Tunneling and Propping: A Justification for Pyramidal Ownership*

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Abstract

One of the reasons for choosing a pyramidal ownership structure is said to be that this structure legally allows controlling shareholders to profitably shift resources from one firm to another, which is known as tunneling. In order to analyze this claim, we present a formal model of tunneling and propping (i.e. tunneling done to save the receiving firm from bankruptcy). We compare the pyramidal ownership structure to the horizontal structure, in which tunneling is not possible (illegal). We show that tunneling may indeed justify the pyramidal structure, but only in the presence of myopic investors or in combination with propping.

Keywords: Tunneling; Propping; Pyramids; Ownership Structure; Business Groups.

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1 Introduction

In a pyramidal ownership structure, where a firm is controlled through a chain of companies, the controlling shareholder often has the possibility to transfer funds from one firm to another. This practice is commonly referred to as tunneling, and as we will explain in detail below it may be highly profitable to the controlling shareholder. Several authors have suggested that this very fact is one of the reasons for choosing a pyramidal ownership structure in the first place (see e.g. Bae et al., 2002). In this paper, we analyze whether indeed tunneling can be seen as a justification for pyramidal ownership. We present a formal model of tunneling and compare the pyramidal ownership structure to the horizontal structure, in which firms are independent and tunneling is not possible.

Empirical evidence shows that firms often belong to a business group characterized by a complex ownership structure, which generally takes the form of a pyramid (La Porta et al., 1999). These firms are controlled through a chain of companies, where firm A holds part of the shares of firm B, which holds part of the shares of firm C, etc. The ultimate controlling shareholder, who is in control of firm A, and thereby of 'lower-level' firms B, C, etc., is often a wealthy family. Thus, the family uses indirect ownership to exert control over firms that belong to the same pyramidal chain. This implies that she is able to maintain control with a relatively small fraction of cash flow rights, thus creating a separation between control rights and cash flow rights. As an example, consider the Li Ka-shing conglomerate, the largest business group in Hong Kong. Li Ka-shing and family own 35% of Cheung Kong, which owns 34% of Hutchison Whampoa. In turn, Hutchison Whampoa owns 60% of Cavendish International, which owns 34% of Hong Kong Electric. The Li Ka-shing family is the ultimate controlling shareholder of Hong Kong Electric with substantial control rights but only 2.5% of cash

flow rights.[1]

The separation between control and cash flow rights in the pyramidal ownership structure gives incentives for self-dealing transactions by the controlling shareholder. That is, the controlling shareholder may find it profitable to tunnel resources from a firm in the pyramidal chain to herself or to another (often a higher-level) firm, at the expense of the minority shareholders of the former firm. Examples include asset sales, transfer pricing contracts that benefit other firms in the pyramid, and simple cash appropriation. Thus, there may be a conflict of interest between the controlling shareholder and minority shareholders. As an illustration, suppose that a family owns 50% of firm A, and firm A owns 50% of firm B. We assume that the 50% shares are controlling shares, so firm B is controlled by firm A, which is itself controlled by the family. Also, we assume for simplicity that funds are equally profitable in firms A and B, and we abstract from discounting. Denote the cash flow of firm i by π_i, $i = A, B$. The family's cash flow rights are 50% in firm A and 25% in firm B. If the family decides not to tunnel, she earns $0.5\pi_A + 0.25\pi_B$. If instead the family tunnels some amount $S > 0$ from firm B to firm A, she earns $0.5\,(\pi_A + S) + 0.25\,(\pi_B - S)$. Clearly, the latter payoff is higher than the former. Therefore, even if the per-dollar return of the funds is the same in the two firms, the family may have an incentive to tunnel. The reason is simply that the family has higher cash flow rights in the higher-level firm A, and therefore would prefer to shift firm B's cash flow to firm A whenever this is possible. Evidently, this makes the minority shareholders of firm B worse off. For a real world example of tunneling, see the next section. A specific type of tunneling which aims to save the receiving firm from bankruptcy is known as propping in the literature (Friedman et al., 2003). With propping, funds may be transferred from a lower-level to a higher-level firm as with 'ordinary' tunneling, or in the opposite direction.

[1]See Claessens et al. (2000, p. 97).

Tunneling may be illegal. However, as Johnson et al. (2000) illustrate, in many countries minority shareholders are not well protected and tunneling between firms in the same business group is often allowed by courts. This holds in particular for (French) civil-law countries, as opposed to common-law countries. In this paper, we focus on 'legal' tunneling activities. The amount of funds tunneled can then be interpreted as retained earnings, i.e. a part of profits that is retained and reinvested, albeit in another firm. The net profits after subtracting retained earnings are distributed to shareholders as dividends according to their cash flow rights. Thus, we assume that tunneling from one firm to another firm within the same group is possible (at least to some extent, limited by the legal protection of minority shareholders as well as by e.g. transaction costs), but we abstract from tunneling funds from a firm *directly* to the ultimate controlling shareholder. The latter would be similar to the family simply looting the firm's cash flow, rather than paying out dividends according to each investor's (including her own) cash flow rights.[2] For that reason, we assume that tunneling is only possible in a pyramidal structure but not in a horizontal structure.

Our results show that the possibility of tunneling may indeed be a justification for using the pyramidal ownership structure, i.e. for preferring it over the horizontal structure, but only in some cases. With rational investors, if propping is not relevant (for example because the newly established lower-level firm B is extremely unlikely to ever be in financial distress), the controlling shareholder will strictly prefer the *horizontal* structure. This is because minority investors foresee that they will be expropriated in the pyramid and adjust their willingness to pay for firm B's shares at its establishment accord-

[2]Clearly such an act can be deemed as illegal, as it is hard to justify why the controlling family seizes the entire cash flow rather than distributing it according to cash flow rights. If the family argues that the absence of dividends is due to the cash flow being retained and reinvested, investors will likely demand a disclosure of information on the use of the retained earnings, and a court case may result.

ingly. If investors are myopic and underestimate the tunneling, or if there is some probability that firm B can be saved from bankruptcy through propping, minority investors have higher willingness to pay for firm B's shares. In that case, the controlling shareholder may be better off adopting the pyramidal structure.

This overall conclusion of our model illustrates that it is important to distinguish between propping and 'ordinary' tunneling. For that reason, we will from now on use the term 'tunneling' in a narrow interpretation, not including transfers of funds to save a firm from bankruptcy (which we will continue to refer to as propping).

The remainder of this paper is structured as follows. We first discuss some related literature in Section 2. Section 3 presents the model. In Section 4 we solve the model and derive the controlling shareholder's payoffs under the two ownership structures. In Section 5 we compare these payoffs and derive the optimal ownership structure. Section 6 concludes.

2 Related literature

As we mentioned above, La Porta et al. (1999) show that firms are often part of a business group with a pyramidal ownership structure. They study the 20 largest publicly owned firms in each of the 27 wealthiest countries and conclude that controlling shareholders often have cash flow rights that are much smaller than their control rights. Claessens et al. (2000) draw similar conclusions from a data set on 2,980 listed firms in nine East Asian countries.

Pyramidal ownership structures may give rise to tunneling or propping. Several authors present real world examples of legal tunneling (see in particular Johnson et al., 2000). We only present one example[3] here: the case of Flambo

[3]For more real world examples of tunneling or propping, see Johnson et al. (2000); Bae

and Barro. Barro, a Belgian company, accused Flambo, its French controlling shareholder, of stripping Barro of its assets and trying to pledge the company as a collateral to guarantee Flambo's debt. The court decided in favor of Flambo on the basis that Flambo's conduct was in conformance with the interests of the business group as a whole. The court argued that it is legal for a subsidiary to help out its parent company as long as this does not jeopardize the financial condition of the subsidiary (Johnson et al., 2000).

Even if tunneling is considered to be legal, it usually hard to verify empirically. Bertrand et al. (2002) develop an indirect approach to measure the extent of tunneling. They track down the propagation of exogenous shocks to different firms in the pyramidal chain by looking at the cash flow movement through the pyramid. They apply their method to Indian business groups for the period 1989-1999. The results indicate that there was significant tunneling.

Despite this expropriation of minority shareholders, pyramids apparently can persist. One possible explanation for this is that minority shareholders underestimate the extent of tunneling (i.e. investors are myopic).[4] But minority shareholders of firms belonging to a pyramidal chain should at least expect that the controlling family has an incentive to expropriate some part of their cash flow rights, and investors should be reluctant to take a minority position in the firm. Even if they are willing to take a minority position, they should discount their willingness to pay accordingly. The empirical evidence on this is mixed. Based on a sample of 131 Chinese listed firms that have conducted 'related party transactions' (i.e. tunneling) Jian and Wong (2003) conclude that at least part of these transactions was anticipated by the market. But from a sample of 328 filings of connected transactions between Hong Kong publicly listed companies and their controlling shareholders during the period

et al. (2002); Friedman et al. (2003); Cheung et al. (2004); and Gopalan et al. (2004).

[4]See also Bertrand et al. (2002), and Bertrand and Mullainathan (2003).

1998-2000, Cheung et al. (2004) find only limited evidence that the market anticipated the expropriation by discounting the firms involved.

Some recent papers present theoretical analyses of tunneling and propping. Obata (2001) presents a simple model of propping which describes how the pyramidal structure allows firms to be propped up in case of financial distress if investor protection is weak. Friedman et al. (2002) also model propping, but use a dynamic model. This allows them to explicitly take into account the fact that an entrepreneur may want to save a firm from bankruptcy by propping because future earnings are valuable. In their model, propping is done by the controlling shareholder in order to revive the firm and to preserve the possibility to tunnel in the future. Both studies, however, do not consider the *establishment* of the ownership structure. That is, they show that if a pyramidal structure is present, tunneling or propping is beneficial to the controlling shareholder. But this does not necessarily imply that entrepreneurs will prefer the pyramidal structure over the horizontal structure. Therefore, the models of Friedman et al. (2002) and Obata (2001) cannot explain the choice of ownership structure.

The establishment of the ownership structure is made explicit in the model of Wolfenzon (1999). In this model operating profits consist of a verifiable part plus a non-verifiable part. Wolfenzon shows that tunneling of the non-verifiable funds directly to the ultimate controlling shareholder (as private benefits) may provide a justification for the pyramidal structure. In contrast, in this paper we abstract from tunneling funds from a firm *directly* to the ultimate controlling shareholder, since this is equivalent to looting and is generally considered illegal. Instead, we consider tunneling funds from one firm to another firm in the same pyramid. We do not need to resort to non-verifiable profits or private benefits, but consider verifiable profits only.[5]

[5]The analysis of the separation between ownership and control and its effects on agency costs by Bebchuk et al. (2000) also focuses on private benefits. With such a separation,

Almeida and Wolfenzon (2004) present related model in which private benefits play a role. They focus on the role of business groups as a substitute for poorly developed financial markets. In their model, the family owns firm A, which already generated a cash flow. When setting up firm B, the family can sell part of the new firm B in order to acquire funds to pay for the setup cost. In addition, she can use the *full* firm-A cash flow under the pyramidal structure, but only *her share* of firm A's cash flow under the horizontal structure. That is, under the pyramidal structure more funds are available ex ante, since outside investors of firm A effectively 'pay' part of the establishment of firm B. In the current paper, we do not model this role of business groups.

3 The model

Suppose that, initially, a revenue-maximizing family owns a controlling fraction α of the shares of a firm A, $0 < \alpha < 1$. At $t = 0$ the family wants to set up a second firm, firm B, either as an independent firm (horizontal structure) or as a pyramidal firm controlled by firm A (pyramidal structure). In the latter case, the family lets firm A establish firm B. Next, the two firms yield cash flows $\pi_A > 0$ and $\pi_B > 0$ for two periods, $t = 1$ and $t = 2$ – unless firm B goes bankrupt, as we will explain below. The discount factor is given by δ, $0 < \delta \leq 1$. For simplicity we assume that there is no discounting between $t = 0$ and $t = 1$, and that after $t = 2$ both firms are worthless.

The establishment of firm B requires an investment of size $I_B > 0$. We assume that the family has no initial cash available, so a fraction of firm B's equity must be sold to outside investors.[6] That is, at $t = 0$ the family not

the private benefits to the controlling shareholder will influence decision making. Bebchuk et al. show that this may result in inefficient decisions with respect to investment, scope, and transfer of control.

[6]The family may alternatively choose to sell a fraction of firm A as well. This seriously complicates our analysis and makes it impossible to compare the two structures. Therefore,

only chooses the ownership structure, but also decides which fraction of firm B to sell. We assume outside investors to be rational (unless explicitly stated otherwise). We denote by β^H the fraction of the shares of firm B held by the family in the horizontal structure, $0 < \beta^H < 1$, and by β^P the fraction of the shares of firm B held by firm A in the pyramidal structure, $0 < \beta^P < 1$. The remaining fraction of the shares of firm B is sold to outside investors in order to generate funds covering the required investment I_B. We assume that investors have an outside option that yields a net return of zero. Also, we assume that indeed the family wants to set up firm B, that is, the family's net expected revenues will be greater with firm B than without it.

At $t = 1$, the family chooses the amount of funds to be tunneled, or whether or not to prop up firm B. For tunneling and propping to be feasible, we require that α and β^P are controlling shares. That is, using the so-called weakest-link approach[7] we will focus on the case where $\min\left(\alpha, \beta^P\right) \geq w$ for some $w > 0$ which represents the smallest possible share ownership that enables a shareholder to exert control. Tunneling and propping are discussed in more detail below.

Tunneling If the pyramidal structure was chosen the family has to possibility to tunnel at $t = 1$. As we mentioned before, we assume that tunneling is possible (legal) only between firms within the same business group or pyramid, and that the family cannot tunnel funds to their own pockets directly.

If there is tunneling, i.e. if the family moves part of the cash flow of firm B to firm A, the tunneled money S is invested in a project in firm A and

we focus on the case where only shares of firm B are sold. In the other extreme case, where only shares of firm A are sold, there will be no tunneling and the horizontal structure is preferred.

[7] In many empirical studies the weakest link of ownership in the pyramidal chain is used as a measure of control rights (see La Porta et al., 1999; and Claessens et al., 2000). A lower bound for controlling shares is somewhere around 10% or 20% (see the references above, and Lemmon and Lins, 2003).

yields an additional cash flow of μS at $t = 2$ for firm A. Here, μ represents the productivity parameter of the funds reinvested, and we assume that this is the same for funds coming from firm A and firm B. We assume that $0 < \mu \leq 1/\delta$, implying that the family has no incentive to reinvest funds from firm A back into the *same* firm A. But as we will show below, for these values of the parameter μ, the controlling family may indeed have an incentive to tunnel and reinvest funds from firm B into firm A. In particular, if $\delta\mu > \beta^P$ tunneling is profitable. Since the case with tunneling is the one we are interested in, we assume this inequality to hold for the equilibrium value of β^P in our model (to be derived in the next section). With tunneling, the cash flow from firm B at $t = 1$ will be $\pi_B - S$ and the cash flow from firm A at $t = 2$ will be $\pi_A + \mu S$. These cash flows will be distributed as dividends among the firms' shareholders according to their respective equity ownership. The family chooses S in order to maximize her total revenues.

The reader should note that although we interpret the tunneling which occurs in our model as legal, this does not necessarily mean that *all* available resources in a pyramid firm can be tunneled. For example, the extent of minority shareholder protection in a country will limit the amount of resources that can be tunneled. In a more general model, legal protection could also affect the *probability* with which one can tunnel funds without being convicted (but we do not model this explicitly). Further, some assets may be hard to take away from a firm in the short run, or a firm may have strategic reasons to limit tunneling. So, we assume that tunneling is limited by legal conditions, transaction costs, and other issues (e.g. concern for reputation). We describe this using a parameter τ, which denotes the maximum fraction of firm B's cash flow π_B that can be tunneled to firm A, $0 < \tau \leq 1$. Clearly, this is a very simple approach where tunneling is costless up to some amount and infinitely costly beyond that amount, and one could think of using a different convex function (say, a quadratic one) to describe the costs of tun-

neling. However, because that seriously complicates the analysis and does not qualitatively change the results, we do not do so. For ease of exposition, we will generally refer to τ as describing legal conditions, interpreting high τ as weak legal protection of minority shareholders – but as we explained above τ may refer to other aspects as well. It can easily be verified that in our model, whenever the family finds it optimal to tunnel, she will choose to tunnel the maximum amount, so $S = \tau\pi_B$.

Propping As we mentioned above, with some probability ρ, $0 \leq \rho < 1$, firm B will be in financial distress in period 1.[8] In that case, firm B will go bankrupt unless it is propped up. We assume that limited liability prevents the controlling shareholder from earning negative profits, so in case of bankruptcy the cash flows of firm B at $t = 1, 2$ will be 0, rather than some negative amount. In the pyramidal structure the family can use part of firm A's first-period cash flow π_A to 'save' (prop up) firm B. If firm B is propped up, it still yields a cash flow of 0 at $t = 1$ (so tunneling is not possible), but it does yield $\pi_B > 0$ at $t = 2$. Note that it seems reasonable to assume that since it is possible to tunnel funds from B to A in a pyramidal structure, it is also possible to shift funds from A to B. Under normal circumstances, the family has no incentive to do this. But if firm B is in financial distress the family may find it optimal to prop firm B in order to safeguard future cash flow streams. The amount of funds needed to prop up firm B is exogenously given as $F > 0$. As in the tunneling case, we let the parameter τ limit the share of a firm's cash flow that can be used to prop up another firm. That is, at most $\tau\pi_A$ can be used to prop up B,[9] and we assume for convenience

[8] For expositional convenience we assume that firm A will never be in financial distress.

[9] It is important to note that for propping, in our model the incentives of majority and minority shareholders of firm A are aligned. Thus, legal protection may not limit propping. However, since our parameter τ can alternatively be interpreted as transaction costs, we do model the amount that can be used to prop up B as limited by τ. Ignoring

that $F \leq \tau\pi_A$.[10] After transferring the amount F to firm B, the remainder of firm A's cash flow, $\pi_A - F$, will be distributed as dividends among firm A's shareholders according to their respective equity ownership. Thus, the controlling family gets $\alpha(\pi_A - F)$ at $t = 1$.

For the horizontal structure, propping up firm B using funds from firm A is not possible. However, the controlling family of course has the legal right to use its share of the cash flow obtained from firm A, i.e. $\alpha\pi_A$. Thus, the family can use this amount to prop up B. Clearly, in this case, the quality of legal protection τ is not binding. In the horizontal structure propping will be possible only if $F \leq \alpha\pi_A$, and if propping occurs the family has a cash flow of $\alpha\pi_A - F$ at $t = 1$.

Summarizing We have a three-stage model, where in the first stage ($t = 0$) the controlling family must choose the ownership structure and set β^H or β^P in order to maximize revenues subject to the budget constraint of financing the establishment of firm B. In the second stage ($t = 1$), the family decides the amount to be tunneled from firm B to firm A (in the pyramidal structure only) or, in case of a bankruptcy threat, whether or not to prop. In the third stage ($t = 2$) the final payoffs are realized. Figure 1 summarizes the sequence of events.

— INSERT FIGURE 1 ABOUT HERE —

this (i.e., replacing τ by 1 here) would only strengthen our results.

[10] In addition to the amount $\tau\pi_A$, the family could use her own funds from dividends to prop up firm B. Note however that since using funds from firm A implies that minority shareholders of A effectively pay part of the propping, it is always more profitable to the family to use those funds first. For expositional convenience, we ignore propping with own funds *in the pyramidal structure*. Including this possibility relaxes the financing constraint, and in that sense strengthens our results (see Riyanto and Toolsema, 2005).

4 Solution of the model

In this section, we solve the model using backward induction. We start with the horizontal structure, where we distinguish two cases: first, the case where propping occurs in equilibrium when firm B is in financial distress, and second, the case where propping does not occur in equilibrium. For the pyramidal structure, we focus on the first case since propping turns out to be required for the pyramidal structure to dominate (at least with rational investors).

4.1 Horizontal structure with propping

As we argued above, in the horizontal structure propping will be possible only if the family has sufficient cash available, $F \leq \alpha\pi_A$, but for propping to actually occur in equilibrium we also require it to be efficient, i.e. $F \leq \beta^H \delta\pi_B$. If the latter condition is violated, it is not worthwhile to prop up firm B because the additional revenues from saving the firm, i.e. cash flows of $\beta^H\pi_B$ at $t = 2$, do not outweigh the cost F involved at $t = 1$. We assume for now that $F \leq \min\left\{\alpha\pi_B, \beta^H\delta\pi_B\right\}$. In that case, the family's expected revenue at $t = 0$ from the horizontal structure is given by

$$\begin{aligned}\Pi^H_{\text{prop}} &= (1-\rho)\left(\alpha\left(1+\delta\right)\pi_A + \beta^H\left(1+\delta\right)\pi_B\right) \\ &\quad +\rho\left(\alpha\left(1+\delta\right)\pi_A - F + \beta^H\delta\pi_B\right) \\ &= \alpha\left(1+\delta\right)\pi_A + \beta^H\left(1+\delta-\rho\right)\pi_B - \rho F.\end{aligned}$$

This revenue clearly is increasing in the fraction of firm B's shares owned by the controlling family, β^H. Hence, the controlling family will just sell enough shares to outside investors to satisfy the budget constraint with equality.[11]

[11] The same argument holds for the other cases we consider below.

Outside investors are willing to pay

$$(1-\rho)\left(1-\beta^H\right)(1+\delta)\,\pi_B+\rho\left(1-\beta^H\right)\delta\pi_B$$

for a fraction $1-\beta^H$ of firm B's shares at $t=0$, taking into account that firm B will be propped up in case of financial distress. The controlling shareholder thus faces the following maximization problem:

$$\begin{aligned}\max_{\beta^H}\quad & \alpha(1+\delta)\,\pi_A+\beta^H(1+\delta-\rho)\,\pi_B-\rho F\\ \text{s.t.}\quad & (1-\rho)\left(1-\beta^H\right)(1+\delta)\,\pi_B+\rho\left(1-\beta^H\right)\delta\pi_B\geq I_B.\end{aligned}$$

The value of β^H that will make the budget constraint satisfied with equality is

$$\beta^{H*}_{\text{prop}}=1-\frac{I_B}{(1+\delta-\rho)\,\pi_B},\tag{1}$$

where we use the * to denote equilibrium values.[12] Substituting (1) into the maximand yields equilibrium expected revenues

$$\Pi^{H*}_{\text{prop}}=\alpha(1+\delta)\,\pi_A+(1+\delta-\rho)\,\pi_B-\rho F-I_B.\tag{2}$$

4.2 Horizontal structure without propping

Now suppose that $F>\min\left\{\alpha\pi_B,\beta^H\delta\pi_B\right\}$, so propping does not occur under the horizontal structure. The family's expected revenue at $t=0$ is then given by

$$\begin{aligned}\Pi^H_{\text{no prop}} &= (1-\rho)\left(\alpha(1+\delta)\,\pi_A+\beta^H(1+\delta)\,\pi_B\right)+\rho\alpha(1+\delta)\,\pi_A\\ &= \alpha(1+\delta)\,\pi_A+\beta^H(1-\rho)(1+\delta)\,\pi_B.\end{aligned}$$

[12] We assume that the family's expected revenues with firm B exceed those without it. For the case under consideration here, this condition can be rewritten into $\alpha(1+\delta)\,\pi_A+\beta^{H*}_{\text{prop}}(1+\delta-\rho)\,\pi_B-\rho F\geq\alpha(1+\delta)\,\pi_A$, which can be simplified into $(1+\delta-\rho)\,\pi_B-\rho F\geq I_B$.

Outside investors are willing to pay an amount

$$(1-\rho)\left(1-\beta^H\right)(1+\delta)\,\pi_B$$

for a fraction $1-\beta^H$ of the shares of firm B. The controlling shareholder thus faces the following maximization problem:

$$\begin{aligned}\max_{\beta^H} \quad & \alpha\,(1+\delta)\,\pi_A+\beta^H\,(1-\rho)\,(1+\delta)\,\pi_B\\ \text{s.t.} \quad & (1-\rho)\left(1-\beta^H\right)(1+\delta)\,\pi_B\geq I_B.\end{aligned}$$

The value of β^H that will make the budget constraint under the horizontal structure satisfied with equality is

$$\beta^{H*}_{\text{no prop}}=1-\frac{I_B}{(1-\rho)\,(1+\delta)\,\pi_B}. \tag{3}$$

Note that $\beta^{H*}_{\text{no prop}}$ is smaller than β^{H*}_{prop}. Since outside investors are willing to pay less per share (because now firm B will not be saved in case of financial distress) a larger part of firm B needs to be sold to obtain the required amount I_B.[13] Using (3) equilibrium expected revenues are

$$\Pi^{H*}_{\text{no prop}}=\alpha\,(1+\delta)\,\pi_A+(1-\rho)\,(1+\delta)\,\pi_B-I_B. \tag{4}$$

4.3 Pyramidal structure

Now we turn to the pyramidal structure. It can easily be verified that tunneling is profitable if and only if $\delta\mu>\beta^P$, which we assume to hold in the equilibrium derived below,[14] and that whenever tunneling is profitable it is optimal for the family to tunnel the maximum amount $S^*=\tau\pi_B$. We also assume that there is sufficient cash available to prop up firm B when it is in financial distress, so $F\leq\tau\pi_A$. But for propping to be efficient, we also

[13] The condition for the family's expected revenues with firm B to exceed those without it can be written as $(1-\rho)\,(1+\delta)\,\pi_B\geq I_B$.

[14] This assumption allows us to focus on interior solutions for expositional convenience.

require $F \leq \beta^P \delta \pi_B$ in equilibrium. Since it turns out that the pyramidal structure may only be preferred over the horizontal structure if it allows for propping (see the next section), we focus on this case and assume propping to be efficient in the equilibrium derived below.[15] Then at $t = 0$ the family's expected revenue is

$$\begin{aligned}\Pi^P &= (1-\rho)\left(\alpha(1+\delta)\pi_A + \alpha\beta^P(1+\delta)\pi_B + \alpha\left(\delta\mu - \beta^P\right)\tau\pi_B\right) \\ &\quad +\rho\left(\alpha\left((1+\delta)\pi_A - F\right) + \alpha\beta^P\delta\pi_B\right) \\ &= \alpha(1+\delta)\pi_A + \alpha\beta^P(1+\delta-\rho)\pi_B + (1-\rho)\alpha\left(\delta\mu - \beta^P\right)\tau\pi_B - \rho\alpha F.\end{aligned}$$

With respect to propping, the difference between this case and the horizontal structure is that now F is multiplied by $\alpha < 1$. That is, the outside investors of firm A carry part of the burden of propping up B. Outside investors are willing to pay

$$(1-\rho)\left(1-\beta^P\right)(1+\delta-\tau)\pi_B + \rho\left(1-\beta^P\right)\delta\pi_B \tag{5}$$

for a fraction $1-\beta^P$ of firm B. Rational investors discern the extent of tunneling and take it into account in their investment decision. This lowers the amount of money that can be raised by the family. The family thus faces the following maximization problem:

$$\begin{aligned}\max_{\beta^P} \quad & \alpha(1+\delta)\pi_A + \alpha\beta^P(1+\delta-\rho)\pi_B + (1-\rho)\alpha\left(\delta\mu - \beta^P\right)\tau\pi_B - \rho\alpha F \\ \text{s.t.} \quad & (1-\rho)\left(1-\beta^P\right)(1+\delta-\tau)\pi_B + \rho\left(1-\beta^P\right)\delta\pi_B \geq I_B.\end{aligned}$$

The value of β^P that will make the budget constraint satisfied with equality is

$$\beta^{P*} = 1 - \frac{I_B}{(1+\delta-\rho-(1-\rho)\tau)\pi_B}. \tag{6}$$

[15] Again, this allows us to focus on interior solutions.

Finally, using (6), equilibrium payoffs under the pyramidal structure[16] can be rewritten as

$$\Pi^{P*} = \alpha\left(1+\delta\right)\pi_A + \left(1+\delta-\rho-\left(1-\rho\right)\left(1-\delta\mu\right)\tau\right)\alpha\pi_B - \rho\alpha F - \alpha I_B. \tag{7}$$

5 Explaining ownership structure

In this section we study the choice of ownership at $t = 0$ in more detail. The aim of the exercise is to find out whether tunneling (and propping) may provide a justification for selecting the pyramidal ownership structure. First, we consider the general model in which both tunneling and propping may occur in equilibrium. Second, we analyze the case with tunneling only (no propping).

Tunneling and propping First consider the case in which the parameters of the model are such that propping occurs both in the horizontal structure and in the pyramidal structure. Thus, we assume that $F \leq \min\left\{\alpha\pi_A, \beta^{H*}_{\text{prop}}\delta\pi_B\right\}$ and $F \leq \min\left\{\tau\pi_A, \beta^{P*}\delta\pi_B\right\}$.[17] In order to derive the optimal ownership structure we compare the family's revenues under the two structures.

Proposition 1 *In our model, if propping occurs in both structures, then the pyramidal structure can never be strictly preferred over the horizontal structure.*

Proof. See appendix. ■

[16] The condition for the family's expected revenues with firm B to exceed those without it can be written as $\left(1+\delta-\rho-\left(1-\rho\right)\left(1-\delta\mu\right)\tau\right)\pi_B - \rho F \geq I_B$.

[17] We abstract from corner solutions, in which the equilibrium value of β does not satisfy the expressions for β^* as derived above.

Thus, if the parameters of the model are such that propping would occur in equilibrium with either structure, then the pyramidal structure is never optimal. Although to the family propping up firm B is cheaper in the pyramidal structure (since outside investors share in the burden) the main difference between the two structures to outside investors is the tunneling. They take this into account in their investment decision and adjust their willingness to pay for firm B's shares accordingly. From the family's point of view, this negative effect turns out to dominate, and the pyramidal structure cannot yield higher revenues to the family than the horizontal structure does.

Now suppose that propping is not feasible in the horizontal structure because the family's cash flow from firm A is insufficient, i.e. $F > \alpha\pi_A$.[18] We continue to assume that propping is possible in the pyramidal structure, that is, $F \leq \min\left\{\tau\pi_A, \beta^{P*}\delta\pi_B\right\}$.[19]

Proposition 2 *In our model, if propping occurs only in the pyramidal structure but not in the horizontal structure, then the pyramidal structure can be strictly preferred over the horizontal structure.*

Proof. See appendix. ■

In this case, the pyramidal structure yields a benefit to outside investors: firm B can be saved from bankruptcy. This acts as a kind of insurance, and investors are willing to pay a premium for it. Alternatively, one could say

[18] Alternatively, we could assume that propping in the horizontal structure is feasible but not efficient from the point of view of the family, i.e. $\beta^{H*}_{\text{prop}}\delta\pi_B < F \leq \alpha\pi_A$. However, to analyze this situation in detail we would have to study corner solutions. We abstract from this.

[19] More generally, in the pyramidal structure the family can also use her own funds, so in total there is $\tau\pi_A + \alpha(1-\tau)\pi_A = \alpha\pi_A + (1-\alpha)\tau\pi_A$ available for propping up firm B. Clearly, this exceeds the amount available in the horizontal structure, $\alpha\pi_A$. Whenever propping is feasible in the horizontal structure, it is so too in the pyramidal structure. Note however that this does not necessarily mean that propping is efficient as well. (See also Riyanto and Toolsema, 2004.)

that outside investors are now willing to be expropriated to some extent via tunneling in exchange for a larger probability of realizing positive returns from their investment in the future. From the point of view of the controlling family, in this case, the pyramidal structure may indeed be optimal (depending on parameter values).

Tunneling only The above analysis suggests that the role of propping is important in determining which structure is the optimal one. In order to verify this, we now consider a version of our model in which there is no propping at all, setting $\rho = 0$, and ask whether tunneling alone can provide a justification for pyramidal ownership.

Proposition 3 *In our model with tunneling only ($\rho = 0$) the pyramidal structure can never be strictly preferred over the horizontal structure.*

Proof. See appendix. ■

This proposition shows that in our model tunneling cannot be the sole reason for the controlling family to choose the pyramidal ownership structure. Again, this is due to the fact that rational outside investors of firm B anticipate that they will be expropriated through tunneling and adjust their willingness to pay (5) for firm B's shares (as suggested by Bertrand, Mehta, and Mullainathan, 2002, p. 146). From the point of view of the controlling family, this effect dominates the benefit of tunneling, and the horizontal structure is preferred.

If outside investors underestimate the extent of tunneling by the controlling family (i.e. if they use some $\tau' < \tau$ in their calculations) then it can be shown that under some conditions the pyramidal structure can indeed be optimal. Consider the following modification of the model. Suppose that investors are myopic. For simplicity, we assume that investors completely ignore the

possibility of tunneling, that is, they believe that the amount tunneled is $\tau' = 0$. We can rewrite the maximization problem of the controlling family as

$$\max_{\beta^P} \ \alpha(1+\delta)\pi_A + \alpha\beta^P(1+\delta)\pi_B + \alpha\left(\delta\mu - \beta^P\right)\tau\pi_B$$
$$\text{s.t.} \quad \left(1-\beta^P\right)(1+\delta)\pi_B \geq I_B.$$

The value of β^P that will make the budget constraint satisfied with equality is

$$\beta^{P*}_{\text{myopic}} = 1 - \frac{I_B}{(1+\delta)\pi_B}. \tag{8}$$

Using(8), equilibrium payoffs[20] can be rewritten as

$$\Pi^{P*}_{\text{myopic}} = \alpha(1+\delta)\pi_A + \alpha(1+\delta-(1-\delta\mu)\tau)\pi_B - \frac{1+\delta-\tau}{1+\delta}\alpha I_B. \tag{9}$$

Comparing this revenue to that of the horizontal structure (with $\rho = 0$), we can establish the following proposition.

Proposition 4 *In our model with tunneling only ($\rho = 0$), if investors are myopic and do not take tunneling into account in their investment decision, then the pyramidal structure can be strictly preferred over the horizontal structure.*

Proof. See appendix. ■

Thus, tunneling alone may lead to the pyramidal structure being optimal only if investors do not (fully) realize the extent of tunneling, that is, if investors are myopic. Admittedly, in the above analysis we have used an extreme assumption - that investors do not take tunneling into account at all. This contradicts 'the stock price evidence [...] which suggests that markets at

[20] The condition for the family's expected revenues with firm B to exceed those without it can now be written as $\frac{1+\delta}{1+\delta-\tau}(1+\delta-(1-\delta\mu)\tau)\pi_B \geq I_B$.

least partly understand the extent of tunneling' (Bertrand and Mullainathan, 2003, p. 481). However, it can easily be verified that the result continues to hold if investors do realize that there will be tunneling, but underestimate the extent of it.

6 Conclusion

The aim of this paper is to investigate whether or not tunneling can justify the existence of pyramidal ownership structures. With tunneling, a controlling shareholder shifts funds from one firm to another firm in which the shareholder has greater cash flow rights. Clearly, this is a profitable action for the shareholder. It is sometimes argued that this could be a reason for selecting a pyramidal ownership structure in the first place. In order to investigate this issue we developed a model of tunneling and asked whether a controlling family would prefer to establish a new firm through pyramidal or horizontal ownership. In doing so, we focused on legal tunneling, that is, shifting funds from one firm to another firm in the same pyramid or business group (see Johnson et al., 2000). Thus, in our model tunneling is possible (legal) only in the pyramidal structure but not in the horizontal structure, in which firms are independent.

We showed that tunneling alone cannot make pyramidal ownership optimal for the family. The reason is that rational minority investors of the new lower-level firm, called firm B, will take the tunneling into account in their investment decision and adjust their willingness to pay for the firm's shares. However, we also showed that if investors are myopic and underestimate the degree of tunneling, then the pyramidal ownership structure may be optimal.

There is another closely related phenomenon that plays a role in the choice of ownership structure. Suppose that the new firm B may be in financial distress

with some probability, but it can be saved from bankruptcy by injecting some amount of funds. In the horizontal structure, the family can use only her own funds for propping up the new firm, whereas in the pyramidal structure a greater share of the cash flow of the old, higher-level firm, firm A, can be used. That is, depending on parameter values it may be the case that the pyramidal ownership structure yields a benefit that the horizontal structure does not have: it may insure the outside investors against bankruptcy. As we showed, the possibility of propping may raise the investors' willingness to pay by so much that indeed the pyramidal structure becomes optimal from the family's point of view.

In our model we related the choice of ownership structure to tunneling and propping, and thereby to the parameter τ which can be described as the ease with which funds can be shifted from one firm to another. In studies of tunneling, this is commonly interpreted as referring to legal conditions (in particular the protection of minority shareholders), but other issues like transaction costs also play a role. For empirical applications the interpretation of τ as legal conditions is most relevant, and some authors have tried to link the prevalence of pyramidal ownership to indicators of minority shareholder protection. For example, La Porta et al. (1999) argue that pyramidal ownership occurs more in countries with weak legal protection. This suggests that pyramidal ownership is associated with high values of τ. Indeed it can be verified that in our model the pyramidal structure will never arise for very low τ, i.e. very strong legal protection. Depending on the precise values of the parameters of the model, the pyramidal structure may occur for high and/or intermediate values of τ.[21] In fact, high values of τ may (for some parameter values) imply that in the pyramidal structure the family's

[21] This can be observed from the model by considering in (τ, F)-space the feasible area determined by $F \leq \min\left\{\tau\pi_A, \beta^{P*}\delta\pi_B\right\}$ and $F > \min\left\{\alpha\pi_A, \beta^{H*}_{\text{no prop}}\delta\pi_B\right\}$. See also the numerical example in the proof of Proposition 2.

cash flow right in the new firm B is so small that propping up the firm is not desirable. In that case, with rational investors, since propping is precisely the benefit from the pyramidal structure to outside investors which is required to make this structure optimal from the family's point of view, the family will prefer the horizontal structure instead.

In our analysis we abstracted from the possibility that the old firm A itself may go bankrupt. Our model could be extended by adding a positive probability for this firm to be in financial distress and to go bankrupt unless it is propped up. However, we do not expect this to affect our qualitative results. In our current setup, in the pyramidal structure funds will be tunneled from the lower-level firm B to the old, higher-level firm A for some parameter values. By introducing the possibility of bankruptcy of firm A, funds will move in this direction for a wider range of parameters.

With respect to the amount of money that is needed to prop up a firm in case of financial distress, we focused on an exogenously given amount. However, in general this amount will not be given but rather follow some probability distribution function. In that case, our result will continue to hold, provided that the probability of being in the relevant interval is sufficiently large.

Summarizing, we showed that tunneling alone will not result in the pyramidal structure being optimal, unless outside investors are myopic and underestimate the extent to which they will be expropriated. But the pyramidal structure may be optimal in the presence of propping (provided that propping occurs in equilibrium only with the pyramidal structure, not with the horizontal structure), even if outside investors are fully rational. These results illustrate that the common wisdom that tunneling provides a justification for pyramidal ownership should be interpreted with care.

Appendix

Proof of Proposition 1

With propping in both structures, the pyramidal structure is strictly preferred over the horizontal structure if and only if $\Delta = \Pi^{P*} - \Pi^{H*}_{\text{prop}} > 0$. Using (2) and (7) this can be expressed as

$$\begin{aligned} \Delta &= (1-\alpha) I_B + (1-\alpha) \rho F \\ &- (1-\alpha)(1+\delta-\rho)\pi_B - \alpha(1-\rho)(1-\delta\mu)\tau\pi_B > 0 \end{aligned}$$

or

$$(1+\delta-\rho)\pi_B + \frac{\alpha}{1-\alpha}(1-\rho)(1-\delta\mu)\tau\pi_B - \rho F < I_B.$$

For the family's expected revenues with firm B to exceed those without it we require the feasibility conditions

$$\begin{aligned} (1+\delta-\rho)\pi_B - \rho F &\geq I_B, \\ (1+\delta-\rho)\pi_B - (1-\rho)(1-\delta\mu)\tau\pi_B - \rho F &\geq I_B. \end{aligned}$$

Since the latter condition (for the pyramidal structure) is stricter than the former (for the horizontal structure), we can focus on the latter. Thus, the pyramidal structure is strictly preferred over the horizontal structure when both this condition and the condition $\Delta > 0$ hold. For these two conditions to be satisfied simultaneously we require

$$\begin{aligned} & (1+\delta-\rho)\pi_B + \frac{\alpha}{1-\alpha}(1-\rho)(1-\delta\mu)\tau\pi_B - \rho F \\ < \; & (1+\delta-\rho)\pi_B - (1-\rho)(1-\delta\mu)\tau\pi_B - \rho F, \end{aligned}$$

that is, $\frac{\alpha}{1-\alpha} < -1$. Since $0 < \alpha < 1$ this can never be satisfied.

Proof of Proposition 2

With propping in the pyramidal structure only, the pyramidal structure is strictly preferred over the horizontal structure if and only if $\Delta = \Pi^{P*} - \Pi^{H*}_{\text{no prop}} > 0$. Using (4) and (7) this can be expressed as

$$\begin{aligned} \Delta &= (1-\alpha) I_B - \rho\alpha F - (1-\alpha)(1+\delta-\rho)\pi_B \\ &+ \rho\delta\pi_B - \alpha(1-\rho)(1-\delta\mu)\tau\pi_B > 0 \end{aligned}$$

or

$$(1+\delta-\rho)\pi_B - \frac{1}{1-\alpha}\rho\delta\pi_B + \frac{\alpha}{1-\alpha}(1-\rho)(1-\delta\mu)\tau\pi_B + \frac{\alpha}{1-\alpha}\rho F < I_B.$$

For the family's expected revenues with firm B to exceed those without it we require the feasibility conditions

$$\begin{aligned} (1-\rho)(1+\delta)\pi_B &\geq I_B, \\ (1+\delta-\rho)\pi_B - (1-\rho)(1-\delta\mu)\tau\pi_B - \rho F &\geq I_B. \end{aligned}$$

It is not clear beforehand which condition is more restrictive. Therefore, we consider two cases.

First suppose that the *first* feasibility condition (for the horizontal structure) is more restrictive. In that case, for some parameter values setting up firm B is feasible only in the pyramidal structure, so the pyramidal structure is clearly preferred. Now consider parameter values for which the first feasibility condition is satisfied as well. Then the pyramidal structure is strictly preferred over the horizontal structure when both this condition and the condition $\Delta > 0$ hold. This requires

$$\begin{aligned} & (1+\delta-\rho)\pi_B - \frac{1}{1-\alpha}\rho\delta\pi_B + \frac{\alpha}{1-\alpha}(1-\rho)(1-\delta\mu)\tau\pi_B + \frac{\alpha}{1-\alpha}\rho F \\ < \; & (1-\rho)(1+\delta)\pi_B, \end{aligned}$$

which can be rewritten as

$$(1-\rho)(1-\delta\mu)\tau\pi_B - \rho\delta\pi_B + \rho F < 0. \tag{10}$$

It can easily be verified that the condition for the first feasibility constraint to be more strict than the second reduces to precisely this expression. That is, whenever the first feasibility condition is more strict, this expression holds true, and this suggests that the pyramidal structure may dominate.

Second, assume that the *second* feasibility condition (for the pyramidal structure) is more restrictive. Then the pyramidal structure is strictly preferred over the horizontal structure when both this condition and the condition $\Delta > 0$ hold. This requires

$$\begin{aligned} & (1+\delta-\rho)\pi_B - \frac{1}{1-\alpha}\rho\delta\pi_B + \frac{\alpha}{1-\alpha}(1-\rho)(1-\delta\mu)\tau\pi_B + \frac{\alpha}{1-\alpha}\rho F \\ < \; & (1+\delta-\rho)\pi_B - (1-\rho)(1-\delta\mu)\tau\pi_B - \rho F, \end{aligned}$$

which can be simplified into (10). Thus, if the second feasibility condition is more restrictive the pyramidal structure can never be preferred over the horizontal structure.

Combining, this suggests that the pyramidal structure may dominate in this situation if and only if the first feasibility condition is more restrictive than the second, that is, if (10) holds. Of course, before concluding that the pyramidal structure may indeed be optimal for some parameter values, one should also check the conditions for propping to occur in the pyramidal structure but not in the horizontal structure, that is, $\alpha\pi_A < F \leq \min\left\{\tau\pi_A, \beta^{P*}\delta\pi_B\right\}$. We illustrate this by presenting a numerical example. Let $\delta = \mu = \tau = 1$, $\rho = 0.5$, $\alpha = 0.8$, $\pi_A = 7$, $\pi_B = 10$, $I_B = 4$, and $F = 6$. It can easily be verified that (10) is satisfied for these parameter values, and so are the feasibility conditions and the condition $\alpha\pi_A < F \leq \min\left\{\tau\pi_A, \beta^{P*}\delta\pi_B\right\}$, where $\beta^{P*} = 0.6$ now. Finally, we have $\Delta = \frac{2}{5} > 0$. Thus, indeed, in this example

setting up firm B is feasible in either structure, propping will occur only in the pyramidal structure, and the pyramidal structure is optimal.

Proof of Proposition 3

With tunneling only ($\rho = 0$), the pyramidal structure is strictly preferred over the horizontal structure if and only if $\Delta = \Pi^{P*} - \Pi^{H*}_{\text{no prop}} > 0$, substituting $\rho = 0$. Using (4) and (7) this can be expressed as

$$\Delta = (1-\alpha)\, I_B - (1-\alpha)\,(1+\delta)\,\pi_B - \alpha\,(1-\delta\mu)\,\tau\pi_B > 0$$

or

$$(1+\delta)\,\pi_B + \frac{\alpha}{1-\alpha}\,(1-\delta\mu)\,\tau\pi_B < I_B.$$

For the family's expected revenues with firm B to exceed those without it we require the feasibility conditions

$$\begin{aligned} (1+\delta)\,\pi_B &\geq I_B, \\ (1+\delta-(1-\delta\mu)\,\tau)\,\pi_B &\geq I_B. \end{aligned}$$

Since the latter condition (for the pyramidal structure) is stricter than the former (for the horizontal structure), we can focus on the latter. Thus, the pyramidal structure is strictly preferred over the horizontal structure when both this condition and the condition $\Delta > 0$ hold. For these two conditions to be satisfied simultaneously we require

$$(1+\delta)\,\pi_B + \frac{\alpha}{1-\alpha}\,(1-\delta\mu)\,\tau\pi_B < (1+\delta)\,\pi_B - (1-\delta\mu)\,\tau\pi_B,$$

that is, $\frac{\alpha}{1-\alpha} < -1$. Since $0 < \alpha < 1$ this can never be satisfied.

Proof of Proposition 4

With tunneling only ($\rho = 0$) and myopic investors who do not take tunneling into account, the pyramidal structure is strictly preferred over the horizontal structure if and only if $\Delta = \Pi^{P*}_{\text{myopic}} - \Pi^{H*}_{\text{no prop}} > 0$, substituting $\rho = 0$. Using (4) and (9) this can be expressed as

$$\Delta = \left(1 - \frac{1+\delta-\tau}{1+\delta}\alpha\right) I_B - (1-\alpha)(1+\delta)\pi_B - (1-\delta\mu)\alpha\tau\pi_B > 0,$$

or

$$(1+\delta)\left(1 - \frac{\alpha\tau\delta\mu}{(1+\delta)(1-\alpha)+\alpha\tau}\right)\pi_B < I_B.$$

For the family's expected revenues with firm B to exceed those without it we require the feasibility conditions

$$\begin{aligned} (1+\delta)\pi_B &\geq I_B, \\ \frac{1+\delta}{1+\delta-\tau}(1+\delta-(1-\delta\mu)\tau)\pi_B &\geq I_B. \end{aligned}$$

It can be verified that the former condition (for the horizontal structure) is stricter than the latter (for the pyramidal structure). For some parameter values setting up firm B is feasible only in the pyramidal structure, so the pyramidal structure is clearly preferred. Now consider parameter values for which the first feasibility condition is satisfied as well. Then the pyramidal structure is strictly preferred over the horizontal condition when both this condition and the condition $\Delta > 0$ hold. For these two conditions to be satisfied simultaneously, we require

$$(1+\delta)\left(1 - \frac{\alpha\tau\delta\mu}{(1+\delta)(1-\alpha)+\alpha\tau}\right)\pi_B < (1+\delta)\pi_B,$$

that is $\frac{\alpha\tau\delta\mu}{(1+\delta)(1-\alpha)+\alpha\tau} > 0$. This condition is satisfied for all feasible values of α, τ, δ, and μ. Thus, the pyramidal structure is optimal for some parameter values.

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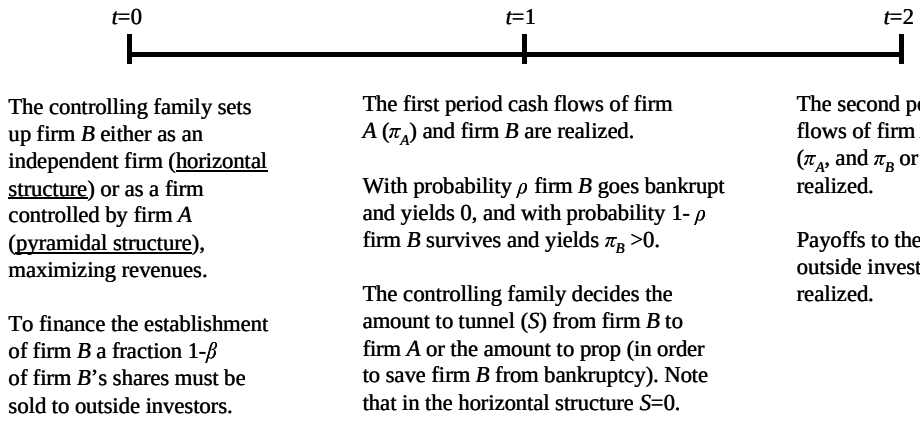

Figure 1: Timing.