\pi(i) - S\right]. \end{aligned}$$

An incumbent's maximum willingness to pay for the assets is thus given by $v_i \equiv \max S$, $s.t\ \Delta_i(S) \geq 0$. Solving for $\Delta_i(S) = 0$, we have

$$v_i = \pi(i). \tag{34}$$

In particular, taxes do not affect the incumbents' maximum willingness to pay, v_i. The reason is that at an acquisition cost $S = \pi(i)$, no taxes are ever paid if the acquisition cost is fully deductible.

Finally, the net gain for a private equity firm for acquiring the assets equals

$$\Delta_p(S) = \pi(p) - S - \tau[\pi(p) - D - S]. \tag{35}$$

A private equity firm's maximum willingness to pay for the assets is thus given by $v_p \equiv \max S$, $s.t\ \Delta_p(S) \geq 0$. Solving for $\Delta_p(S) = 0$, we have

$$v_p = \pi(p). \tag{36}$$

Taxes do not affect the private equity firms' maximum willingness to pay, v_p. The reason is that at an acquisition cost $S = \pi(p)$, no taxes are ever paid if the acquisition cost is fully deductible. Hence, in a single taxation system under monopoly and full deductibility, CON would hold and the ownership structure would be efficient.

However, this result does not extend to oligopoly. It is straightforward to show that in

oligopoly, a single tax system implies CON, but might not lead to an efficient ownership structure due to the replacement effect and the market power effect associated with incumbent acquisitions. Thus, we can state the following proposition:

Proposition 6 *(i) In a single taxation system under monopoly and full deductibility, CON would hold and the ownership structure would be efficient. (ii) In a single taxation system under oligopoly and full deductibility, CON would hold and the ownership structure could be inefficient.*

6 Discussion

Let us now provide a brief discussion on possible future extensions to our framework. We start out in subsection 6.1 by discussing the inter-temporal effects of tax payments. In subsection 6.2, we discuss organizational form and in subsection 6.3, we discuss personal income taxes in the context of our model.

6.1 Inter-temporal effects of tax payments

For reasons of simplification, in our model, we have abstracted from inter-temporal issues related to tax payments. This is clearly an important avenue for future research. One of the main arguments for having a corporate tax and thereby a double taxation system is that capital gains income is difficult to tax on a yearly basis and is therefore taxed when realized. This implies that capital income has a tax advantage over personal income. A yearly corporate tax can therefore be motivated from a neutrality perspective (Gordon (2010)).

In our setting, the potential seller will in a single tax system have a tax advantage from not selling the firm since it can delay tax payments (unless payments are constructed in such a way that capital gains could be carried forward). This suggests that a double taxation system with corporate taxes could indeed be CON under some circumstances. The trade-off lies in balancing the incentive for sellers to delay tax payments and avoid paying corporate taxes. We consider this to be a promising avenue for further research, but outside the scope of this paper.

6.2 The choice of organizational form

Our framework can be used to study the choice of organizational form (partnership or incorporation) and the tax benefits/disadvantages that it entails. Typically, the general partners of private equity firms are wealthy experienced business people with specific skills and a strong network among investors and banks. To exploit their skills and have control over the firms they acquire (and reduce agency problems), private equity firms are

often organized as partnerships. Further, since the basic business idea for private equity firms is to restructure the firms they acquire, they could benefit from not being listed on the stockmarket since listing entails increased reporting requirements (Jensen (2007)).

For incumbent firms, incorporation could be more advantageous. Incorporation is claimed to have two main advantages: access to external capital and limited liability. Adopting the corporate form requires tighter bookkeeping, accounting and reporting standards which impose an additional overhead cost that would not be necessary with a partnership. The advantage of these standards is increased transparency to external investors and other stakeholders. Therefore, managerial discretion is lower. The owners are thus able to raise more external capital for any given amount of own equity (although recently, large private equity partnerships such as Blackstone and KKR have undergone IPOs and listed a share of their partnership as a way of raising new capital).

Another advantage of incorporation is limited liability. Typically, owners do not only dispose of financial assets that they inject as own equity in the firm, but are also endowed with 'private' assets such as housing. The value of these private assets is likely to be higher for the owner than for the bank. Banks can often seize all assets of partners in partnership including private assets. In contrast, depending on the bankruptcy rules, the corporate form protects a larger part of private assets due to limited liability.

The economics literature has previously analyzed the choice of organizational form, and we believe that our framework could be useful for generating additional insights. For example, Egger et al. (2009) emphasize two opposing consequences of limited liability. The need to pledge private assets sharpens the incentives for partnerships and allows them to raise more external financing. However, owners attach a higher value to their private assets than do banks or the market. They are thus unwilling to pledge the asset and lose it in case of bankruptcy. The need to pledge private assets emphasizes the downside risk of partnerships. If owners have a sufficiently high private valuation of the private asset and are risk averse, they want to protect it against the downside risk even if the asset could serve as collateral and raise the borrowing capacity. Hence, sufficiently risk averse owners prefer to incorporate in order to benefit from limited liability and protect their private wealth. In terms of private equity firms, it is likely that wealthy general partners could protect their most valuable assets in any circumstances and are less in need of such "insurance" that limited liability provides.

6.3 General partners and personal income taxes

The way in which private equity funds are taxed varies between jurisdictions and investors. In the main analysis, we assumed that the incumbent pays corporate taxes at the rate τ_c on total net profits. The owners of the private equity fund pay capital gains taxes at the rate τ_g on the profits net of corporate taxes and deductions. This formalization abstracts

from the taxation details of private equity funds. In particular, private equity funds are often set up as partnerships, with limited partners being the investors in the fund and general partners being the partners in the private equity firm.

Taxation of general partners—as a consequence of private equity firms and funds being set up as partnerships instead of limited liability corporations—could be of importance. For example, dividends and capital income are in many countries taxed as personal income in firms with few active owners. Further, carried interest that goes to the general partners in the U.S. is taxed as capital income, and there is currently a heated debate on whether it should instead be taxed as labor income.

To incorporate this into our framework, we could assume that the private equity firm consists of only a few general partners. General partners would then pay personal income taxes at the rate τ_i on the profits, net corporate taxes and deductions, an analysis similar to the one in our benchmark model. In particular, we conjecture that if the acquisition cost is fully deductible at the personal income level, the results derived above hold with the difference that personal income taxes τ_i are substituted for capital gains taxes, τ_g. However, if acquisition costs are not fully deductible at the personal income level, general partners and investors in private equity funds could be tax disadvantaged (or advantaged) in this respect. We consider incorporating personal taxes in our framework to be an interesting avenue of further research and that it could generate important policy implications.

7 Concluding remarks

We have developed an endogenous corporate asset ownership model with taxation, and applied it to a situation where private equity firms and incumbents compete to acquire target firms. The starting point was that private equity firms have tax advantages arising from the equilibrium behavior of private equity firms as compared to other firms (and not from specific tax advantages in the tax law). In particular, their business model allows them to better benefit from the tax shield of debt.

We then established that with limited deductibility of acquisition costs, tax advantages for private equity firms will affect ownership efficiency. A buyer's willingness to pay for the target will depend on corporate taxes. Consequently, a private equity firm with corporate tax advantages can outbid other (more efficient) incumbent bidders. Moreover, in the presence of oligopolistic externalities, incumbent acquisitions also have a replacement effect meaning that a less efficient private equity firm with tax advantages can outbid more efficient incumbents. In particular, we show that these inefficiencies may be substantial when there is limited competition in the market for corporate control and limited competition in the product market. This suggests that an active practise of the anti-trust law will improve the functioning of the tax law by reducing distortions in the

market for corporate control.

Our results also point to the fact that acquisition costs need to be fully deductible from corporate taxes to ensure that private equity firms cannot use tax advantages to outbid more efficient incumbents. However, in a double taxation system, too many acquisitions take place from an efficiency perspective if the goodwill associated with acquisitions is deductible.

More generally, we have studied the effects of stylized tax policies such as the effects of allowing full or no deductibility of goodwill associated with acquisitions, and effects of a double taxation system. Even though these stylized policies abstract from details of tax policy in practice, we believe that these exercises capture important effects of tax policies. The complexity of the externalities involved in an acquisition indicates that practical and informational constraints will be important for deriving optimal tax policies.

Endogenizing taxes, debt levels, tax exemptions and tax credits in this framework could lead to new interesting results on the welfare effects of tax policy on the market for corporate control.

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A Appendix

A.1 Proof Lemma 5 when $v_p > v_t$

First, $b_i \geq \max v_{ml}$, $l = \{i,p\}$ is a weakly dominated strategy, since no firm will post a bid equal to or above its maximum valuation of obtaining the assets and firm T will accept a bid in stage 2, iff $b_i > v_t$. Then assume that $v_p > v_t$. Since there are several private equity firms competing, the equilibrium sales price will be at least v_p. Then, using that $v_t < v_p$, it follows that a sale will take place. This implies that v_{it} and v_t will not affect the equilibrium and we can focus the analysis on the relations between valuations v_p, v_{IP} and v_{ii}. There are six possible ordering of these valuations:

Inequality I1 Consider equilibrium candidate $b^* = (b_1^*, b_2^*, ..., yes)$. Let us assume that incumbent firm $w \neq t$ is the firm that has posted the highest bid and obtains the assets and firm $s \neq t$ is the firm with the second highest bid.

Then, $b_w^* \geq v_{ii}$ is a weakly dominated strategy. $b_w^* < v_{ii} - \varepsilon$ is not an equilibrium, since incumbent firm $j \neq w, t$ then benefits from deviating to $b_j = b_w^* + \varepsilon$, since it will then obtain the assets and pay a price lower than its valuation of obtaining them. If $b_w^* = v_{ii} - \varepsilon$, and $b_s^* \in [v_{ii} - \varepsilon, v_{ii} - 2\varepsilon]$, then no firm has an incentive to deviate. By deviating to *no*, firm t's payoff decreases since it foregoes a selling price exceeding its valuation, v_t. Accordingly, firm t has no incentive to deviate and thus, b^* is a Nash equilibrium.

Let $b = (b_1, , , b_m, yes)$ be a Nash equilibrium. Let private equity firm h be the firm with the highest bid. Firm h will then bid a maximum of v_p. But incumbent firm $j \neq t$ will have the incentive to deviate to $b' = v_p$ in period 1, since $v_{IP} > v_p$. This contradicts the assumption that b is a Nash equilibrium.

Inequality I2 Consider equilibrium candidate $b^* = (b_1^*, b_2^*, ..., yes)$. Let us assume that incumbent firm $w \neq t$ is the firm that has posted the highest bid and obtains the assets and incumbent $s \neq t$ is the firm with the second highest bid.

Then, $b_w^* \geq v_{ii}$ is a weakly dominated strategy. $b_w^* < v_{ii} - \varepsilon$ is not an equilibrium, since incumbent firm $j \neq w, t$ then benefits from deviating to $b_j = b_w^* + \varepsilon$, since it will then obtain the assets and pay a price lower than its valuation of obtaining them. If $b_w^* = v_{ii} - \varepsilon$, and $b_s^* \in [v_{ii} - \varepsilon, v_{ii} - 2\varepsilon]$, then no firm has an incentive to deviate and thus, b^* is a Nash equilibrium.

Consider equilibrium candidate $b^* = (b_1^*, b_2^*, ..., yes)$. Let us assume that private equity firm $w \neq t$ is the firm that has posted the highest bid and obtains the assets and firm $s \neq t$ is the firm with the second highest bid.

Then, $b_w^* \geq v_p$ is a weakly dominated strategy. $b_w^* < v_p - \varepsilon$ is not an equilibrium, since the private equity firm then benefits from deviating to $b_j = b_w^* + \varepsilon$, since it will then obtain

the assets and pay a price lower than its valuation of obtaining them. If $b_w^* = v_p - \varepsilon$, and $b_s^* \in [v_p - \varepsilon, v_p - 2\varepsilon]$, then no firm has an incentive to deviate. By deviating to *no*, firm t's payoff decreases since it foregoes a selling price exceeding its valuation, v_t. Accordingly, firm t has no incentive to deviate and thus, b^* is a Nash equilibrium.

Inequality I3 Consider equilibrium candidate $b^* = (b_1^*, b_2^*, ..., yes)$. Let us assume that incumbent firm $w \neq t$ is the firm that has posted the highest bid and obtains the assets and incumbent $s \neq t$ is the firm with the second highest bid.

Then, $b_w^* \geq v_{ii}$ is a weakly dominated strategy. $b_w^* < v_{ii} - \varepsilon$ is not an equilibrium since incumbent firm $j \neq w, t$ then benefits from deviating to $b_j = b_w^* + \varepsilon$, since it will then obtain the assets and pay a price lower than its valuation of obtaining them. If $b_w^* = v_{ii} - \varepsilon$, and $b_s^* \in [v_{ii} - \varepsilon, v_{ii} - 2\varepsilon]$, then no firm has an incentive to deviate and thus, b^* is a Nash equilibrium.

Let $b = (b_1, , , b_m, yes)$ be a Nash equilibrium. Let the private equity firm h be the firm with the highest bid. Firm h will then bid a maximum v_p. But the incumbent firm $j \neq t$ will have the incentive to deviate to $b' = v_p$ in period 1, since $v_{IP} > v_p$. This contradicts the assumption that b is a Nash equilibrium.

Inequality I4 Consider equilibrium candidate $b^* = (b_1^*, b_2^*, ..., yes)$. Let us assume that an incumbent firm $w \neq t$ is the firm that has posted the highest bid and obtains the assets and private equity firm $s \neq t$ is the firm with the second highest bid. Then, $b_w^* \geq v_p$ is not an equilibrium since a private equity owner will not put a bid above $v_p - \varepsilon$ and incumbent $j \neq w, t$ then benefits from deviating to $b_j = v_p$. $b_w^* < v_p - \varepsilon$ is not an equilibrium, since private equity firm $j \neq w, t$ then benefits from deviating to $b_j = b_w^* + \varepsilon$. If $b_w^* = v_p - \varepsilon$, and $b_s^* \in [v_p - \varepsilon, v_p - 2\varepsilon]$, then no potential buyer firm has an incentive to deviate and thus, b^* is a Nash equilibrium.

Let $b = (b_1, , , b_m, yes)$ be a Nash equilibrium. Let private equity firm h be the firm with the highest bid. Firm h will then bid a maximum of v_p. But the incumbent firm $j \neq t$ will have the incentive to deviate to $b' = v_p$ in period 1, since $v_{ip} > v_p$. This contradicts the assumption that b is a Nash equilibrium.

Inequality I5 Consider equilibrium candidate $b^* = (b_1^*, b_2^*, ..., yes)$. Let us assume that a private equity owner $w \neq t$ is the firm that has posted the highest bid and obtains the assets and firm $s \neq t$ is the firm with the second highest bid.

Then, $b_w^* \geq v_p$ is a weakly dominated strategy. $b_P^* < v_p - \varepsilon$ is not an equilibrium, since private equity firm $j \neq w, t$ then benefits from deviating to $b_j = b_w^* + \varepsilon$, since it will then obtain the assets and pay a price lower than its valuation of obtaining them. If $b_w^* = v_p - \varepsilon$, and $b_s^* \in [v_p - \varepsilon, v_p - 2\varepsilon]$, then no firm has an incentive to deviate and thus, b^* is a Nash equilibrium.

Let $b = (b_1, , , b_m, yes)$ be a Nash equilibrium. Let incumbent h be the firm with the highest bid. Firm h will then bid a maximum v_{ii}. But the private equity firm $j \neq t$ will have the incentive to deviate to $b' = v_{ii}$ in period 1, since $v_p > v_{ii}$. This contradicts the assumption that b is a Nash equilibrium.

Inequality I6 Consider equilibrium candidate $b^* = (b_1^*, b_2^*, ..., yes)$. Let us assume that a private equity owner $w \neq t$ is the firm that has posted the highest bid and obtains the assets and firm $s \neq t$ is the firm with the second highest bid.

Then, $b_w^* \geq v_p$ is a weakly dominated strategy. $b_P^* < v_p - \varepsilon$ is not an equilibrium, since private equity firm $j \neq w, t$ then benefits from deviating to $b_j = b_w^* + \varepsilon$, since it will then obtain the assets and pay a price lower than its valuation of obtaining them. If $b_w^* = v_p - \varepsilon$, and $b_s^* \in [v_p - \varepsilon, v_p - 2\varepsilon]$, then no firm has an incentive to deviate and thus, b^* is a Nash equilibrium.

Let $b = (b_1, , , b_m, yes)$ be a Nash equilibrium. Let incumbent h be the firm with the highest bid. Firm h will then bid a maximum of v_{ip}. But private equity firm $j \neq t$ will have the incentive to deviate to $b' = v_{ip}$ in period 1, since $v_p > v_{ip}$. This contradicts the assumption that b is a Nash equilibrium.

A.2 Proof of Lemma 5 when $v_t > v_p$

First, $b_i \geq \max v_{ml}$, $l = \{i,t\}$ is a weakly dominated strategy since no firm will post a bid equal to or above its maximum valuation of obtaining the assets and firm t will accept a bid in stage 2, iff $b_i > v_t$. Then assume that $v_t > v_p$. Since the private equity firms will never post a bid above v_p, they will not acquire since $v_t > v_p$. This implies that v_{ip} and v_p will not affect the equilibrium, and we can focus the analysis on the relations between valuations v_t, v_{it} and v_{ii}. There are six possible orders of these valuations:

Inequality I1 Consider equilibrium candidate $b^* = (b_1^*, b_2^*, ..., yes)$. Let us assume that incumbent $w \neq t$ is the incumbent that has posted the highest bid and obtains the assets and firm $s \neq t$ is the incumbent with the second highest bid.

Then, $b_w^* \geq v_{ii}$ is a weakly dominated strategy. $b_w^* < v_{ii} - \varepsilon$ is not an equilibrium since firm $j \neq w, t$ then benefits from deviating to $b_j = b_w^* + \varepsilon$, since it will then obtain the assets and pay a price lower than its valuation of obtaining them. If $b_w^* = v_{ii} - \varepsilon$, and $b_s^* \in [v_{ii} - \varepsilon, v_{ii} - 2\varepsilon]$, then no incumbent has an incentive to deviate. By deviating to *no*, firm t's payoff decreases since it foregoes a selling price exceeding its valuation, v_t. Accordingly, firm t has no incentive to deviate and thus, b^* is a Nash equilibrium.

Let $b = (b_1, , , b_m, no)$ be a Nash equilibrium. Let incumbent h be the incumbent with the highest bid. Firm t will then say *no* iff $b_h \leq v_t$. But incumbent $j \neq t$ will have the incentive to deviate to $b' = v_t + \varepsilon$ in period 1 since $v_{it} > v_t$. This contradicts the

assumption that b is a Nash equilibrium.

Inequality I2 Consider equilibrium candidate $b^* = (b_1^*, b_2^*, ..., y)$. Then, $b_w^* \geq v_{ij}$ is a weakly dominated strategy. $b_w^* < v_{ij} - \varepsilon$ is not an equilibrium since firm $j \neq w, t$ then benefits from deviating to $b_j = b_w^* + \varepsilon$, since it will then obtain the assets and pay a price lower than its valuation of obtaining them. If $b_w^* = v_{ii} - \varepsilon$, and $b_s^* \in [v_{ii} - \varepsilon, v_{ii} - 2\varepsilon]$, no incumbent has an incentive to deviate. By deviating to no, firm t's payoff decreases since it foregoes a selling price exceeding its valuation, v_t. Accordingly, firm t has no incentive to deviate and thus, b^* is a Nash equilibrium.

Consider equilibrium candidate $b^{**} = (b_1^{**}, b_2^{**}, ..., no)$. Then, $b_w^* \geq v_{it}$ is not an equilibrium, since firm t would then benefit by deviating to yes. If $b_w^* \leq v_t$, then no incumbent has an incentive to deviate. By deviating to yes, firm t's payoff decreases, since it then sells its assets at a price below its valuation, v_t. Firm t has no incentive to deviate and thus, b^{**} is a Nash equilibrium.

Inequality I3 Consider equilibrium candidate $b^* = (b_1^*, b_2^*, ..., yes)$. Then, $b_w^* \geq v_{ii}$ is a weakly dominated strategy. $b_w^* < v_{ii} - \varepsilon$ is not an equilibrium, since firm $j \neq w, t$ then benefits from deviating to $b_j = b_w^* + \varepsilon$, since it will then obtain the assets and pay a price lower than its valuation of obtaining them. If $b_w^* = v_{ii} - \varepsilon$, and $b_s^* \in [v_{ii} - \varepsilon, v_{ii} - 2\varepsilon]$, then no incumbent has an incentive to deviate. By deviating to no, firm t's payoff decreases, since it foregoes a selling price exceeding its valuation, v_t. Accordingly, firm t has no incentive to deviate and thus, b^* is a Nash equilibrium.

Let $b = (b_1, ..., b_M, no)$ be a Nash equilibrium. Firm t will then say no iff $b_h \leq v_t$. But incumbent $j \neq t$ will then have the incentive to deviate to $b' = v_t + \varepsilon$ in stage 1, since $v_{it} > v_t$. This contradicts the assumption that b is a Nash equilibrium.

Inequality I4 Consider equilibrium candidate $b^* = (b_1^*, b_2^*, ..., yes)$. Then, $b_w^* > v_t$ is not an equilibrium since firm w would then benefit from deviating to $b_w = v_t$. $b_w^* < v_t$ is not an equilibrium, since firm t would then not accept any bid. If $b_w^* = v_t - \varepsilon$, then firm w has no incentive to deviate. By deviating to $b_j' \leq b_w^*$, the payoff of firm $j \neq w, t$ does not change. By deviating to $b_j' > b_w^*$, firm j's payoff decreases since it must pay a price above its willingness to pay, v_{ii}. Accordingly, firm j has no incentive to deviate. By deviating to no, firm t's payoff decreases since it foregoes a selling price above its valuation, v_t. Accordingly, firm t has no incentive to deviate and thus, b^* is a Nash equilibrium.

Let $b = (b_1, , , b_m, yes)$ be a Nash equilibrium. If $b_w \geq v_{ii}$, then firm w will have the incentive to deviate to $b' = b_w - \varepsilon$. If $b_w < v_{ii}$, then firm t will have the incentive to deviate to no, which contradicts the assumption that b is a Nash equilibrium.

Let $b = (b_1, ..., b_m, no)$ be a Nash equilibrium. Firm t will then say no iff $b_h \leq v_t$. But the incumbent $j \neq t$ will have the incentive to deviate to $b' = v_t + \varepsilon$ in stage 1 since

$v_{it} > v_t$, which contradicts the assumption that b is a Nash equilibrium.

Inequalities I5 or I6 Consider equilibrium candidate $b^* = (b_1^*, b_2^*, ..., no)$, where $b_i^* < v_t$ $\forall i \in M$. It then directly follows that no firm has an incentive to deviate and thus, b^* is a Nash equilibrium.

Then, firm t will accept a bid iff $b_i \geq v_t$. But $b_i \geq v_t$ is a weakly dominating bid in these intervals, since $v_t > \max\{v_{ii}, v_{it}\}$. Thus, the assets will not be sold in these intervals.