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Chapter I

Introduction

Most corporations face one fundamental challenge: Corporate insiders take investment decisions, but may pursue objectives different to those that provide funding. Funding the corporation can be viewed as a nexus of financing contracts between these groups of decision makers. These financing contracts can be designed to mitigate the problems that result from the separation of investment and financing decisions. However, designing financing contracts as a response to these problems is only indicated if the counterparties in fact each take advantage of the chances they have to pursue their own interests. Hardly any study even considers the converse case, namely that the counterparties trust each other and deliberately act trustworthily.

My first research objective is to distinguish between environments in which corporate decision makers show high levels of mutual trust and environments with low levels of trust. I can show that the separation of investment and financing decisions determines the design of financing contracts in countries that are culturally characterized by low trust. In contrast, this separation plays only a subordinate role in countries of high trust. From these results, I conclude that trust—as an aspect of the cultural tradition of a country—shapes corporate financial structures.

Consequently, ignoring trust can lead to misinterpretations of the observed financial structures. More serious than just misinterpretations are subsequent misleading recommendations on the design of financing contracts: On the premise of distrust, the appropriate advice to the providers of capital may be to control the investment decisions by corporate insiders. Tight control, in turn, prevents trust from rising. Therefore, this recommendation may end up self-fulfilling the premise of distrust, and prevents trust from unfolding its benefits. My second research objective is to explore in detail the conditions under which shareholders optimally provide managers with large amounts of cash, based on mutual trust. I show that trust excels in the long run.

The idea of viewing corporate funding as a nexus of financing contracts leads over to my third research objective. Corporations devote a lot of time to the design of these contracts, which may indicate by its own the importance to study how corporate funding is provided. More fundamental is the closely related question of whether funding is provided at all. This question puts real economic activity at stake.

My third research objective is to examine the link between corporate financing contracts and the level of real economic activity. In studying this link, I acknowledge that country-specific financial systems set the framework both for the design of specific forms of financing contracts and for the amount of financing made available to corporations. On the other hand, both the needs for the specific form and for the amount of financing are—at least partly—dictated by industry necessities. Therefore, I analyze the impact of country-level financial systems on industry growth rates.

These three research objectives are addressed in three self-contained chapters.

Chapter 2 deals with the question why the corporate choice of capital structure widely differs across European countries. According to my results, an important piece in this "capital structure puzzle" is trust.

Theoretical and empirical studies so far have identified two categories as determinants of corporate capital structure, numerous firm characteristics (such as firm size or collateral value of assets), and some country-level characteristics (such as legal rights of investors). However, the identification of country-level characteristics is still in its infancy. The traditional determinants do not bring light to all aspects of that puzzle. I deem trust as a major key to the understanding of cross-country differences in capital structure: The level of trust can—in part—identify which traditional determinants are predominant for a particular country.

Broadly accepted determinants are, among others, derived from theories that perceive the choice of capital structure as an optimal response to agency problems and problems of asymmetric information. These determinants rely on the assumption that the parties choosing the corporate financial structure operate in an environment of low trust. At the same time, there is the empirical observation that certain countries experience higher levels of trust than others. Consequently, it is doubtful to what extent these characteristics also dominate in countries with high levels of trust.

I conduct an empirical analysis based on a large sample of listed and unlisted firms across 24 European countries. Complementarily, I use survey data on the levels of trust within these countries. I find empirical evidence that the determinants related to agency problems and problems of asymmetric information are only of subordinate importance in countries that are culturally characterized by high levels of trust. These results encourage the conclusion that trust is a missing link between the established theories and the puzzling cross-country differences in capital structure.

Chapter 3 is motivated by two—prima facie inconsistent—observations regarding corporate cash holdings: In the context of company valuation, corporate cash holdings tend to have a negative marginal contribution to firm value as they are supposedly wasted to some extent. Yet, there is still a considerable number of firms with inexplicably high amounts of cash on their balance sheets. Observing both phenomena at the same time is striking. It can be rationalized by a model, though, which is set up in chapter 3. The analysis of this model allows the conclusion that the value of corporate cash holdings depends on the time horizon of the manager's directing the firm. In addition and in contrast to previous studies, I show that large cash holdings—even with negative marginal contribution to firm value—can be optimal if there is mutual trust between a shareholder and a manager.

The one-period version of my model confirms the "traditional view" that a shareholder has essentially two options if financing with standard debt contracts is not available: either restraining the cash at the manager's discretion or controlling the manager's investment decision. The main new insight of my model is that mutual trust can substitute for corporate control. In a long-term shareholder-manager relationship, entrusting large amounts of cash to the manager is to the shareholder's best advantage. Even if a part of these cash holdings is wasted, trust outperforms control mechanisms that are costly to implement.

Therefore, control may be good, but trust can even be better. The "traditional recommendation" to either restrain cash or control the manager's investment decision is incomplete: Control can destroy trust and, hence, even decrease firm value.

Chapter 4 analyzes the idea that a financial system promotes economic growth by reallocating capital to industries where it can be used more productively (so-called capital reallocation hypothesis). My analysis originates from discordance between two traditional attempts to operationalize this idea. The discordance consists in the ways to identify industries that benefit from a financial system: on the one hand, any industry with positive growth opportunities; on the other hand, only industries that—for technological reasons—depend on external financing. There is empirical support for both ways, but any endeavor to bring them in accordance has failed. This study establishes a link between both approaches.

For this purpose, I develop a model that links findings from the microeconomic literature on corporate financing to the macroeconomic literature on economic growth. The basis for this model is the corporate choice to finance growth opportunities either by internal or by external sources. I assume that shareholders cannot perfectly control the managers' investment decisions, thereby making internal financing difficult. The ease of external financing, on the other hand, depends on the development of the financial system in the respective economy.

The analysis yields the conclusion that both approaches to the capital reallocation hypothesis implicitly confine themselves to different financing needs: on the one hand, short-term financing of temporary and stochastic growth opportunities at a steady-state in an industry growth cycle; on the other hand, long-term financing of persistent and deterministic growth opportunities at an early stage in an industry growth cycle.

My theoretical analysis provides the foundation for formulating separate empirical tests of the two attempts to operationalize the capital reallocation hypothesis. Only separate tests reveal the mechanisms through which a financial system can promote economic growth. Detailed insights into these mechanisms are crucial to anyone who takes actions of financial development. Only those that are aware which facets of a financial system foster growth in which type of industry can go for the path to sustained economic growth in the future. Advances in the details that connect financial development to economic growth will likely even gain in importance in the future: Increasing international integration of financial systems will likely change the relative importance of the channels through which a national financial system can promote national economic growth.

Chapter II

Does Culture Explain Cross-Country Differences in Capital Structures? An Empirical Study of the Impact of Trust on the Corporate Choice of Capital Structure Across European Countries

1 Introduction

The empirical literature has identified striking differences in the use of debt and equity financing in different countries. Firms in Italy, for instance, are reluctant to use equity. Firms in France, the Netherlands, and Belgium use moderate leverage, while firms in the U.K. use low leverage (De Bondt, 1998). Such well-known discrepancies in capital structures appear as well among the 24 Western and Eastern European countries investigated in this study: average levels of leverage differ considerably across countries (the standard deviation is 24% and Italy has the highest leverage). Even though these stylized facts have been widely known for a long time, a convincing theoretical explanation with supporting empirical evidence is still missing.

In this paper, I propose that a missing piece in this puzzle is trust. I define trust as the prior belief that in a relationship one party is cooperative because it expects a certain fairness and cooperation from the other even in a one-time event (cf. La Porta et al., 1997). Survey evidence shows that trust differs systematically across countries. Part of these differences can be explained by persistent cultural attributes, such as religious attitudes. In accordance with Guiso, Sapienza, and Zingales (2006), p. 23, I define culture as "customary beliefs and values".[1] I find that differences in the levels of trust explain in part why firms across Europe decide on capital structure so differently. My results indicate that firms choose significantly lower levels of leverage in countries with high trust (the so-called level effect). In addition, trust affects the way in which certain firm characteristics influence leverage: There are studies documenting that agency problems and problems of asymmetric information drive the corporate choice of capital structure. There is also empirical literature that recognizes to what extent a particular firm exhibits such problems. However, the results of these studies are incomplete without reference to trust. I discover that firm characteristics related to these problems have a weaker impact on capital structure in countries with high trust as compared to countries with low trust (the so-called correlation effect).

These conclusions result from analyzing a large sample of listed and unlisted firms from the AMADEUS database. Complementarily, I use data on the levels of trust across countries that has been collected by the World Value Studies.

I ascribe the leverage of an individual firm to those firm characteristics that the literature on corporate capital structure has related to agency problems or problems of asymmetric information, such as firm age, the proportion of intangible assets, growth opportunities, and profitability. In addition, I test the impact of the interactions between these firm characteristics and the level of trust that prevails

[1] In contrast to Guiso, Sapienza, and Zingales (2006), p. 23, I do not refer merely to those beliefs and values "that ethnic, religious, and social groups transmit fairly unchanged from generation to generation." This latter restriction, I indicate as the persistent component of beliefs and values.

in the country in which the respective firm is located. The results show that trust influences the level of leverage (level effect). In addition, trust affects the way in which certain firm characteristics influence leverage (correlation effect).

In order to show the level effect, I estimate firm-fixed effects in a regression of leverage on a selection of firm characteristics and treat them as a kind of core leverage for the firm. This core leverage is statistically significantly lower, by 1.96 percentage points, if the level of trust in the respective country increases by one standard deviation, which, for example, is equivalent to the difference in trust-levels between Portugal with 17% and Bulgaria with 31%. The correlation effect of trust is mirrored in the interactions between relevant firm characteristics and trust. For instance, in most countries older firms show lower leverage because they are able to substitute (debt-like) external funds with (equity-like) internal funds. If trust reduces the costs of external financing, these firms have a smaller incentive to use internal funds. An increase in firm age and trust by one standard deviation has a joint effect of 2.06 percentage points on firm leverage. The interactions between trust and other relevant firm characteristics (intangible assets, growth opportunities, profitability) as well have a statistically significant impact on leverage with the predicted signs.

My results are robust to controls for other factors of influence, such as legal or financial institutions in a particular country. Even if I control for measures of the degree of financial development in a country, measures of creditor protection along with contract enforceability, inflation, gross domestic product, and corporate tax rates, the impact of trust on the core leverage of a firm, as well as the impact of trust on the way in which certain firm characteristics affect leverage, stays statistically significant with the expected signs.

Furthermore, I address endogeneity concerns: I account for the issue of reverse causality by including predetermined values of trust and other institutional variables. Concerning the issue of omitted variables, I apply an instrumental-variable approach to separate the persistent, culturally inherited, exogenous variation in trust from the component that might be endogenously determined by current economic conditions. This exogenous component of trust is neither caused by the contemporaneous choice of capital structure, nor by omitted institutions at the country level. As an instrument, I use religious upbringing because there are studies that show that religious views and practices have a relatively persistent impact on trust over time (Guiso, Sapienza, and Zingales, 2003).

In summary, my study shows that trust is an important driver of the corporate capital structure. In particular, it clarifies the role of the cultural dimension of trust in explaining cross-country differences in capital structure along two dimensions: On the one hand, country-level trust can explain why average levels of leverage differ across countries. On the other hand, country-level trust can explain why certain firm characteristics influence leverage differently across countries. The literature on corporate capital structure—without such a reference to trust—fails to convincingly explain these two patterns in an international context.

My work is related to three lines of research. The first strand that relates to my work explains the corporate choice of capital structure exclusively by firm characteristics. There are numerous studies that derive and empirically test such factors of influence at the level of an individual firm.[2] Following these studies, variations in capital structure across countries can only be explained by cross-country differences in firm characteristics. In summary, approaching the puzzling differences in international capital structure exclusively at the firm level is not sufficient. In particular, it leaves an important question unanswered: Why do some firm characteristics impact leverage so differently across countries as found by Rajan and Zingales (1995)?[3] In addition, the explanation at the firm level raises

[2]Among others, Frank and Goyal (2009) and Harris and Raviv (1991) summarize firm characteristics traditionally used in the empirical literature on corporate capital structure.

[3]While the empirical literature on corporate capital structure has restrained itself to such a firm-level approach and to U.S. data, for a long time, within the last 15 years, a number of studies have extended the evidence on capital structure to the international scope. These international studies explicitly compare the corporate choice of capital structure in various countries. While early studies

the question of why firm characteristics vary systematically across countries.

Another, more recent strand of the literature suggests that cross-country differences in capital structure are due to different institutions at the country level. Rigorous tests of this suggestion have only been possible since data on institutions have become available for a broad range of countries, in particular following the emergence of the "law and finance" literature advanced by La Porta et al. (1998). Subsequent studies analyze both developed and developing countries, rarely including Eastern European countries. Despite general support for traditional firm characteristics, they uncover substantial cross-country differences, both in the levels of leverage and in the impact of the traditional firm characteristics on leverage (e.g., Booth et al., 2001; De Jong, Kabir, and Nguyen, 2008; Giannetti, 2003; Hall, Hutchinson, and Michaelas, 2004). Such persistent differences suggest that important factors at the country level are at work.[4] Many of these studies indeed pin down the impact of certain institutions on firm leverage. From her results, (inter alia) Giannetti (2003) concludes that financial development, the quality of accounting standards, creditor protection, and law enforcement influence capital structure by mitigating agency problems. Acknowledging that certain firm characteristics describe whether agency problems and problems of asymmetric information are important for a particular firm, De Jong, Kabir, and Nguyen (2008) and Giannetti (2003) do not only test the direct impact of institutions on leverage. They also test whether interactions between such firm characteristics and institutions influence leverage.[5]

of international scope merely perform an out-of sample test of the firm characteristics identified in US samples, Rajan and Zingales (1995) are among the first to transfer the single-country approach to a multi-country approach: For the then G-7 states, they find overall support for traditional firm-level factors of influence, but also considerable cross-country differences. Aggarwal and Jamdee (2003) replicate their study with more recent data and improved methods, but only find partial support for the relevance of the firm-level factors, identified in U.S. studies, and moreover they uncover considerable cross-country differences.

[4]In the sample by Fan, Titman, and Twite (2008), country dummies increase the adjusted R^2 by 8 percentage points.

[5]While most studies analyze differences in capital structure across countries applying econometric regression analysis, there are two studies at the European level that follow the survey approach that Graham and Harvey (2001) use for the U.S.: Bancel and Mittoo (2004) survey financial managers from 16 European countries and find substantial variation within Europe. The survey by Brounen, de Jong, and Koedijk (2004) finds surprising similarities between the U.K.,

With the help of cross-country differences in institutions alone, these studies of international scope cannot explain the observed differences in capital structure across countries. After all, these studies still do not fully answer the question of why firm characteristics impact leverage so differently across countries, nor do they provide satisfying reasons for systematic differences in institutions across countries.

The third strand related to this study has discovered culture (in general) and trust (in particular) as drivers of economic outcomes.[6] While there is a number of studies ascribing economic outcomes to culture, the literature that links culture and specifically the corporate choice of capital structure is still in its infancy. However, such a link is important because cultural differences across countries may be the root both of the observed cross-country differences in firm characteristics and institutions, and of the cross-country differences in the way in which these factors impact leverage. The first category of studies in this area shows that average levels of leverage differ across so-called cultural realms. In an early study, Sekeley and Collins (1988) find dissimilarities in capital structure among cultural realms, such as Western Europe, Anglo-America, and Latin-America. Park (1998) and, more recently, Gleason, Mathur, and Mathur (2000) cluster countries according to their uncertainty avoidance, one of several cultural dimensions proposed by Hofstede (1980). They find evidence that the average levels of leverage differ according to this cultural dimension. These studies mainly confirm that there are differences in capital structure among countries. However, they do not specifically test how culture influences capital structure, nor do they convincingly control for other factors of influence. The second category of studies shows a relation between culture and certain drivers of capital structure at the firm level and at the country level. Hilary and Hui (2009) establish that religiosity (as a persistent aspect of culture) is linked to lower risk aversion, at least in Western societies (cf. Miller and Hoffmann, 1995; Miller, 2000). They find evidence that religion specifically impacts the choice of

the Netherlands, Germany, and France, despite large differences in institutions.

[6] Guiso, Sapienza, and Zingales (2006) summarize the literature on trust and economic outcomes.

business risk. The magnitude of business risk, in turn, affects the choice of corporate capital structure. Stulz and Williamson (2003) show that religion impacts the quality of a country's creditor protection, which is relevant for the corporate choice of capital structure also. Tabellini (2010) finds a correlation between cultural aspects (such as respect for others or confidence in individual self-determination) and the current degree of economic development within Europe. Studies within this latter category indicate a specific channel through which culture impacts capital structure, namely by changing firm characteristics or institutions that drive the corporate choice of capital structure. However, this approach does not provide a satisfactory explanation for the cross-country capital structure puzzle either. In particular, these studies still do not explain why firm characteristics impact leverage differently in different countries.

To the best of my knowledge, this is the first study to investigate the effect of the cultural dimension of trust both directly on the levels of leverage (level effect) and indirectly on the way in which certain firm characteristics influence leverage (correlation effect).[7] I extend the literature on corporate capital structure by simultaneously considering traditional firm characteristics and institutions at the country level on the one hand and cultural aspects on the other. The cultural dimension of trust has the potential to reconcile the observed empirical puzzles in cross-country capital structures with the established theories.

In this study, I proceed as follows: In Section 2, I present my hypotheses about the impact of trust on corporate capital structure. Section 3 presents the data and the methods used in the empirical test. Section 4 interprets the results. Section 5 carries out robustness tests. Section 6 concludes.

[7]Chui, Lloyd, and Kwok (2002) pursue a similar research objective using, instead of trust, the cultural dimensions of conservatism (values important in close relationships) and mastery (of a social environment through self-assertion). These cultural dimensions by Schwartz (1994) build upon those by Hofstede (1980). However, they do not test whether the interaction between traditional factors of influence and cultural variables have a statistically significant impact on leverage, maybe because their cultural dimensions are too vague to formulate more specific hypotheses.

2 Hypotheses

In this section, I derive propositions about the impact of the level of trust in a country on capital structures of firms in that country.

2.1 Traditional Theories of Capital Structure and Trust

2.1.1 The Impact of Agency Problems and Problems of Asymmetric Information on Corporate Capital Structure

A firm's decision to finance its operations with equity-type internal funds as opposed to equity- or debt-type external funds determines its capital structure. The choice between external debt and external equity financing has direct consequences for a firm's static capital structure. In contrast, the choice between internal and external financing only indirectly predicts a firm's static capital structure. This is the case, for example, if firms predominantly use debt to finance an external funding deficit because firms have only limited access to external equity financing.[8]

Both forms of external financing rely on cooperation, the firm's assurance not to expropriate the investor's assets, and its dependence on factors that facilitate or impede such cooperation, such as agency problems and problems of asymmetric information (Harris and Raviv, 1991, survey these factors in detail). These problems, therefore, affect both the choice between external debt and external equity financing and the choice between internal and external financing.

In regard to the first decision between external debt and external equity, agency

[8]More directly than for a firm's static capital structure, the choice between internal and external financing has implications for a firm's dynamic capital structure. Shyam-Sunder and Myers (1999) suggest as an adequate test to regress changes in leverage on a proxy for a firm's external funding deficit. However, due to data restrictions I do not directly compute an external funding deficit (as defined in Shyam-Sunder and Myers, 1999). Retained earnings are necessary in order to directly compute a firm's funding deficit. In the AMADEUS database, this balance-sheet item is included in the broader category of "other shareholder funds", an item that is not consistently defined across countries. In addition, using the item "other shareholder funds" may create data selection biases as the coverage of this item differs across countries. Furthermore, for a considerable number of firms there is only little time-series information (while there is abundant cross-sectional information). Therefore, I link the choice between external and internal funding to a firm's static capital structure.

costs are linked to external equity and external debt to different degrees. Jensen and Meckling (1976) distinguish between two types of conflicts that lead to such agency costs. Conflicts between shareholders and managers of the firm constitute agency-related benefits to debt financing and are prominent if ownership and control of the firm are separate: The managers bear the costs of profit enhancement activities, but do not gain all the benefits; leverage resolves this conflict because it increases—ceteris paribus—the manager's equity share in the firm. Conflicts between equity and debt holders constitute agency-related costs to debt financing and arise if default risk becomes substantial: equity holders have an incentive to invest in riskier projects with an upside potential.

The second decision between internal and external financing regards the costs of asymmetric information. These costs create a wedge between the costs of equity-type internal and debt- or equity-type external financing because insiders may exploit their superior information to the detriment of outsiders. From asymmetric information between insiders and outsiders, Myers and Majluf (1984) derives the pecking-order theory of financing. According to this pecking-order theory, capital structure is driven by a firm's desire to finance new investments, first with internal equity, then with external low-risk debt, and—as a last resort—with external equity. Whether high costs of external financing increase or decrease leverage, depends, among other things, on a firm's access to external financing. If firms are restricted to using external debt financing (due to limited access to equity markets for instance), then the choice between internal and external financing ultimately materializes through the choice between equity and debt.[9] In addition, according to Ross (1977) leverage is valuable in the presence of asymmetric information because it serves as a credible signal to convey insider information about investment prospects.

Overall, a basis of standard economic theory is the assumption that managers

[9]Of course, the firm characteristic of being listed is not a perfect indicator of a firm's access to external equity financing. There are other forms of external equity, such as venture capital or private equity. Still, listed firms should typically have easier and cheaper access to external equity financing than unlisted firms.

are not fully trustworthy from the point of view of the investors: They exploit any discretion to pursue their own interests. On the other hand, investors are distrustful in the sense that they anticipate this behavior.

2.1.2 The Role of Trust in Mitigating Agency Problems and Problems of Asymmetric Information

However, these standard economic arguments disregard trust. Trust on the side of the investors and trustworthiness on the side of the managers affect the optimal choice between debt and equity.

According to La Porta et al. (1997), trust has two meanings in economic theory: First, in repeated game theory, trust is the prior belief that an opponent is cooperative; a higher prior belief makes cooperation more likely. Second, trusting people cooperate even in one-time situations; this suggests that people expect certain fairness and cooperation even if they do not see their opponents again. Trust is especially important for economic activities that rely on an opponent's mere assurance not to expropriate someone else's assets. In high-trust environments, people have to spend less to protect themselves from expropriation (Knack and Keefer, 1997). Reputation or the possibility of future punishment (for instance, via law suits) can establish cooperation even at low levels of trust (La Porta et al., 1997).[10] Notably, if the results of surveys on trust indicate that people are trusting, in most cases they are also trustworthy themselves (Glaeser et al., 2000).[11]

In summary, people in high-trust environments are more likely to expect as well as to actually experience cooperative behavior.

[10] Guiso, Sapienza, and Zingales (2006) see trust as the opening through which culture enters the economic discourse: Zak and Knack (2001) show a theoretical and empirical link between trust and overall economic growth. La Porta et al. (1997) pin down the impact of trust on the performance of large organizations. Knack and Keefer (1997) investigate the interrelation between trust, civic cooperation and economic performance.

[11] The correlation between trust and trustworthiness is not surprising from an evolutionary point of view: A group of trusting principals will be worse off than their distrusting counterparts if they interact with dishonest agents. Therefore, only in an environment with a sufficiently large fraction of honest agents are trusting principals better off than distrusting principals and a culture of mutual trust can evolve.

2.1.3 From Common Beliefs Within a Country to Corporate Decisions

In order to explain how different levels of trust across countries impact the corporate choice of capital structure in those countries, it is necessary to clarify why a belief at the country level can have any relevance in corporate decisions.

Common and Individual Beliefs. In standard economic theory, it is individual beliefs that matter for individual decisions, rather than the beliefs that are common to the inhabitants of a particular country. Such common beliefs and values, which I define as culture, potentially impact economic decisions by shaping the beliefs and values of individuals. Country borders are not a perfect, but reasonable, separation of cultural realms, at least with respect to differences in the levels of trust across Europe. Table II.1 shows that trust varies greatly across European countries, with a minimum trust value of 5%, a maximum trust value of 64% and a standard deviation of 14% in the sample of this study. By defining cultural borders as country borders, I ignore cultural diversity within one country as well as cultural proximity across countries. Country borders are still the adequate choice for the purpose of this study because I want to show that the puzzling differences in capital structure across countries can be traced back, at least partly, to cultural differences.

[Insert Table II.1 about here.]

Therefore, I propose that although trust is first and foremost the prior belief of an individual that some opponent is cooperative (cf. definition by La Porta et al., 1997), a certain proportion of trust can reasonably be assumed to be common to the inhabitants of a certain country, shaped, e.g., by common religious roots.

Individual Beliefs and Corporate Decisions. Given that individual beliefs are partly determined by common beliefs within a country, such individual beliefs still primarily determine individual decisions, and not directly corporate decisions. Of course, as Hilary and Hui (2009), p. 1 state, “firms do not make decisions, people do and what they do outside work is likely to affect the ways they make these decisions inside work." To the extent that culture shapes managers' beliefs and preferences, culture impacts corporate decisions if the managers have the discretion to let their own beliefs and values influence corporate decisions. Cronqvist, Makhija, and Yonker (2009) provide evidence that unobserved personal characteristics of managers impact the personal mortgage and—at the same time—the corporate leverage decision. This impact supports the assumption that there is some discretion for managerial beliefs and values to impact corporate decisions.[12]

Culture may of course impact beliefs and values of some individuals, and impact corporate decisions of some managers more than those of others. Even if a manager is less prone to cultural biases than the average person, local cultural norms can matter for decisions by managers even though their own beliefs and values may not be affected at all: According to the social identity theory (Tajlef and Turner, 1979, among others), much of an individual's personal identity is derived from social group membership such as nationality, ethnicity, religion and occupation. Individuals tend to conform to the beliefs and preferences that are dominant within these groups. This conformity supports the assumption that corporate culture is linked to the local cultural environment in general (Hilary and Hui, 2009). Specifically: Rational managers make corporate decisions as trustees for the stakeholders of the firm, i.e., for customers, suppliers, investors, politicians, and employees. Rational, profit-maximizing managers cater to the cultural biases of these stakeholders.

In summary, culture in general and trust in particular can impact corporate decisions through two channels: The managers decide as individuals, influenced by their own cultural upbringing that determines whether they are more or less trusting

[12] Of course, one could ask whether product market competition from other cultural environments allows cultural biases to impact corporate decisions at all. To the extent that such culturally oriented corporate decisions are inefficient and destroy firm value, culture may have a weaker impact on corporate decisions because, otherwise, firms could be driven out of the market. Despite global product market competition, cultural biases could be important at least for corporate decisions that do not dramatically impact firm profitability: as regards the corporate choice of capital structure, it is not even clear—from a theoretical perspective—whether leverage matters for profitability or rather is irrelevant in the sense of Modigliani and Miller (1958).

and trustworthy. Alternatively, even though the cultural environment may not affect the managers' own beliefs, their decisions reflect their roles as trustees on behalf of the stakeholders of the firm who are more or less trusting and trustworthy according to their cultural environment.

Through both channels, the effect of the particular cultural norms in one country on a firm that operates in multiple cultural environments is less clear-cut than the effect on a firm that operates within only one cultural environment.[13]

Hypothesis 1. *The impact of country-level trust on corporate capital structure is weaker for multinational firms.*

2.2 The Level Effect

Trust can directly impact the level of corporate leverage. I denote this aspect as the level effect of trust.

The literature on corporate capital structure has connected agency problems and problems of asymmetric information to capital structure without reference to trust. However, trust is relevant for this connection because it facilitates cooperation even without firm reputation or formal control and punishment mechanisms. Consequently, these problems are less important for corporate capital structures in high-trust countries than in low-trust countries.

Concerning the choice between external debt and equity, trust mitigates agency costs that are associated to a different degree with both types of financing contracts. Debt contracts typically schedule fixed interest payments and amortization, but contain only few control rights. Equity holders as the "residual claimants", in contrast, rely less on contract specifications. They typically do not specify fixed repayments, but have more control rights than debt holders. Trust on the side of investors and

[13] Similarly, Stulz and Williamson (2003) argue that, at the macroeconomic level, a country's openness to international trade mitigates the influence of religion on creditor rights.

trustworthiness on the side of managers mitigate agency problems: Trustworthy managers, on the one hand, do not expropriate the investors' assets. Trusting investors, on the other hand, do not have to adopt costly control mechanisms because they have the prior belief that the manager of the firm cooperates, even without formal control. Therefore, high levels of trust shift the optimal choice of corporate capital structure towards equity contracts with less specified repayments and more room for asset expropriation as compared to debt contracts. In addition, Ross (1977)'s signaling power of debt in the presence of asymmetric information between insiders and outsiders is less important for companies in high-trust countries.

Hypothesis 2. *Firm leverage decreases with trust.*

2.3 The Correlation Effect

The correlation effect concerns the impact of trust on the relation between corporate leverage and those firm characteristics that are related to agency problems or problems of asymmetric information.

The empirical literature has identified numerous firm characteristics that explain corporate capital structure. Frank and Goyal (2009) and Harris and Raviv (1991) give a comprehensive summary of firm characteristics typically used in empirical studies on corporate capital structure. One set of firm characteristics explains corporate leverage by indicating the extent of agency problems and problems of asymmetric information in a particular firm. These firm-level factors are important for my study because I argue that country-level trust mitigates these problems.

Because I use the same data source and similar methods as Giannetti (2003), I follow her in my selection of firm characteristics that represent the extent of agency problems and problems of asymmetric information. In particular, I use firm age, the proportion of intangible assets, growth opportunities, and profitability. These factors cover the main areas that Frank and Goyal (2009) and Harris and Raviv

(1991) associate with agency problems or problems of asymmetric information.[14]

In order to formulate hypotheses about the impact of country-level trust on the way in which these firm characteristics impact leverage, I present the effect of these firm characteristics on leverage alone, according to the literature on corporate capital structure.

Firm Age. Firm age can impact leverage in two manners. According to the substitution-hypothesis, firms are able to accumulate profits over time. Therefore, old firms face smaller external funding deficits than young firms and, hence, are able to substitute expensive (debt- or equity-type) external funds with (equity-type) internal funds (substitution effect). This substitution effect only has an indirect impact on leverage: If firms have limited access to external equity financing (e.g., unlisted firms), they are more likely to use external debt financing to cover an external financing deficit. In that case, substituting (debt-type) external with (equity-type) internal funds decreases leverage. Giannetti (2003) finds such a negative, but statistically weak coefficient of firm age, predicted by the substitution-hypothesis.

Hypothesis 3.a. *Firm leverage decreases with firm age.*

Hypothesis 3.b. *The substitution effect of firm age is stronger for the subsample of unlisted than for listed firms.*

According to the reputation-hypothesis, old firms with long credit histories are able to build up the reputation of being a "good" borrower and decrease the risk premium of debt (reputation effect). This effect may be relevant only for sufficiently mature firms implying a non-linear relation between age and leverage (cf. the reasoning in Diamond, 1991; Giannetti, 2003).

[14] Using a sample of predominantly unlisted firms, I have to omit those firm-level factors that are only available for listed firms, such as market-to-book value or dividend payments. Furthermore, some factors fall prey to data restrictions, e.g., advertising expenses, R & D or a measure of free cash flow. Although these factors are reported in principle, their coverage substantially differs across the countries of my studies and, hence, their inclusion would lead to data selection biases.

Hypothesis 4. *Firm leverage increases with squared firm age.*

Intangible assets. Intangible assets are associated with a low liquidation value. Compared to firms where funds have already been committed to investment in place (high proportion of tangible assets), a low liquidation value increases the agency costs of debt. Therefore, firm leverage is expected to decrease with the proportion of intangible assets (Harris and Raviv, 1990; Williamson, 1988). Previous empirical studies generally confirm that intangible assets are negatively related to leverage and that tangible assets are positively related to leverage (Bradley, Jarrell, and Kim, 1984; Harris and Raviv, 1991; Rajan and Zingales, 1995).

Hypothesis 5. *Firm leverage decreases with the proportion of intangible assets.*

Growth opportunities. High growth opportunities increase a firm's demand for external financing as internal funds are scarce. Provided moderate costs for external financing, firms that face high growth opportunities will increase external financing. Unlisted firms with limited access to equity markets have to rely predominantly on external debt financing. Therefore, at least for these firms, growth opportunities should be positively related to leverage. However, in particular for the subsample of listed firms that are characterized by the separation of ownership and control, there can also be two countervailing effects to this positive correlation. In firms with low growth opportunities, managers are inclined to waste large cash inflows on unprofitable projects, rather than to pay out cash dividends, and debt can serve as a disciplinary device; these agency-related benefits of debt (in the sense of Jensen, 1986) are lower in firms that face high growth opportunities. In addition, firms with high growth opportunities face high agency costs of debt because their investment choice is relatively flexible (Giannetti, 2003; Titman and Wessels, 1988). These two countervailing forces suggest a negative correlation between proxies for growth and leverage, which some empirical studies observe (Kim and Sorensen, 1986).

Hypothesis 6.a. *Firm leverage increases with growth opportunities.*

Hypothesis 6.b. *The positive effect of growth on leverage is stronger for the subsample of unlisted than for listed firms.*

Profitability. Past profits enable firms to accumulate internal funds. According to Myers and Majluf's pecking-order theory, profitable firms should substitute expensive (equity- or debt-type) external funds with less expensive (equity-type) internal funds. At least for unlisted firms with limited access to external equity financing, this substitution will decrease leverage.

Hypothesis 7.a. *Firm leverage decreases with profitability.*

Hypothesis 7.b. *The negative effect of profitability on leverage is stronger for the subsample of unlisted than for listed firms.*

Given the hypothesized impact of these firm characteristics on leverage, I formulate hypotheses about the influence of country-level trust on the way in which these firm characteristics impact leverage.

As proposed before, agency problems and problems of asymmetric information should be less important in environments with high rather than low levels of trust. Therefore, the impact of the above firm characteristics on the corporate choice of capital structure should be weaker in high-trust than in low-trust countries. Accordingly, the interaction terms between trust and the firm characteristics of age, the proportion of intangible assets, growth opportunities and profitability should be statistically significant explanatory variables in the leverage regression. In particular, I test the following hypotheses:

Firm Age. Trust reduces the costs for external financing due to asymmetric information between insiders and outsiders and, hence, it reduces the need to substitute external with internal funds. Therefore, for the subsample of unlisted firms, the negative effect of age on leverage is weaker in high-trust countries: Unlisted firms with limited access to external equity predominantly substitute debt-type external funds with internal equity as they become older if trust in the respective country is low.

Hypothesis 8.a. *Firm leverage decreases less with age if trust is higher.*

Hypothesis 8.b. *The correlation effect of age is stronger for the subsample of unlisted than for listed firms.*

Intangible assets. Trust mitigates the agency costs of debt that are particularly high for firms with low collateral value due to a high proportion of intangible assets. Trust substitutes for collateral and, therefore, reduces the negative correlation between the proportion of intangible assets and leverage.

Hypothesis 9. *Firm leverage decreases less with the proportion of intangible assets if trust is higher.*

Growth opportunities. Trust can mitigate the premium for external financing. Therefore, in countries characterized by high levels of trust, firms can better finance growth opportunities from external sources. This easier access to external financing in high-trust countries should increase leverage for those firms that rely predominantly on external debt financing, i.e., for unlisted firms. In addition, for listed and unlisted firms, trust mitigates the agency costs of debt that are particularly severe for firms with high growth opportunities. Therefore, debt financing of growth opportunities is more attractive in high-trust countries—both for listed and for unlisted firms.

Hypothesis 10.a. *Firm leverage increases more with growth opportunities if trust is higher.*

Hypothesis 10.b. *The correlation effect of growth is stronger for the subsample of unlisted than for listed firms.*

Profitability. Low-trust countries are associated with high costs in external financing due to asymmetric information between insiders and outsiders. Therefore, in these countries, profitable firms have a particularly strong incentive to substitute external with internal funds. Especially for unlisted firms with limited access to external equity, such a substitution of predominantly debt-type external funds with equity-type internal funds should decrease leverage.

Hypothesis 11.a. *Firm leverage decreases less with profitability if trust is higher.*

Hypothesis 11.b. *The correlation effect of profitability is stronger for the subsample of unlisted than for listed firms.*

3 Data and Methods

3.1 Firm-Level Data

At the firm level, I use information on balance sheets and income statements of individual firms from the AMADEUS (Analyze Major Database from European Sources) database, collected by Bureau van Dijk. I use yearly accounting data for the ten-year period of 1998–2007. The final sample includes the following 24

Western and Eastern European countries with sufficient relevant accounting information: Austria (AT), Belgium (BE), Bulgaria (BG), the Czech Republic (CZ), Denmark (DK), Estonia (EE), Finland (FI), France (FR), Germany (DE), Hungary (HU), Ireland (IE), Italy (IT), Latvia (LV), Lithuania (LT), the Netherlands (NL), Norway (NO), Poland (PL), Portugal (PT), Romania (RO), the Slovak Republic (SK), Sweden (SE), Spain (ES), Switzerland (CH), the United Kingdom (GB).

This database has several advantages over more commonly used databases.

It covers not only large-listed, but also small-unlisted firms. This coverage of small-unlisted firms is important for testing the impact of national culture on the corporate choice of capital structure because national culture may particularly affect this group. Consequently, I define leverage in terms of book values of equity and debt because for the majority of firms, market values are not available.

In addition, the AMADEUS database provides ownership information. This information allows a distinction between the groups of national and multinational firms, for which national culture may have a distinct impact on leverage (cf. Hypothesis 1). Whether separation of national and multinational ownership is relevant, of course, depends on the extent to which the owners are involved in corporate decision making. For the majority of privately held firms in AMADEUS, such an involvement seems to be at least plausible.[15]

Also, the database has broad coverage in Eastern Europe, which is important for my study given its pan-European focus.

However, there are some concerns with respect to the AMADEUS database that I try to address. Bureau Van Dijk standardizes balance sheet information with the stated objective of achieving uniformity and enabling cross-border analysis. There

[15] There are other plausible definitions of a multinational firm as well: Ramirez and Tadesse (2007) define multinationality as a sales-side concept and find a weaker impact of national culture on corporate cash holdings for firms with exposure to different cultures and business practices. Alternatively, with sufficiently detailed data, one could look at the cultural background of individual managers that are responsible for the corporate choice of capital structure. Defining multinationality as an ownership concept, this study emphasizes the (equity) investors' perspective: A firm with owners from only one cultural background will let beliefs, shared within this cultural realm, influence capital structure more than a firm with owners from multiple cultural backgrounds.

is still not a completely uniform classification of leverage components, which is of particular importance for my study. Some countries do not separate financial liabilities from other long-term liabilities, which include provisions, and other countries do not distinguish between long-term and short-term debt. Therefore, in order to avoid country-specific classification biases I base my analysis on the broad classification of total leverage, i.e., total liabilities divided by total assets.

Some countries do not report certain firm characteristics. If that concerns crucial firm characteristics (such as the year of incorporation of the firm), a country that does not report such a firm characteristic (in this case Slovenia) has to be excluded. If that only refers to characteristics of secondary importance, the respective firm characteristics are excluded. There is, for instance, only little information on depreciation in Lithuania, the Netherlands, and Latvia. Consequently, if I include depreciation as a measure of "non-debt tax shield" in the analysis, then I create a country-selection bias. Therefore, differently from Giannetti (2003), I do not control for "non-debt tax shield".

Given that AMADEUS has broad coverage throughout Europe even for small-unlisted firms, the quality of the data will naturally depend both on the quality of the accounting standards in the particular country and on the size of the firm (because this usually determines disclosure requirements). I address these problems in three ways:

- Even though I explicitly want to include small firms, I impose minimum size requirements. I use the top firm sample that includes all firms that satisfy one of three size requirements: more than 150 employees, more than 15 million € operating revenue, or more than 30 million € total assets (for the U.K., Germany, France, and Italy), and for all other countries, 100, 10 million, and 20 million €, respectively.

- The accounting standards of countries are likely to converge in the advent of an accession to the EU (Day and Taylor, 2005). Therefore, I only take current

EU member states (plus Switzerland and Norway) to minimize concerns about differences in international accounting data.

- I winsorize the data at the 1% level to avoid that the results are driven by certain erroneous data points.

Table II.2, Panel A defines all the firm-level variables in this study in detail. Table II.3 compares the number of firms in the original AMADEUS sample with the number of firms that satisfy the requirements to be included in the final sample of this study. Table II.4 presents the statistics on leverage and firm characteristics across countries.

[Insert Table II.2 about here.]

[Insert Table II.3 about here.]

[Insert Table II.4 about here.]

3.2 Country-Level Data

At the country level, I use cultural data on trust, and religious upbringing, as well as data on institutions as control variables.

Cultural data has been collected in four waves of surveys by the World Value Studies (WVS), from 1981–1984 (first wave) to 1999–2004 (fourth wave). My measure of trust aggregates the answers of inhabitants j of a particular country c to the following survey question: "Generally speaking, would you say that most people can be trusted or that you need to be very careful in dealing with people?" If an individual answers that most people can be trusted, the answer is coded as "1". If the individual answers that you cannot be too careful in dealing with people, the answer is coded as "0". The measure of trust at the country level is defined as the average over the individual trust-answers within one country for all four waves (1981-2004): $trust_c = \frac{1}{J}\sum_{j=1}^{j=J} trust_j$. Consequently, $0 \leq trust_c \leq 1$.

For example, the measure of 34% for Germany indicates that 34% of the German respondents answer "yes" to the question whether, generally speaking, they would say that most people can be trusted. Table II.5 presents the trust-values across countries, as well as the mean and standard deviation of country-level trust over all 24 countries in this sample.

[Insert Table II.5 about here.]

In addition to trust, I use data on the religious upbringing of individuals within a country. The variable raised measures the percentage of people that have been raised religiously in a particular country. Table II.2, Panel B summarizes the definitions of the cultural variables. Table II.1 shows the minimum, maximum, and standard deviation of these cultural variables.

This study is restrained to Western and Eastern European countries: Europe offers great cultural variation and economic proximity. Table II.1 documents that the cultural variation within the sample is relatively large: Compared to the entire WVS sample, which includes more than 80 countries world-wide, the variation in my European subsample of only 24 countries (measured as the standard deviation or as the distance between the minimum and maximum observation) is still reasonably high.

In addition to cultural data, I use several measures of the degree of financial development as well as on general economic conditions of a country from the World Development Indicators, provided by the World Bank. These measures are available on a yearly basis for most countries and for most years.

Data on creditor protection and law enforcement is taken from the working paper version of Djankov, McLiesh, and Shleifer (2007). Their index on creditor rights follows that by La Porta et al. (1998), but is also available for Eastern European countries: It ranges from zero (weak creditor rights) to four (strong creditor rights) and integrates the following aspects: (1) restrictions to file for reorganization; (2)

ability of secured creditors to seize their collateral after approval of the reorganization petition; (3) pay-out preference for secured creditors in the case of liquidation; (4) management retaining administration of property pending the resolution of the reorganization. In addition, Djankov, McLiesh, and Shleifer (2007) provide cross-country data on contract enforcement, measured as the number of days needed to resolve a payment dispute through the courts.

Table II.2, Panel B defines the legal rules, measures of the degree of financial development and of general economic conditions at the country level. For all country-level factors, I use average values over all sample years (1998–2007) where data is available in the baseline regression, but provide robustness tests with predetermined country-level variables in Subsection 5. Table II.5 presents the respective values of these variables across countries, as well as the mean and standard deviation over all 24 countries in this sample.

3.3 Methods

I follow Giannetti (2003) in applying a two-stage procedure to measure the direct effect of trust on the core leverage of a firm (level effect), and to measure the correlation effect, i.e., the indirect effect of trust on the way in which certain firm characteristics impact leverage.

At the first stage, I regress corporate leverage on the selected firm characteristics and the interactions between these firm characteristics and the country-level measure of trust. I employ a panel regression that exploits the time-series as well as the cross-sectional variation in the data. For each firm i, I estimate firm-fixed effects (α_i).[16] Estimating firm-fixed effects has the advantage that I control for time-invariant differences across firms that are not observed. Thus, the core leverage of a firm (α_i) captures its average internal funding capacity that depends on the historical

[16] A Hausman test rejects the null hypothesis that the random effects estimator is consistent at the 1% significance level. In addition, the null hypothesis that the individual fixed effects are jointly nonsignificant is rejected at the 1% significance level (F-test).

profits of the firm even before it has entered the data set. Further, firm-fixed effects control for eventual data problems due to potential cross-country differences in the definitions of balance sheet items in AMADEUS. Even if there are cross-country biases in the way in which certain items are treated, they are unlikely to vary over time. In addition, according to empirical evidence on corporate capital structure, firm-fixed effects explain a large proportion of a firm's leverage that is unrelated to agency problems and problems of asymmetric information, for which I need to control. In particular, firm-fixed effects capture a firm's industry classification.[17]

The interactions between relevant firm characteristics and trust describe the time-variant effects of trust on corporate leverage. These effects indicate the channels through which trust impacts leverage, namely by weakening the impact of firm characteristics that are related to agency problems and problems of asymmetric information. In the baseline specification, I explain firm leverage with the firm characteristics of age, the proportion of intangible assets to total assets, growth opportunities, and profitability as well as with the interaction between these firm characteristics and trust. In addition, I control for size and squared firm age (to account for non-linearity), estimating the following regression:

$$\begin{aligned} &leverage_{it} = \\ &age_{it} + \mathbf{age^2}_{it} + intang_{it} + growth_{it} + profit_{it} + size_{it} \\ &+ trust_c * age_{it} + trust_c * intang_{it} + trust_c * growth_{it} + trust_c * profit_{it} + \alpha_i + \varepsilon_{it}. \end{aligned} \tag{II.1}$$

After estimating the first stage, the firm-fixed effects are recovered as $\hat{\alpha_i} = \bar{y}_i - \hat{\beta}\bar{x}_i$, where $\bar{y}_i$ and $\bar{x}_i$ are time averages of the dependent and independent variables for a particular firm. Firm-fixed effects (α_i) reflect the time-invariant core leverage of a particular firm. Therefore, at the second stage, I regress using ordinary

[17] Frank and Goyal (2009) find that a firm's industry already explains 19% of the variation in leverage, while the additional 35 factors typically used to explain leverage only add another 17% to the cumulative $\mathbf{R^2}$.

least squares α_i on country-level trust, as well as on a dummy for being listed on the stock market, while controlling for other time-invariant characteristics (x_i) at the country level. In addition, I control for industry dummies. The OLS results as:

$$\alpha_i = listed_i + trust_i + x_i + \eta_i. \tag{II.2}$$

4 Results

4.1 Within-Country Analysis

For each country, I regress leverage on a selection of firm characteristics using ordinary least squares. Panel A of Table II.6 presents the detailed results per country. Panel B of Table II.6 aggregates the coefficients of the firm characteristics over countries.

[Insert Table II.6 about here.]

Panel A of Table II.6 shows the proportion of the variation in leverage that is explained by the linear combination of the selected firm characteristics. It varies considerably across countries. While the average adjusted R^2 is 16% (cf. Panel B of Table II.6), it is relatively low in Germany and Norway at 2% and 4%, respectively, and relatively high for countries such as Estonia and Romania at 31% and 27%, respectively.

The within-country results partly confirm the hypotheses (3.a to 7.b) as regards the selected firm characteristics that are associated with the extent of agency problems and problems of asymmetric information.

Firm age. Firm age has a statistically significant impact on leverage in most countries, but squared firm age (that accounts for a non-linear influence) only in few. In most of the countries (87%), leverage decreases with firm age for the subsample of unlisted firms. This evidence supports the substitution-hypothesis (Hypothesis

3.a) that older firms substitute external with internal financing; given that these unlisted firms have only limited access to external equity, such a substitution tends to decrease leverage. In contrast, only 46% of countries show a negative coefficient for firm age in the subsample of listed firms, in accordance with Hypotheses 3.b. Given the access of listed firms to external equity markets, the substitution of external with internal funds seems to have a less uniform prediction for leverage in this subsample. In accordance with the reputation-hypothesis (Hypothesis 4), the squared term is negative in most countries for the subsample of unlisted firms (83%): Sufficiently mature firms can use their reputation of being a good borrower to increase leverage. For the subsample of listed firms, only 46% of countries show a positive sign. In the whole sample, the standard deviation for age is 22 years. Over all countries, leverage decreases on average by 9.87 percentage points if firm age increases by one standard deviation.

Intangible assets. The impact of the proportion of intangible assets on leverage is inconsistent across countries: in 71% of countries, it is positive; in 29% of countries, it is negative. Such cross-country differences might be partially due to cross-country differences in accounting rules: in some countries (especially in German civil law countries), the balance-sheet item intangible assets does not include capitalized advertising and R & D expenses.[18] The degree of the positive sign of the coefficient for intangible assets is still surprising and refutes Hypothesis 5. The argument that a positive correlation may be due to the fact that firms can only capitalize intangible assets that they have acquired (predominantly by debt financing) still does not answer the question why of all countries Germany has a negative sign. Overall, the results of the within-country analysis concerning the proportion of intangible assets are inconclusive.

[18]In the later panel regression across countries with firm-fixed effects, such measurement concerns are reduced because firm-fixed effects control for time-invariant cross-sectional differences, such as the measurement of intangible assets.

Growth opportunities. In 96% of countries, growth opportunities have a significant and positive impact on leverage for the subsample of unlisted firms, but only in 67% of countries for the subsample of listed firms. Such a predominantly positive sign, particularly for unlisted firms, supports Hypotheses 6.a. and 6.b. It can be explained by an increased demand for external financing in firms with high growth opportunities. Unlisted firms have only limited access to external equity markets and, therefore, satisfy their external financing needs predominantly using external debt financing.

The average (and median) firm in the whole sample increases leverage by 5.55 percentage points if the growth rate of operating revenues increases by one standard deviation.

Profitability. The impact of firm profitability on leverage is relatively consistent across countries: As expected (cf. Hypothesis 7.a), all coefficients are statistically significant at the 1% level with a negative sign, albeit of different magnitude, both for the subsample of unlisted and for the subsample of listed firms, hence, there is no clear empirical support for Hypothesis 7.b. Firm profitability increases internal funds and, therefore, the firm's ability to substitute (equity- or debt-type) external with (equity-type) internal funds, as suggested by Myers and Majluf (1984)'s pecking-order theory. The pecking-order theory is—in the first place—a funding theory without clear prediction for a firm's static capital structure. However, in my sample, the majority of firms are privately held. These firms have only limited access to external equity financing (for instance, via venture capital or private equity) and, hence, they have to rely predominantly on external debt financing if internal funds are scarce. Therefore, the substitution of internal for external financing materializes in a decrease in leverage. If profitability increases by one standard deviation, for listed firms leverage decreases on average by 6.50 percentage points, and for unlisted firm by 8.18 percentage points.

Control variable: Firm size. I include firm size as a control variable, albeit there is no unique prediction about the link between size and leverage (cf. Frank and Goyal, 2007). Most empirical studies find a positive impact of size on leverage (cf. e.g., Frank and Goyal, 2007; Giannetti, 2003). This impact supports the idea that larger firms are more creditworthy because size represents lower risk or firm visibility. There are considerable cross-country differences in the coefficients for size, both in terms of statistical significance and in the sign of the coefficient. Without controlling for firm-fixed effects (as done in the later panel regression), these differences could be due to different accounting rules that apply for large compared to small firms.

4.2 Cross-Country Analysis

The within-country analysis uncovers substantial differences in the impact of firm characteristics on leverage across countries.

A comprehensive analysis within a cross-country panel is necessary in order to answer two questions: Does trust impact the core leverage of a firm (measured as the firm-fixed effect in the panel regression)? Does trust impact the way in which firm characteristics that are related to agency problems and problems of asymmetric information impact leverage?

4.2.1 The Level Effect

In order to address the first question (level effect), I analyze the firm-fixed effects from the panel regression (α_i). The α_i captures the firm-specific influences on leverage that are invariant over time. Table II.7 presents the results from a regression of core leverage on trust and various time-invariant firm or country characteristics, using OLS. All specifications control for industry dummies.

[Insert Table II.7 about here.]

In specification 1 of Table II.7, core leverage is regressed on trust and a dummy for being listed. In accordance with Hypothesis 2, trust decreases the core leverage of a firm by 1.96 percentage points if the measure of country-level trust increases by 14 percentage points. This is the standard deviation of trust that is equivalent to the difference in trust-levels between the low-trust country of Portugal and the high-trust country of Bulgaria. This effect is statistically significantly stronger for listed firms with easier access to external equity markets compared to unlisted firms. The interaction between country-level trust and the dummy for being listed is statistically significant and negative (cf. specification 2 in Table II.7).[19] In summary, firms in countries with high levels of trust choose lower core leverage than their counterparts in low-trust countries. This empirical evidence supports Hypothesis 2.

Defining cultural boundaries as country boundaries, my analysis is prone to the accusation that other factors at the country level might drive the results instead of trust. In order to show that culture supersedes these alternative factors, it is necessary to control for them. Among others, Giannetti (2003) shows that legal rules and the degree of financial development of a country play an important role in determining the extent of agency problems. More precisely, Giannetti (2003) argues that corporate leverage is higher in countries with high protection for creditor rights along with good contract enforcement that eases ex ante contractibility; that leverage increases with high bond market capitalization, which makes external debt financing available at reasonable costs; as well as with a high corporate tax rate due to the associated tax advantages of debt financing. In contrast, high stock market capitalization is associated with lower leverage because it makes external equity financing available. Booth et al. (2001) and Demirgüç-Kunt and Maksimovic, 1999—assessing the impact of different institutions across countries on capital structure—emphasize the role of the following factors: the degree of development of the financial system (size and activity measures), protection of investor rights along with legal efficiency

[19]The effect of the firm characteristic of being listed alone stays negative, but becomes statistically nonsignificant.

(e.g., enforceability of contracts), inflation, economic growth, government subsidies to certain industries, and tax rates. Therefore, I include proxies for the degree of development of the financial system (stock and bond market capitalization), protection of creditor rights along with the enforceability of contracts, inflation, gross domestic product, and the corporate tax rate.[20]

Even if I control for these alternative factors of influence at the country level (cf. specifications 4 to 8 of Table II.7), the impact of trust on the core leverage of a firm stays statistically significant and positive. Of these control factors, only the measures of contract enforcement, bond market development, GDP, as well as inflation turn out to be statistically significant.

4.2.2 The Correlation Effect

For the second question outlined in the beginning of Subsection 4.2 (correlation effect), I analyze the coefficients of the time-variant interactions between trust and firm age, the proportion of intangible assets, growth opportunities, and profitability. To the extent that these firm characteristics are related to agency problems and problems of asymmetric information, their impact is deemed weaker in countries with high levels of trust than in countries with low levels of trust.

Table II.8 presents the results from the panel regression with firm-fixed effects with and without interactions with trust (specifications 1 and 2, respectively), as well as separately for certain subsamples of firms (specifications 3-6).

[Insert Table II.8 about here.]

For the whole sample, all interaction terms between trust and the firm characteristics that are related to agency problems or problems of asymmetric information

[20] From a theoretical point of view, using the marginal corporate tax rate is only appropriate for corporations. For private companies, personal tax rates should be used with potentially different incentives for corporate capital structure. Given the difficulties associated with including personal tax rates (for instance due to progression in most national tax codes) and the statistically nonsignificant coefficient for the corporate tax rate, I do not distinguish between personal and corporate tax rates.

are statistically significant at the 1% level with the expected signs. These significant results confirm the predictions of Hypotheses 8.a, 9, 10.a, and 11.a: Trust indeed changes the way in which certain firm characteristics impact leverage. In particular, firm characteristics that explain leverage with reference to agency problems and problems of asymmetric information have a weaker impact on leverage in high-trust countries as compared to low-trust countries. Also, there are significant differences between certain subsamples of firms, especially between national and multinational firms (specifications 3 and 4 in Table II.8): While all trust-related interaction terms are statistically significant at the 1% level in the national subsample, the interaction term with the proportion of intangible assets loses its statistical significance in the multinational subsample. This provides some empirical support for Hypothesis 1. Furthermore, there are significant differences between listed and unlisted firms as formulated in Hypotheses 8.b, 10.b, and 11.b.

The results allow detailed conclusions about the ways in which trust changes the impact of age, intangibility, growth opportunities, and profitability on leverage.

Firm age. Age can represent a firm's external funding deficit as old firms are able to substitute external with internally accumulated funds. The results for the whole sample support this prediction, formulated in Hypothesis 8.a. This substitution turns out to have clear implications for corporate leverage only for the subsample of unlisted firms that seem to rely more on debt financing to cover an external funding deficit (cf. specification 5 in Table II.8). In contrast, for listed firms, the coefficient is not statistically significant (cf. specification 6). This evidence supports Hypothesis 8.b. Trust reduces the costs of external financing and makes the substitution of external for internal funds less necessary in the first place. Consequently, for unlisted firms leverage decreases less with firm age if trust is higher.[21] If firm age increases by one standard deviation, the low-trust country of Portugal and the high-trust country

[21]A t-statistics of 3.6 indicates a statistically significant difference of the regression coefficients for firm age between these two subsamples at the 1% level (one-sided t-test).

of Bulgaria display a difference in levels of leverage of 2.06 percentage points.

Intangible assets. In high-trust countries, firms can use debt financing even with a high proportion of intangible assets, i.e., trust substitutes for collateral value. In accordance with Hypothesis 9, an increase in intangibility and country-level trust by one standard deviation increases leverage by 0.21 percentage points.

Growth opportunities. Trust mitigates the costs for external financing. These reduced costs favor particularly high-growth firms that are characterized both by an external financing deficit and by high agency costs of debt. In support of Hypothesis 10.a, the interaction term between trust and growth opportunities has a positive impact on leverage. The coefficient of the interaction term is statistically significant at the 1% level only for the subsample of unlisted firms, while it is statistically nonsignificant for the subsample of listed firms (cf. Hypothesis 10.b). Depending on country-level trust, the overall impact of growth on firm leverage can be positive or negative: A one-standard-deviation increase in the growth rate of operating revenues (which represents growth opportunities) decreases leverage by 0.12 percentage points in the low-trust country of Portugal, and increases leverage by 0.36 percentage points in the high-trust country of Bulgaria.

Profitability. According to Myers and Majluf (1984)'s pecking-order theory, profitable firms should substitute external funds for internal funds. To the extent that firms predominantly substitute external debt financing with equity-type internal funds, this financing theory implies a decrease in corporate leverage. Trust decreases the costs of external financing and, hence, makes this substitution less necessary in the first place. The results for the whole sample support this prediction, formulated in Hypothesis 11.a. In particular for unlisted firms with limited access to external equity markets, the interaction between trust and profitability has a statistically significant and positive impact on leverage: An increase of one standard deviation in profitability and country-level trust increases leverage by 0.74 percentage points. The impact is stronger for unlisted firms, namely 0.75 percentage points compared to 0.46 percentage points for listed firms (in accordance with Hypothesis 11.b).[22]

Control Variables. Firm-fixed effects capture the direct impact of legal or financial institutions on leverage, except if there are changes over time. Therefore, in this first-stage panel regression I have to control mainly for those legal or financial institutions that affect leverage through the same firm characteristics as trust (age, intangibility, growth opportunities, profitability) by mitigating agency problems or problems of asymmetric information, and are, in addition, correlated with trust.

Giannetti (2003) finds that institutions do not only impact the core leverage of a firm, but also affect the way in which traditional firm characteristics influence capital structure. In particular, her results suggest that interactions between intangibility and creditor rights, between growth opportunities and stock market development, and between firm age and bond market development are drivers of corporate leverage. Therefore, I control for these interaction terms. Table II.9 shows the time-variant results with control variables.

[Insert Table II.9 about here.]

Even if I control for these alternative interaction terms (cf. specification 2 in Table II.9), all trust-related interaction terms stay statistically significant at the 1% level with the expected signs. The interactions with legal and financial institutions, by contrast, lose some statistical significance due to the inclusion of the trust-related interactions. Hence, the trust-related interactions outperform the interactions with institutional factors in terms of statistical significance. In addition, the difference between national and multinational firms becomes more evident after controlling for these alternative factors at the country level: In contrast to the subsample of

[22] A t-statistics of 2.5 indicates that the coefficient for the subsample of unlisted firms is statistically significantly larger (at the 1% level) than for the subsample of listed firms.

national firms and in accordance with Hypothesis 1, the trust-related interaction terms lose some statistical significance in the subsample of multinational firms (cf. specifications 4 and 5 in Table II.9).

More precisely, Giannetti (2003) argues that firms with a high proportion of intangible assets have less access to debt financing in countries with poor creditor protection. However, the coefficient of the interaction between creditor rights and the proportion of intangible assets is statistically nonsignificant both without (cf. specification 1) and with (cf. specification 2) the trust-related interaction terms.

In addition, Giannetti (2003) argues that a well-capitalized stock market favors unlisted companies with high growth opportunities by the availability of more credit. The positive coefficient of the interaction between growth opportunities and stock market development (cf. specification 1) might in fact represent the positive coefficient of the interaction between growth opportunities and trust if stock markets develop primarily in high-trust countries. However, the interaction between growth opportunities and stock market capitalization becomes statistically nonsignificant if I include the trust-related interaction terms (cf. specification 2), while the trust-related interaction terms stay statistically significant at the 1% level.

Next, Giannetti (2003) argues that firms can exploit their reputation (measured by firm age) to increase leverage only in countries with well-capitalized bond markets. The interaction between firm age and bond market capitalization is statistically significant, but—in contrast to the prediction by Giannetti (2003)—suggests a negative impact on corporate leverage. It stays statistically significant and negative after including the trust-related interaction terms (cf. specification 2). Trust does not only affect the way in which relevant firm characteristics influence leverage. In addition, trust serves as a substitute or complement to institutions and also affects the way in which these country-level factors influence leverage. I include the interactions between trust, institutions and relevant firm characteristics in specification 3. It turns out that—depending on country-level trust—the interaction between firm age and bond market development can be positive (as predicted by Giannetti, 2003) or negative. It is positive in the low-trust country of Portugal and negative in the high-trust country of Bulgaria.[23]

In summary, trust affects the way in which traditional firm characteristics influence capital structure.

5 Robustness Tests

5.1 Endogeneity Concerns

Deriving measures of country-level trust from survey evidence on the current levels of trust may raise endogeneity concerns due to reverse causality because the level of trust that individuals express in the interview situation may not be exogenous. Instead, current economic conditions can impact individuals' answers about their general trust with respect to others. Such economic conditions, in turn, may be influenced by corporate capital structure decisions because increased corporate leverage can cause an increased number of bankruptcies and, as a consequence, financial crises. In such economic circumstances, individuals may be more cautious about whom to trust. However, such concerns of reverse causality are moderate because a single firm's capital structure has only a small impact on the country-level phenomenon of trust. Giannetti (2003) even argues that country-level factors are certainly exogenous with respect to the individual firm. In addition, the endogeneity concern is moderate because measures of trust are relatively stable over time as Table II.10 shows.

[Insert Table II.10 about here.]

[23] These interaction terms between trust, institutions and the relevant firm characteristics should be interpreted with caution, given that the degree of financial development may not be regarded as exogenous with respect to corporate leverage and, in addition, legal rules are likely to be correlated with country-level trust.

The endogeneity concern might be due to omitted variables that are both correlated with the dependent variable (corporate leverage) and with the explanatory variable (country-level trust). Such omitted variables might consist of additional legal or financial institutions that the empirical literature has not yet identified as drivers of capital structure.

5.2 Data and Methods

I address the endogeneity concerns in two ways: Concerning the issue of reverse causality, I carry out the same analysis as before using predetermined values of trust (and—as far as available—predetermined values of institutions) reasoning that contemporaneous corporate capital structure choices do not impact past country-level variables. As regards the issue of omitted variables, I use an instrumental-variable approach to separate the persistent, culturally inherited, exogenous variation in trust. This exogenous component of trust is neither caused by the contemporaneous choice of capital structure, nor by omitted institutional variables at the country level. What is more, if one argues that such alternative institutional factors drive the capital structure decisions instead of trust, one still has to argue why these alternative institutional factors differ across countries as they themselves are subject to choices by politicians or due to economic developments (cf. the questions outlined in Section 1). The culturally inherited component of trust, to the contrary, may even be the root of changes in such institutional factors, but (at least within a reasonable period of time) not vice versa.

5.2.1 Predetermined-Value Approach

Instead of aggregating individual trust-answers over all available waves from the WVS, I only use the earliest available wave for each country because trust enters the regression as the independent variable (Guiso, Sapienza, and Zingales, 2006). The concern with this procedure is that—due to limited data availability—predetermined trust-measures cover different periods of time for different countries (see Table II.10 for country coverage in the different WVS waves). This may create certain distortions.

The endogeneity concern with respect to the measures of institutions, in particular with respect to the degree of financial development, is greater by far than that with respect to trust: Bond and stock market development does not only determine firm-level leverage, but vice versa, corporate leverage also determines the current bond and stock market capitalization of a particular country. Therefore, analogously to trust, I use predetermined values of bond and stock market development (values from the year 1997). This procedure may not entirely dismiss the endogeneity concern with respect to these measures of the degree of financial development. However, the impact of financial development on corporate leverage is not the main interest of my study. Measures of financial development are only included to show that the effect that I attribute to country-level trust is not driven by the degree of financial market development, as suggested by Giannetti (2003).

5.2.2 Instrumental-Variable Approach

In an instrumental-variable approach, I separate two components of country-level trust: The first one is the persistent, exogenous component of beliefs and values, which Guiso, Sapienza, and Zingales, 2003 and Guiso, Sapienza, and Zingales, 2006 define as culture, namely the inherited beliefs and values that are transmitted fairly unchanged from generation to generation. The second component is individual-specific and changes over time, and hence might be subject to endogeneity concerns.

The literature shows that religious views and practices change only slowly over time and have a relatively stable impact on individual beliefs and values even if they change. The impact of religion persists even though religious views have changed after a religious reform (Botticini and Eckstein, 2005; Guiso, Sapienza, and Zingales, 2003), or even though individuals lose their faith (Guiso, Sapienza, and Zingales, 2003). In particular, religious views and practices have been shown to impact trust. Guiso, Sapienza, and Zingales (2003) find evidence that a religious upbringing as well as regular attendance at religious services significantly increase the level of trust in general, but find a different impact for different religious denominations. Religious views and practices have not only a persistent impact on trust, but they also differ widely across countries. Therefore, religion can serve as an instrument to separate the inherited, exogenous component of country-level trust from the endogenously chosen component.

Religious practices, such as attendance at services, might be subject to similar endogeneity concerns as trust. Therefore, I choose the percentage of people in a country that have been raised religiously as an instrument because people have little impact on their religious upbringing. Therefore, the reverse causality argument does not apply and the variation in religious upbringing is exogenous with respect to corporate leverage, at least over one generation, which is certainly sufficient for my analysis.

The percentage of people in a particular country that have been brought up religiously is only a good instrument (z) for country-level trust if it satisfies two requirements: It has to be strongly correlated with the deemed endogenous trust-covariates (x): $cov(x;z) > 0$.[24] In addition, it has to be uncorrelated with the residuals from the firm-level leverage regression (u): $cov(z,u) = 0$.[25]

In order to judge whether the instruments are weak, I perform first-stage under-

[24]In the OLS analyzing time-invariant effects, the endogenous covariate is country-level trust. In the panel-regression analyzing time-variant effects, the endogenous covariates are the interactions between country-level trust and the relevant firm characteristics.

[25]In the time-invariant analysis, I perform a χ^2- test of the endogeneity of trust. The test statistic is defined as the difference between the two Sargan-Hansen test statistics; one for the equation with endogenous regressors, and one for the equation with exogenous regressors. Unlike the Durbin-Wu-Hausman test, it is robust with respect to violations of conditional homoskedasticity. The null hypothesis that the specified endogenous regressors can be treated as exogenous is rejected (p-value=0.000). In the time-variant analysis, I also perform a χ^2- test for the endogeneity of the interaction terms between trust and the firm characteristics of age, intangibility, growth opportunities, and profitability. The null hypothesis that the specified endogenous regressors can be treated as exogenous is rejected (p-value=0.000). The instrumental-variable analysis is, therefore, reasonable.

and weak-identification tests, both for the time-invariant and for the time-variant analysis. I carry out the Kleibergen and Paap (2006)-Lagrange-multiplier χ^2- test as the adequate under-identification test in a case where error terms are assumed not to be independent and identically distributed.[26] Further, I carry out the Wald-F-test by Kleibergen and Paap (2006) as the adequate weak-identification test.

In the time-invariant analysis that assesses the level effect of trust, I can reject the null hypothesis of under-identification (p-value = 0.000). The F-statistic of the weak-identification test by far exceeds the critical value suggested by Stock and Yogo (2005). In the time-variant analysis that assesses the correlation effect of trust, I can also reject the null hypothesis of under-identification (p-value = 0.000). The F-statistic of the weak-identification test is considerably large, although I cannot compare it to the Stock and Yogo (2005) cut-off values because they do not provide such values for more than three endogenous regressors.

The statistical rejection of the under- and weak-identification tests alone is not enough to preclude that the instruments are weak. In addition, there are economic arguments. The literature on religion and trust shows that some proportion of the variation in observed beliefs and values, in particular of trust, is culturally inherited and can be explained by the persistent impact of religious views and practices (cf. e.g., Botticini and Eckstein, 2005; Guiso, Sapienza, and Zingales, 2003). Together with the unambiguous econometric test results, I can confidently conclude that the instruments are not weak.

The exclusion restriction cannot be tested formally in these regressions (e.g., with a test of overidentifying restrictions) because they are just identified, which means that the number of instruments is equal to the number of endogenous covariates. From an economic point of view, it might indeed be doubtful whether religious upbringing impacts corporate leverage only through its impact on trust. Using religious upbringing instead of, e.g., current religiosity, the instrumental-variable

[26] The more commonly used Lagrange-multiplier-test by Anderson (1951) assumes i.i.d. error terms.

approach is less prone to the accusation that contemporaneous religiosity directly impacts the choice of leverage because individuals may have stopped professing their faith.[27] However, there might be other beliefs and values that are driven by religious upbringing and that are—at the same time—relevant for the corporate leverage decision. Guiso, Sapienza, and Zingales (2003) analyze the impact of religious views and practices on individual beliefs and values. Most of the beliefs and values that they relate to religious upbringing, such as intolerance, attitudes towards women, attitudes towards legal rules, can hardly be argued to impact leverage.

However, there is a value that indeed could be correlated with religiosity and also impact leverage: risk aversion. There are already studies that explore the link between religion and risk attitude suggesting a positive impact of religiosity on risk aversion.[28] The evidence on this link is mostly based on current religiosity, rather than on the instrument that I use, namely religious upbringing. Risk aversion is not only related to religiosity, but may also be correlated with the corporate choice of capital structure, although the proxies for business risk are often neglected in empirical capital structure studies (Booth et al., 2001, as an exception, do include a proxy for business risk). Also, if risk aversion relates to corporate leverage via the same firm characteristics as trust, i.e., via age, intangibility, growth opportunities, and profitability, then religiosity might drive corporate leverage by impacting risk aversion in addition to trust. Given the small time-series variation for most of the firms in my sample (which is necessary to compute a proxy for a firm's business risk) and the yet under-explored link between religious upbringing and current levels of risk aversion, I cannot convincingly test whether such alternative explanations might impact the validity of the instruments. Nevertheless, the instrumental-variables approach is an additional assurance that the results are not driven by endogeneity

[27] Also, religious upbringing and current religiosity will be correlated.

[28] Miller and Hoffmann (1995), e.g., relate gender differences in religiosity to gender differences in risk aversion and conclude that religious behavior is associated with risk aversion. Hilary and Hui (2009) show that people who attend church regularly are less likely to accept risky payouts. Hilary and Hui (2009) even use religiosity as a proxy for risk aversion in order to explain corporate decisions.

concerns.

5.3 Results

5.3.1 The Level Effect

Table II.11 shows the results from the robustness test for the time-invariant effects, both the results using predetermined values of trust (and of measures of the degree of financial development)[29] and the results using instrumental variables. The coefficient for being listed and also the coefficient for trust remain statistically significant and negative, after controlling for other country-level factors. The main insight that the core leverage of a firm increases with country-level trust does not seem to be driven by endogeneity issues.

[Insert Table II.11 about here.]

5.3.2 The Correlation Effect

Table II.12 presents the results from the cross-country panel regression using predetermined values of country-level trust (and of measures of the degree of financial development). The impact of country-level trust on corporate leverage is robust using this variant of the trust-measure.

[Insert Table II.12 about here.]

Table II.13 shows the results from the panel regression using instrumented trust-covariates.

[Insert Table II.13 about here.]

The impact of trust on corporate leverage is also robust with respect to the instrumental-variable approach: In countries with higher levels of culturally-inherited

[29]For creditor rights, Djankov, McLiesh, and Shleifer (2007) only provide an aggregate index, but show that there is relatively little change to creditor rights over the period from 1978–2004.

trust (transmitted via religious upbringing), firm characteristics that are related to agency problems or problems of asymmetric information have a weaker impact on corporate leverage than in low-trust countries. With the exception of intangible assets, the coefficients of the relevant firm characteristics and the interactions with trust are similar to the results shown in Subsection 4.2.2, both with respect to their statistical significance and as regards their economic magnitude.[30]

In summary, the robustness tests provide additional evidence that the main insights of my study are not driven by endogeneity concerns: Trust decreases the core leverage of a firm and weakens the impact of firm characteristics that are related to agency problems and problems of asymmetric information on leverage.

6 Conclusion

My study shows that cross-country differences in trust in part explain the puzzling differences in corporate capital structure across countries. Trust impacts the level of firm leverage, and also affects the way in which certain firm characteristics influence leverage: Firm leverage is significantly lower in countries with high levels of trust. Furthermore, the influence of firm-specific factors that are related to agency problems or problems of asymmetric information (firm age, intangible assets, growth opportunities, and profitability) is weaker in countries with high trust as compared to countries with low trust. My analysis shows that this pattern holds for a data set comprising large-listed and small-unlisted firms throughout Europe.

There are, however, some limitations to the results of this study: While this study is based on abundant data on firm characteristics, the data on trust is restricted to 24 country observations. Even though this restriction might appear large compared to other studies (Giannetti, 2003 carries out a comparable cross-country analysis using only eight countries), it is still vulnerable to the accusation that relatively few

[30]The impact of the interaction between intangibility and trust remains positive, but loses its statistical significance.

observations at the country level drive the results. But restraining the analysis to European countries has decisive benefits: Europe offers wide cultural variety and—at the same time—economic proximity. Another limitation refers to the validity of religious upbringing as an instrument for trust. I am not able to completely dismiss the concern that religious upbringing also impacts the corporate choice of capital structure through other cultural beliefs or values, in particular through its impact on risk aversion.

Based on the results of this study, I have three suggestions for future research: Following this latter limitation of the results, it would be fruitful to connect other cultural aspects, such as risk aversion, to the corporate choice of capital structure by formulating analogous hypotheses about the direct impact of risk aversion on the level of leverage as well as its indirect impact through relevant firm characteristics. Next, I study debt and equity as rather broad categories of financing. In particular for small-unlisted firms with limited access to external equity markets, the choice between internal and external financing may be a more dominant driver of corporate leverage than the choice between external debt and external equity. Therefore, it would be interesting to analyze the effect of trust on finer categories of financing contracts as well. For instance, one could test the impact of trust on the specific terms and conditions of debt financing contracts, such as covenants. Also, I argue that trust mitigates agency problems and problems of asymmetric information and, thereby, affects leverage directly by changing the choice between external debt and external equity, as well as indirectly, by changing the choice between external and internal financing. While the former channel can adequately be tested with static capital structure regressions, the latter would be more adequately tested in a dynamic way. However, for such a test, reliable data on a firm's external funding deficit as well as a reasonably large time series would be needed.

Myers (2001) states: "There is no universal theory of capital structure, and no reason to expect one. There are useful conditional theories, however. Each factor could be dominant for some firms or in some circumstances, yet unimportant elsewhere." The less likely a universal theory of capital structure is, the more important it is to explain the conditions under which the theories turn out to be valid, and to find the connecting piece between them. Using trust in explaining corporate capital structure has proven successful in reconciling some capital structure predictions with the observed empirical contradictions and contributes to connecting the pieces of that puzzle.

Appendix

A Tables

Table II.1: Cultural Variation Within Europe

This table compares the variation of the cultural variables of trust and religious upbringing in the sample of this studies consisting of 24 Eastern and Western European countries (sample-minimum, sample-maximum, and sample-standard deviation) with the variation in the whole sample of countries for which the World Value Studies provide data (minimum, maximum, and standard deviation).

Variable	**Min**	**Max**	**Stand. Dev.**	**Sample-Min**	**Sample-Max**	**Sample-Stand. Dev.**
Trust	5%	65%	13%	15%	64%	14%
Raised	7%	98%	24%	16%	97%	22%

Table II.2: Definition of Variables

This table defines all variables of the econometric study. Panel A defines accounting and ownership data from AMADEUS at the firm level. Panel B defines the variables at the country level: Cultural data on trust and religious upbringing is taken from the 4-wave integrated survey from the Word Value Studies (between 1980–2004). Institutional data on creditor protection is taken from Djankov, McLiesh, and Shleifer (2007). Macroeconomic data is taken from the World Development Indicators (between 1997–2007).

Panel A: Firm-Level Variables

Variable	**Definition**
Leverage	Total liabilities divided by the sum of total liabilities and shareholder funds
Listed	Dummy variable = 1 if a firm is listed
Age	Years since incorporation
Intangibles	Intangible fixed assets/total assets
Growth	Ln(operating revenue/turnover (t))-ln(operating revenue/turnover (t-1))
Profit	Profit (loss) after tax/total assets
Size	Ln(# employees)
National	Dummy variable = 0 if a firm has no owner of at least 50% abroad
Industry	2-digit NACE code

Panel B: Country-Level Variables

Variable	**Definition**
Trust	WVS-question A.165: "Generally speaking, would you say that most people can be trusted or that you need to be very careful in dealing with people? Dummy=1 if an individual answers: "Most people can be trusted"; dummy=0 if an individual answers: "Can't be too careful."
Raised	WVS-question F.029: Dummy=1 if a person has been raised religiously
Creditor protection	Index of creditor rights, by Djankov et al. (2007): from 0 (weak) to 4 (strong rights); constructed for the years 1978–2003; includes: 1. restrictions for debtor to file for reorganization (e.g., creditor consent); 2. ability of secured creditors to seize collateral after approval of the reorganization (no "automatic stay" or "asset freeze"); 3. priority pay-out of secured creditors, pending the resolution of the reorganization; 4. management not retaining the administration of property, pending the resolution of the reorganization
Contract enforcement days	Number of calendar days needed to resolve a payment dispute through courts, referring to a contract of unpaid debt worth 50% of the country's GDP; constructed as of January 2003; provided by Djankov et al. (2007)
Bond market capitalization	(Total outstanding domestic debt securities issued by private domestic entities/GDP) + (total outstanding domestic debt securities issued by public entities/GDP)
Stock market capitalization	Market capitalization of listed companies (% of GDP)
Inflation	Inflation, consumer prices (annual %)
Tax rate	Highest marginal corporate tax rate (%)
GDP per capita	Gross domestic product per capita (constant 2000 US$)

Table II.3: Number of Firms

This table reports the number of firms per country used in the final sample. It indicates the proportion of listed as well as the proportion of nationally owned firms. The number of firms in the final sample differs from that in the original AMADEUS sample mainly because some firms do not provide sufficient information on the firm characteristics required for the econometric analysis.

Country	**# Firms: original sample**	**# Firms: analysis**	**% Listed firms**	**% National firms**
AT	1,887	630	4%	56%
BE	8,929	7,779	1%	64%
BG	1,716	1,086	8%	80%
CH	797	488	34%	61%
CZ	5,344	4,981	0%	88%
DE	16,758	11,181	5%	72%
DK	5,749	3,454	3%	59%
EE	682	647	2%	64%
ES	17,296	15,571	1%	73%
FI	3,295	3,096	4%	74%
FR	25,077	20,894	3%	73%
GB	38,196	22,244	5%	69%
HU	2,441	838	0%	78%
IE	3,805	868	4%	53%
IT	21,776	19,893	1%	63%
LT	820	812	5%	84%
LV	717	715	3%	na
NL	10,479	5,529	2%	57%
NO	7,279	5,145	3%	78%
PL	8,023	6,921	2%	74%
PT	3,884	2,968	2%	83%
RO	2,919	2,668	2%	66%
SE	10,283	9,002	3%	73%
SK	1,167	1,121	6%	90%
Total	**199,328**	**148,531**	**3%**	**71%**

Table II.4: Statistics: Firm Level

This table reports average values of the selected firm characteristics. Panel A displays descriptive statistics for each country of the sample separately. Panel B displays aggregate values (mean and standard deviation) for the whole sample and also separate for listed and unlisted firms.

Panel A: Values Per Country

Country	Leverage	Age	Employees	Intangibles	Growth	Profit
AT	65%	28	625	2%	8%	6%
BE	69%	26	190	1%	112%	3%
BG	58%	23	455	1%	24%	4%
CH	30%	57	1478	2%	5%	2%
CZ	55%	10	313	1%	13%	4%
DE	67%	32	837	2%	9%	4%
DK	63%	20	436	2%	11%	6%
EE	56%	13	232	1%	20%	9%
ES	57%	20	389	2%	17%	4%
FI	59%	24	444	2%	13%	7%
FR	71%	26	719	2%	10%	4%
GB	68%	26	1017	2%	11%	5%
HU	60%	11	414	1%	17%	6%
IE	60%	24	577	1%	18%	8%
IT	76%	22	273	2%	13%	2%
LT	54%	9	330	0%	32%	5%
LV	61%	9	337	1%	22%	5%
NL	68%	30	1329	2%	7%	5%
NO	70%	10	134	3%	15%	6%
PL	57%	24	452	1%	12%	4%
PT	67%	26	660	2%	9%	2%
RO	66%	8	504	0%	44%	7%
SE	67%	27	404	1%	14%	5%
SK	56%	11	460	1%	12%	4%

Panel B: Aggregate Values

Country	Leverage	Age	Employees	Intangibles	Growth	Profit
Total	68%	23	605	2%	20%	4%
(Stand. Dev.)	24%	21	916	3%	101%	10%
Listed	56%	35	1806	4%	13%	2%
(Stand. Dev.)	23%	33	2415	4%	76%	11%
Unlisted	68%	23	313	2%	20%	4%
(Stand. Dev.)	24%	20	766	3%	102%	10%

Table II.5: Statistics: Country Level

This table describes the country-level factors of influence used in the empirical analysis. It displays the baseline measure of trust per country, constructed as the non-weighted average of the individual trust-answers from the WVS over all available survey waves (ranging from 1980–2004). It displays the baseline measures of institutions and economic conditions per country, constructed as the non-weighted average of the respective measures from 1998–2007. The total values and standard deviations refer to the non-weighted average values over the 24 countries in the sample.

Country	**Trust**	**Creditor Protection**	**Contract Enforcement Days**	**Bond Market Capitalization**	**Stock Market Capitalization**	**Inflation**	**Tax Rate**	**GDP per capita**
AT	33%	3	374	72%	25%	1%	33%	24,424
BE	22%	2	112	132%	75%	1%	37%	22,927
BG	31%	2	440	na	10%	7%	21%	1,778
CH	39%	1	170	64%	257%	0%	17%	34,238
CZ	27%	3	300	46%	23%	3%	31%	5,956
DE	34%	3	184	82%	51%	1%	27%	23,257
DK	59%	3	83	166%	61%	2%	31%	30,305
EE	24%	na	na	na	31%	4%	31%	4,981
ES	34%	2	169	73%	81%	3%	35%	14,842
FI	55%	1	240	58%	146%	1%	28%	24,525
FR	23%	0	75	89%	85%	1%	33%	22,809
GB	37%	4	288	48%	152%	2%	30%	25,372
HU	27%	1	365	40%	26%	7%	17%	5,155
IE	41%	1	217	38%	66%	3%	20%	26,862
IT	32%	2	1390	126%	50%	2%	35%	19,264
LT	26%	2	154	na	18%	1%	19%	3,952
LV	21%	3	189	na	9%	3%	21%	4,015
NL	53%	3	48	98%	120%	2%	34%	24,288
NO	64%	2	87	38%	47%	2%	28%	38,542
PL	24%	1	1000	28%	21%	4%	27%	4,723
PT	17%	1	320	69%	44%	2%	31%	10,965
RO	15%	1	335	na	10%	27%	27%	1,934
SE	62%	1	208	86%	115%	1%	28%	28,112
SK	21%	2	565	22%	7%	7%	29%	4,201
Total	**35%**	**1.91**	**318**	**72%**	**64%**	**4%**	**28%**	**16,976**
(Stand. Dev.)	**14%**	**1.00**	**310**	**38%**	**59%**	**5%**	**6%**	**11,548**

Table II.6: Within-Country Results

This table presents the results from the within-country regressions using OLS. Total leverage as the dependent variable is regressed on firm age, squared firm age, a proxy for firm size, proportion of intangible assets to total assets, a proxy for growth opportunities, profitability and a constant. A detailed description of all variables can be found in Table II.2. Panel A gives the detailed results per country, including the number of firm-year observations as well as adjusted R^2 for each within-country regression. With ***, **, *, I indicate statistical significance of the coefficients at the 1%, 5%, or 10% level, respectively (based on standard errors that have been adjusted to take into account the potential correlation of errors over time for a given firm). Panel B aggregates the results from the within-country regressions: It displays the average adjusted R^2 and the average coefficient for each of the firm characteristics and indicates the percentage of countries that have a positive sign in the respective coefficient for the whole sample as well as for listed and unlisted firms separately.

Panel A: Detailed Results

Country	**Age**	**Squ. Age**	**Size**	**Intangibles**	**Growth**	**Profit**	**Constant**	**# Observations**	**Adjusted RSQ**
AT	0.00**	0.00*	0.00	0.32	0.07*	-0.56***	0.70***	783	0.08
BE	0.00**	0.00***	0.00	0.38**	0.00	-0.95**	0.77***	55,271	0.11
BG	-0.01**	0.00***	-0.02**	3.40***	0.04***	-0.75***	0.82***	6,271	0.21
CH	0.00*	0.00	0.00	-0.40**	0.05**	-0.36***	0.59***	3,180	0.07
CZ	-0.01**	0.00**	-0.04**	2.14***	0.08***	-0.95**	0.85***	27,299	0.17
DE	0.00***	0.00***	0.00	-0.28**	0.02***	-0.24***	0.67***	29,758	0.02
DK	-0.01**	0.00	0.02***	0.12	0.04***	-0.76**	0.63***	11,459	0.17
EE	-0.01***	0.00***	-0.02**	3.05**	0.02***	-0.93**	0.81***	4,094	0.31
ES	-0.01**	0.00***	0.01***	0.21***	0.03***	-1.13**	0.73***	92,972	0.17
FI	0.00***	0.00	0.00	0.33***	0.05***	-0.61***	0.68***	19,965	0.12
FR	0.00**	0.00***	0.02***	-0.58**	0.05***	-1.01**	0.74***	124,914	0.19
GB	-0.01**	0.00***	0.01***	-0.35***	0.07***	-0.88**	0.76***	118,129	0.15
HU	-0.02*	0.00	-0.05***	0.11	0.07***	-0.75***	0.96***	1,184	0.18
IE	-0.01**	0.00**	0.00	0.23	0.03**	-0.74***	0.77***	1,178	0.16
IT	-0.00**	0.00	-0.01***	0.02	0.05***	-1.27***	0.85***	127,320	0.16
LT	-0.01	0.00	-0.05***	3.84***	0.15***	-0.73***	0.90***	4,257	0.19
LV	-0.02**	0.00***	-0.07**	1.59	0.12***	-0.92**	1.08***	4,805	0.24
NL	-0.00**	0.00***	0.00	-0.31**	0.06***	-0.95**	0.77***	25,738	0.17
NO	-0.01***	0.00***	0.00**	-0.36***	0.03***	-0.28***	0.76***	31,214	0.04
PL	-0.01**	0.00***	-0.03***	1.21***	0.11***	-0.93**	0.83***	32,856	0.19
PT	-0.00**	0.00	0.00	0.51***	0.05***	-1.14**	0.73***	1,184	0.18
RO	0.01***	0.00***	-0.05***	2.19	0.04***	-0.86***	1.01***	17,297	0.27
SE	-0.00**	0.00***	0.00*	-0.25***	0.04***	-0.47**	0.72***	58,650	0.09
SK	-0.01**	0.00	-0.04**	1.53	0.07	-0.81***	0.85	4,634	0.15

Panel B: Aggregate Results								
	Age	**Squ. Age**	**Size**	**Intan gibles**	**Growth**	**Profit**	**Constant**	**Adjusted RSQ**
Mean	-0.005	0.000	-0.014	0.776	0.055	-0.790	0.790	0.16
Positive Sign	13%	83%	38%	71%	96%	0%	100%	
Positive-Listed	54%	46%	83%	54%	67%	0%	100%	
Positive-Unlisted	13%	83%	29%	75%	96%	0%	100%	

Table II.7: Time-Invariant Results

This table presents the results from the regression with core leverage using OLS (the firm-fixed effects from the previous panel regression) as the dependent variable. As explanatory variables, I include time-invariant firm characteristics (a dummy of whether a firm is listed), country-level trust, as well as institutions as controls, and interactions between these factors. I include industry dummies in all specifications. T-statistics are calculated using standard errors that have been adjusted to take into account the potential correlation of errors over time for a given country. With ***, **, * , I indicate statistical significance of the coefficients at the 1%, 5%, or 10% level respectively.

Core Leverage	**(1)**	**t-stat**	**(2)**	**t-stat**	**(3)**	**t-stat**	**(4)**	**t-stat**	**(5)**	**t-stat**	**(6)**	**t-stat**	**(7)**	**t-stat**	**(8)**	**t-stat**
Listed	-0.15***	-6.62	-0.06	-1.47	-0.14***	-5.95	-0.14***	-6.06	-0.15***	-6.85	-0.14***	-6.25	-0.14***	-6.42	-0.15***	-6.63
Trust	-0.14*	-1.86	-0.13*	-1.79			-0.23**	-2.21	-0.41***	-7.38	-0.22*	-2.01	-0.26***	-3.26	-0.40***	-6.48
Trust*Listed			-0.22**	-2.51												
Creditor					-0.01	-0.44	0.00	-0.15	0.00	-0.44	0.00	-0.14	0.00	0.53	0.00	0.32
Stock					0.03	1.07	0.05*	1.80	0.02	1.29	0.05*	1.75	0.02	0.70	0.01	0.61
Bond					0.09**	2.12	0.10**	2.55	0.05**	2.14	0.10*	1.91	0.06	1.28	0.07*	2.01
Enforcement									0.00***	3.74						
Inflation													-2.61**	-3.63		
GDP									0.00***	7.03					0.00***	7.99
Tax Rate											-0.03	-0.07				
Constant	-0.07	-0.90	-0.07	-0.92	-0.19**	-2.90	-0.14*	-2.10	-0.16***	-3.35	-0.13	-1.23	-0.03	-0.29	-0.13**	-2.39
# Observations	146,996		146,996		141,127		141,127		141,127		141,127		141,127		141,127	
Adjusted RSQ	0.07		0.07		0.08		0.10		0.12		0.10		0.11		0.11	

Table II.8: Time-Variant Results

This table presents the results from the panel regression estimating firm-fixed effects, with total leverage as the dependent variable. The firm characteristics of age, squared age, a proxy for size, proportion of intangible assets to total assets, a proxy for growth opportunities, and profitability are used as explanatory variables. Country-level trust interacts with the firm characteristics that are related to agency problems or problems of asymmetric information (age, size, intangible assets, growth). A detailed description of all variables can be found in Table II.2. Specifications 3-6 show separate results for the subsamples of national, multinational, unlisted and listed firms. T-statistics are calculated using standard errors that have been adjusted to take into account the potential correlation of errors over time for a given firm. With ***, **, * , I indicate statistical significance of the coefficients at the 1%, 5%, or 10% level respectively.

Leverage	**(1)**	**t-stat**	**(2)**	**t-stat**	**(3) National**	**t-stat**	**(4) Multinational**	**t-stat**	**(5) Unlisted**	**t-stat**	**(6) Listed**	**t-stat**
Age	-0.01***	-27.25	-0.01***	-38.15	-0.01***	-17.20	-0.01***	-19.51	-0.01***	-27.91	0.00	1.54
Squ. Age	0.00***	18.80	0.00***	18.74	0.00***	12.37	0.00***	13.00	0.00***	18.88	0.00	-0.15
Size	0.02***	24.51	0.02***	24.57	0.01***	15.55	0.02***	14.27	0.02***	23.99	0.02***	5.56
Intangibles	-0.05	-0.82	0.15***	7.68	-0.28***	-3.39	0.13	1.34	-0.09	-1.44	0.34	1.34
Growth	-0.01***	-7.87	0.00***	25.05	-0.01***	-10.81	-0.01***	-3.06	-0.01***	-7.94	0.01*	1.78
Profit	-0.74***	-64.49	-0.53***	-126.120	-0.75***	-48.38	-0.77***	-39.17	-0.75***	-64.22	-0.53***	-8.74
Trust*Age	0.01***	8.96			0.00***	3.21	0.01***	9.04	0.01***	9.19	-0.00	-0.96
Trust*Intangibles	0.51***	3.60			1.01***	5.37	0.07	0.29	0.59***	4.02	-0.49	-0.80
Trust*Growth	0.03***	12.49			0.05***	13.49	0.03***	5.88	0.03***	12.21	0.01	0.92
Trust*Profit	0.56***	19.86			0.60***	16.33	0.58***	12.16	0.56***	19.68	0.30**	2.11
Constant	0.73***	213.46	0.72***	212.16	0.73***	162.90	0.72***	108.61	0.74***	214.93	0.41***	16.39
# **Observations**	809,714		809,714		424,535		253,152		781,984		27,730	
Adjusted RSQ	0.07		0.08		0.07		0.05		0.08		0.08	

Table II.9: Time-Variant Results: Control Variables

This table presents the results from the panel regression estimating firm-fixed effects, with total leverage as the dependent variable. The firm characteristics of age, squared age, a proxy for size, proportion of intangible assets to total assets, a proxy for growth opportunities, and profitability are used as explanatory variables. In addition, various interaction terms between firm characteristics, trust, as well as creditor rights and stock and bond market development are included. Specifications 4 and 5 show separate results for the subsamples of national and multinational firms. T-statistics are calculated using standard errors that have been adjusted to take into account the potential correlation of errors over time for a given firm. With ***, **, * , I indicate statistical significance of the coefficients at the 1%, 5%, or 10% level respectively.

Leverage	**(1)**	**t-stat**	**(2)**	**t-stat**	**(3)**	**t-stat**	**(4) National**	**(5) Multinational**
Age	-0.00***	-13.26	-0.01***	-12.58	-0.02***	-15.67	-0.01***	-0.02***
Squ. Age	0.00***	17.46	0.00***	17.45	0.00***	18.16	0.00***	0.00***
Size	0.02***	27.06	0.02***	26.68	0.02***	26.62	0.02***	0.02***
Intangibles	0.15***	3.77	-0.05	-0.75	-0.35***	-3.34	-0.31***	0.29
Growth	-0.00**	-2.54	-0.01***	-12.46	0.00	1.09	-0.01***	-0.01***
Profit	-0.53***	-120.29	-0.76***	-60.54	-0.75***	-60.32	-0.77***	-0.75***
Trust*Age			0.00***	4.65	0.03***	12.28	0.03***	0.04**
Trust*Intangibles			0.57***	4.03	1.48***	5.25	0.99***	-0.08
Trust*Growth			0.05***	17.74	0.01	0.72	0.06***	0.04*
Trust*Profit			0.59***	19.98	0.58***	19.63	0.63***	0.53
Creditor*Intangibles	-0.01	-0.43	-0.02	-1.00	0.23***	3.50	0.01	-0.05***
Stock*Growth	0.01***	6.49	0.00	1.33	-0.02***	-5.21	-0.00	0.00***
Bond*Age	-0.00***	-7.34	-0.00***	-5.79	0.01***	9.24	0.01***	0.01**
Bond*Squ. Age					0.00			
Trust*Cred*Intang.					-0.70***	-3.99		
Trust*Stock*Growth					0.06***	5.90		
Trust*Bond*Age					-0.04***	-11.73		
Constant	0.72***	210.08	0.72***	211.47	0.73***	210.61	0.74***	0.71
# Observations	772,990		772,990		772,990		414,59	242,076
Adjusted RSQ	0.05		0.06		0.06		0.05	0.06

Table II.10: Persistence of Cultural Aspects

This table presents the persistence in country-level trust values over time, for each country separately. The average country-level measure of trust is based on all available WVS waves. "Trust: Earliest-Latest" indicates the difference (in percentage points) between the country-level measure of trust based on the earliest available WVS wave and the measure based on the latest available WVS wave. "Ranking: Earliest-Latest" indicates the absolute difference between the ranking position of the respective country according to the country-level measure of trust based on the earliest available WVS wave and the measure based on the latest available WVS wave.

Country	Waves	Trust: Average	Trust: Earliest-Latest	Ranking: Earliest-Latest
AT	2;4	33%	2%	2
BE	1;2;4	31%	0%	4
BG	2;3;4	29%	4%	2
CH	2;3	39%	6%	0
CZ	2;3;4	27%	3%	2
DE	2;3;4	34%	-5%	5
DK	1;2;4	59%	-14%	3
EE	2;3;4	24%	4%	1
ES	1;2;3;4	34%	-1%	3
FI	2;3;4	55%	5%	3
FR	1;2;4	23%	3%	1
GB	1;2;3;4	37%	14%	3
HU	1;2;3;4	27%	11%	2
IE	1;2;4	41%	5%	0
IT	1;2;4	32%	-6%	2
LT	2;3;4	26%	5%	1
LV	2;3;4	21%	2%	2
NL	1;2;4	53%	-15%	0
NO	1;2;3	64%	-4%	1
PL	2;3;4	24%	13%	0
PT	2;4	17%	9%	0
RO	2;3;4	15%	6%	3
SE	1;2;3;4	62%	-10%	0
SK	2;3;4	21%	6%	0
Total		**34.6%**	**1.7%**	**1.7**

Table II.11: Time-Invariant Results: Predetermined Values and Instrumental Variables

This table presents the results from the OLS regression with core leverage (the firm-fixed effects from the previous panel regression) as the dependent variable. As explanatory variables, I include time-invariant firm characteristics (a dummy of whether a firm is listed), country-level trust, as well as institutions as controls, and interactions between these factors. This table displays the results for predetermined values of country-level trust (and predetermined values of financial development and economic conditions), and the results for country-level trust, instrumented by the percentage of people that have been brought up religiously in a country. I include industry dummies in all specifications. T-statistics are calculated using standard errors that have been adjusted to take into account the potential correlation of errors over time for a given country. With ***, **, * , I indicate statistical significance of the coefficients at the 1%, 5%, or 10% level respectively.

	Predetermined Values		**Instrumental Variables**	
Core Leverage	**(1)**	**t-stat**	**(2)**	**t-stat**
Listed	-0.15***	-6.78	-0.15***	-7.28
Trust	-0.29***	-6.16	-0.75*	-1.78
Creditor	0.00	-0.42	0.01	0.43
Stock	0.00	0.05	0.00	-0.08
Bond	0.07**	2.44	0.06	1.71
GDP	0.00***	6.40	0.00**	2.24
Constant	-0.14**	-2.79	-0.08	-1.05
# Observations	141,127		141,127	
Adjusted RSQ	0.11		0.09	

Table II.12: Time-Variant Results: Predetermined Values

This table presents the results from the panel regression estimating firm-fixed effects, with total leverage as the dependent variable. The firm characteristics of age, squared age, a proxy for size, proportion of intangible assets to total assets, a proxy for growth opportunities, and profitability are used as explanatory variables. Predetermined values of country-level trust (measured as the country-level aggregate of the individual trust-answers over the earliest available WVS wave) interact with those firm characteristics that are related to agency problems or problems of asymmetric information (age, size, intangible assets, growth). In addition, interaction terms between firm characteristics and institutions are included as control variables. I use as well predetermined values of stock and bond market development, measured as the country-level value from the year prior to the sample period (1997). A detailed description of all variables can be found in Table II.2. T-statistics are calculated using standard errors that have been adjusted to take into account the potential correlation of errors over time for a given firm. With ***, **, * , I indicate statistical significance of the coefficients at the 1%, 5%, or 10% level respectively.

Leverage	**(1)**	**t-stat**	**(2)**	**t-stat**
Age	-0.01***	-29.00	-0.01***	-16.40
Squ.Age	0.00***	18.78	0.00***	17.60
Size	0.02***	24.34	0.02***	26.56
Intangibles	-0.04	-0.80	-0.04	-0.72
Growth	-0.01***	-6.81	-0.01***	-13.63
Profit	-0.68***	-71.32	-0.69***	-66.38
Trustearly*Age	0.01***	8.89	0.00***	6.19
Trustearly*Intangibles	0.50***	4.11	0.52***	4.35
Trustearly*Growth	0.03***	12.58	0.04***	16.98
Trustearly*Profit	0.42***	18.17	0.44***	17.87
Creditor*Intangibles			-0.01	-0.61
Stockearly*Growth			0.01***	4.11
Bondearly*Age			-0.00***	-6.78
Constant	0.73***	213.47	0.72***	211.36
# Observations	809,714		772,990	
Adjusted RSQ	0.07		0.06	

Table II.13: Time-Variant Results: Instrumental Variables

This table presents the results from the panel regression estimating firm-fixed effects, with total leverage as the dependent variable, and instrumented values for country-level trust. The firm characteristics of age, squared age, a proxy for size, proportion of intangible assets to total assets, a proxy for growth opportunities, and profitability are used as explanatory variables. At the first stage, country-level trust is instrumented by the percentage of people with religious upbringing in the particular country. At the second stage, total leverage is regressed on the explanatory variables, using instrumented values of country-level trust. A detailed description of all variables can be found in Table II.2. Z-statistics are calculated using standard errors that have been adjusted to take into account the potential correlation of errors over time for a given firm. With ***, **, *, I indicate statistical significance of the coefficients at the 1%, 5%, or 10% level respectively.

Leverage		**z-stat**
Age	-0.01***	-15.16
Squ.Age	0.00***	18.87
Size	0.02***	23.60
Intangibles	0.13*	1.72
Growth	-0.03***	-20.62
Profit	-0.78***	-44.49
Trust*Age	0.00*	1.67
Trust*Intangibles	0.02	0.12
Trust*Growth	0.11***	22.64
Trust*Profit	0.65***	14.34
# Observations	793,081	
Adjusted RSQ	0.1182	

Chapter III

The Value of Cash Holdings in Long-Term Principal-Agent Relationships

1 Introduction

The value of cash is perceived as one of the ten unsolved problems in the area of corporate finance (at least according to Brealey, Myers, and Allen (2008), a standard textbook in corporate finance). Two empirical observations are particularly striking: The first one refers to the level of cash held by corporations. There is a considerable number of firms with inexplicably high amounts of cash on their balance sheets. Practitioners as well as academics—among others—explain that firms in rather volatile industries should in fact hold large amounts of cash for precautionary savings motives. Regarding information technology companies (such as Apple, Cisco Systems, Dell, IBM and Microsoft) and pharmaceutical or chemical firms (such as Exxon, Merck or Pfizer), this explanation seems to be plausible. But does Apple, for example, really need almost $10 billion to buffer the volatile cash needs in the information technology industry? Volatility as the cause of large cash holdings seems even less plausible with regard to other business segments, such as the beverage industry. How can Coca Cola's almost $8 billion of cash be justified?[1]

[1] These figures are taken from the respective companies' published 2008-10-Q filings.

The second striking observation concerns the contribution of cash to a firm's value. It is peculiar that academic studies often assign a value below parity to corporate cash holdings in the context of company valuation. Again and again, one can even observe firms with a market value below the book value of their cash holdings (net of liabilities). Three recent examples have been reported by Henriques (2008): Ditech Networks (each share trading at about \$1.50 although net cash amounts to \$2.52 per share), Peerless Systems (each share trading at less than \$2.00 although net cash amounts to \$3.10 per share), and Trident Microsystems (each share trading at about \$3.00 although net cash amounts to nearly \$4.00). These examples show that investors do not cheer up in the light of corporate cash holdings and yet, there are still a lot of firms that hold high levels of cash.

These findings seem rather anecdotal. In addition, academic empirical studies hitherto well establish these two striking observations: Some firms hold high levels of cash for which theories of optimal cash holdings do not account and some firms hold cash even though the valuation of a number of corporations shows that one dollar of cash is worth more outside than inside a firm (cf. Subsection 2.2).

According to a number of academic empirical studies, these puzzling empirical findings are due to the agency theory. These studies point to Jensen (1986) who links agency theory to corporate cash holdings and concludes that—under certain conditions—there are agency costs to free cash (cf. Subsection 2.1). Such an explanation of the puzzling observations regarding corporate cash holdings seems to serve rather as a fig leaf and is, therefore, far from satisfying. While agency costs of cash can explain the low value of free cash in some firms, they do not explain why firms hold free cash at all even though it contributes negatively to firm value. Moreover, despite their negative contribution, high levels of cash can be explained by entrenched managers shielding cash holdings from the distribution to the shareholders (entrenchment hypothesis). In that case, high levels of cash have to be interpreted as a sign of suboptimal firm behavior due to—above all—inefficiently lax corporate governance.

In contrast to previous studies, my study emphasizes that the causality between the quality of corporate governance mechanisms and the observed level and value of cash holdings can also be the reverse. I propose that high levels of corporate cash holdings can partially align the conflicting interests of the shareholder and the empire-building manager of a firm. Therefore, high levels of cash substitute for corporate governance mechanisms. Since large cash holdings only partially solve the conflict of interests, they are associated with a certain level of agency costs (and therefore may appear to have a value below parity). High levels of cash are still the second-best solution if the associated agency costs are lower than the costs of implementing corporate governance.

I augment the literature on corporate cash holdings by developing a theoretical framework to analyze the interrelations between corporate cash holdings, the principal-agent problem and agency costs. As a start, I develop a one-period model based on standard assumptions. In this model, a firm's shareholder and its manager only interact once. The manager has limited liability and private information on the return of investment in physical assets. The shareholder's and the manager's objectives are conflicting in that the shareholder wants to maximize the value of the firm, but the manager prefers over-investment in physical assets compared to holding financial assets (empire-building preferences). The shareholder controls the manager with two decisions: The shareholder decides whether or not to implement a particular corporate governance mechanism that allows him to elicit the manager's private information about investment prospects, and hence to overcome his initial opacity. Further, the shareholder determines the amount of cash that is left to the manager's discretion (given that outside financing is endogenously rationed). In this model, I analyze the value of the firm for different levels of cash holdings in order to draw conclusions about the level of cash that maximizes firm value: In a firm with an unsolved principal-agent problem (lax corporate governance), the shareholder should constrain free cash. This optimal restriction of free cash mirrors the predictions of Jensen's free-cash-flow-hypothesis. Better corporate governance, in contrast, allows the shareholder to leave more cash to the manager's discretion and to increase firm value (provided moderate costs to acquire the manager's private information).

In a second step, I develop a multi-period version of this model, in which the shareholder and the manager interact repeatedly or, more precisely, infinitely. As in the one-period model, a shareholder can invest in corporate governance and leave moderate levels of cash to the manager. In addition to the one-period model, a range of so-called Trigger-Equilibriums emerge in which the shareholder can leave (potentially very) large cash holdings to the manager by conditioning future funding for investment projects on past firm performance. Despite opacity, the shareholder induces optimal investment incentives (the same as if he had sold the firm to the risk-neutral manager via a debt contract).

In an extension of this multi-period model, so-called extreme situations occur from time to time. In such extreme situations, firms only survive in the market if they gain a considerable size by spending a certain large amount of cash on unprofitable investment projects. This is meant to reflect, for example, times of financial crises or waves of corporate takeovers. As before, there is an equilibrium in which the shareholder elicits the manager's private information and only funds profitable investments. Interestingly, there is another equilibrium in which the shareholder—despite opacity—leaves high levels of cash to the manager and thus accommodates the waste in extreme situations that assures the firm's survival. This equilibrium contributes to a long-term principal-agent relationship that in turn is the prerequisite for aligning the conflicting interests of the shareholder and the manager. The waste in extreme situations constitutes agency costs. Yet, incentivizing the manager with high levels of cash is still optimal if it is less costly than corporate governance.

Based on this multi-period model with extreme situations, I analyze two competing firms, each with the same principal-agent problem, but with different costs for corporate governance. In equilibrium, the firm with high costs for corporate governance leaves large cash holdings to the manager. These high levels of cash in the hands of an empire-building manager serve as a threat to the competitor because in extreme situations they commit the firm to aggressive investment at a large scale. Given this commitment, the firm with low costs for corporate governance elicits the manager's private information and discontinues operations after an extreme situation. Paradoxically, such a competitive threat works only for firms with high costs for corporate governance. Otherwise, it lacks credibility because the firm would rather invest in corporate governance than to allow aggressive investment in extreme situations. This extension yields the interesting insight that a firm can even have an advantage over its competitor due to high costs for corporate governance.

As a contribution to the empirical literature on corporate cash holdings, this theoretical study identifies new firm and manager characteristics that are important to explain why different firms hold different levels of cash and display different values for cash. Such characteristics are, for example, a firm's interest in long-term principal-agent relationships as well as the manager's time preference. Furthermore, it provides a rational explanation for the observation that firms optimally hold high levels of cash even though they negatively contribute to firm value: Large cash holdings serve as a less expensive substitute for corporate governance, which is set up to exploit the manager's private information in the multi-period setting. Stricter corporate governance mechanisms increase firm value in the one-period setting (provided that implementation costs are moderate), but not necessarily in the multi-period setting.

This chapter proceeds as follows: In Section 2, I review the theoretical literature, the building block for this study, as well as the empirical literature that has motivated my own theoretical work. In Section 3, I develop and analyze a one-period model to demonstrate the principle interdependence between corporate cash holdings and the conflicting interests between the shareholder and the manager of the firm. In Section 4, I transfer the one-period to a multi-period framework. In two subsequent extensions, I additionally consider situations in which the firm needs large amounts of cash to survive in the market, and also add product market competition. Section 5 contains suggestions for further empirical tests. Section 6 is the conclusion.

2 Literature Review

2.1 Theory

This study places particular emphasis on three characteristics that the literature commonly associates with corporate cash holdings: Cash is the most liquid asset (that is, immediately available). In addition, cash holdings are visible to any outside stakeholder of the company, at least at the reporting date. Lastly, the manager has the discretion to decide how to spend it, whereas the spending of funds from outside sources is generally more scrutinized; this understanding is a general one in the literature on corporate cash holdings (Dittmar and Mahrt-Smith, 2007; Jensen, 1986; Opler et al., 1999).

The analysis builds on theoretical studies that add to the explanation of the level of corporate cash holdings as well as of their contribution to firm value.

Emphasizing the immediate availability of cash, the trade-off theory explains that there exists an optimal level of cash holdings where the costs of cash outweigh its benefits. According to this theory, if firms deviate from the optimal level of cash, they reduce their value. As to costs, the trade-off theory primarily refers to opportunity costs for holding liquid assets instead of investing them, for example, in interest-bearing assets (the liquidity premium), as well as to potential tax disadvantages. Regarding the benefits from holding cash, there are precautionary saving motives, which intend to meet unexpected contingencies, and speculative saving motives, which intend to exploit future investment opportunities (cf. e.g., Kim, Mauer, and Sherman, 1998). Therefore, internal cash overcomes the flaws of external financing in terms of transaction costs (Keynes, 1936) and costs associated with asymmetric information.

Myers and Majluf (1984) derive from information asymmetry between insiders and outsiders of the firm that funding of investment projects follows a pecking order. According to this pecking-order theory, firms should finance investments using first internal funds, then external debt financing, and only as a last resort the most expensive source of financing, external equity. Therefore, to the extent that cash holdings are associated with internal funds, they increase firm value (Pinkowitz and Williamson, 2002). However, this pecking order of financing can explain cash holdings only under the controversial assumption that cash is equivalent to negative debt (rightly doubtful insofar Acharya, Almeida, and Campello, 2007). The pecking-order theory particularly fails to explain why firms would hold large amounts of cash and—at the same time—debt.

Agency theory, lastly, emphasizes the managerial discretion associated with cash. It deals with the cooperation between principal and agent in the presence of conflicting interests and discretion by the agent to pursue his own interests. Linking agency theory to the value of cash and assuming that managers tend to over-invest, Jensen (1986) claims that free cash (defined as cash in excess of the amount required to fund all positive NPV projects) reduces firm value. In order to reduce this detriment of free cash, the shareholders (as the principals) can implement corporate governance mechanisms, which can be defined as the sum of actions undertaken to assure the shareholders of getting an adequate return on their investment (Shleifer and Vishny, 1997). According to this concept of corporate governance, a principal-agent problem can either be solved by minimizing the conflict of interests or by controlling the manager's investment decisions. Alternatively, the shareholder can restrain the funds left to the manager's discretion that are necessary to make investment decisions. Jensen's free-cash-flow hypothesis, consequently, recommends such tight cash constraints in order to reduce the principal-agent conflict (if the firm is financed by equity).

2.2 Empirics

Notwithstanding their contribution to the understanding of corporate cash holdings, these theoretical studies fail to explain empirical observations regarding corporate cash holdings: One of these empirical observations refers to the level of cash holdings. The static trade-off theory is consistent with the—on average—observed levels of cash holdings (Kim, Mauer, and Sherman, 1998; Opler et al., 1999), but it cannot explain why some firms hold surprisingly large levels of cash and why average cash levels have even risen during the last decades (Bates, Kahle, and Stulz, 2009).

Another observation, which has not yet been explained plausibly, refers to the value of cash holdings. Most empirical studies analyze the marginal contribution of one additional unit of cash to firm value. Some of these studies determine the contribution of cash to firm value directly by analyzing the ways in which managers dissipate cash (i.e., whether they spend it reasonably or waste it). One example is the study by Blanchard, López-de-Silanes, and Shleifer (1994), who find that firms spend unexpected cash windfalls inefficiently. Predominantly, empirical studies do not examine directly the way in which managers dissipate cash, but indirectly link firm value to the observed level of cash. Controlling for certain firm characteristics that alternatively impact the value of a firm, these studies draw conclusions about the proportion of firm value that can be attributed to cash holdings. Their results show a considerable variation, both across different studies and within one and the same study. Ultimately, many of these studies find that one dollar of cash contributes significantly less than one dollar to firm value (cf. e.g., the range of values in Dittmar and Mahrt-Smith, 2007; Faulkender and Wang, 2006; Pinkowitz and Williamson, 2002). More specifically, the higher a firm's cash holdings the lower is the marginal value of cash (Faulkender and Wang, 2006). This relation between the level and the value of cash may be different for extremely large cash holdings: Especially persistently large cash holdings do not substantially reduce the value of a firm (Mikkelson and Partch, 2003; Opler et al., 1999). However, firms with large cash holdings destroy firm value by spending more on value-decreasing acquisitions (Harford, 1999; Harford, Mansi, and Maxwell, 2008). In summary, it seems puzzling why firms hold large amounts of cash, given that many studies find that cash decreases firm value. Moreover, the conditions under which cash reduces firm value remain unclear.

In order to justify surprisingly large corporate cash holdings and—at the same time—low values of cash, empirical studies often point to the agency theory, but without elaborating this link. This justification is not satisfying. Principal-agent problems can be diagnosed as drivers of both high and low cash holdings: Some international studies find that measures of lax corporate governance that are associated with higher principal-agent problems positively correlate with cash holdings (Dittmar, Mahrt-Smith, and Servaes, 2003; Kalcheva and Lins, 2007; Pinkowitz, Stulz, and Williamson, 2003). In contrast, Harford, Mansi, and Maxwell (2008) find evidence of a negative correlation for a U.S. sample. Additionally, empirical tests that try to more explicitly pin down principal-agent problems as the cause of large cash holdings fail (cf. Bates, Kahle, and Stulz, 2009; Mikkelson and Partch, 2003; Opler et al., 1999). In the light of these inconsistent results as regards the relation between principal-agent problems and the level of cash, Dittmar and Mahrt-Smith (2007) suggest that unsolved principal-agent problems are more important for the value than for the level of cash holdings. To the extent that corporate governance mechanisms can reduce principal-agent problems, they, consequently, suggest to focus on the role of corporate governance to explain the value of corporate cash holdings. However, the empirical evidence regarding the relation between corporate governance and the value of cash holdings is as well inconsistent. On the one hand, there is empirical evidence that the quality of corporate governance substantially increases the average value of cash (Dittmar and Mahrt-Smith, 2007; Pinkowitz, Stulz, and Williamson, 2006). For instance, lax corporate governance enables managers to spend free cash on value-decreasing projects, mainly, but not exclusively, on acquisitions (Dittmar and Mahrt-Smith, 2007; Harford, Mansi, and Maxwell, 2008). On the other hand, there is evidence that among the group of firms with extremely high cash holdings, the impact of corporate governance on the managers' investment behavior seems to be negligible (Harford, Mansi, and Maxwell, 2008; Mikkelson and Partch, 2003), except for the fact that firms with lax corporate governance spend considerably more on value-decreasing acquisitions. Moreover, there is empirical evidence that at least some measures of corporate governance do not significantly increase firm value or may even have negative implications for the value of a firm (e.g., Bebchuk, Cohen, and Ferrell, 2009).[2] It is doubtful that the high costs for implementing corporate governance alone can account for this empirical observation.

The literature on cash holdings seems to be under-explored, as also Faulkender and Wang (2006) note, maybe because cash is often doubtfully regarded as negative debt. Therefore, the rich literature on capital structure is simply transferred to explain the level and value of cash holdings as well. The negligence of cash holdings has left a number of empirical observations unexplained that refer to typical features of cash, over and above the characteristics of negative debt. Consequently, a deeper and more comprehensive examination of the determinants of cash holdings beyond the traditional capital structure arguments is the goal of my study.

[2]Note that the relationship between corporate governance and firm value is highly controversial.

3 One-Period Model

The one-period model builds the framework to systematically think about the interrelations between corporate cash holdings and the principal-agent conflict. This section describes the important concepts and definitions of the one-period model: It first specifies the agents' strategy spaces. Second, it presents all assumptions along with the constraints on the parameter values. These assumptions mirror the arguments, commonly brought forward. Third, it presents the extensive form of the game.

3.1 Assumptions

3.1.1 The Players and Their Strategies

The model describes the one-time interaction between a shareholder and a manager.

Strategy Sets. The manager has private information about the returns to investment in physical assets and decides about new investment in physical assets ($I \ \epsilon \ \{0, 1, ...\}$). His strategy set consists of plans of investment decisions for every possible strategy choice by the shareholder. The level of investment can take any non-negative integer. The manager's investment decision implicitly determines the stock of physical assets ($A \ \epsilon \ \{0, 1, ...\}$) and financial assets ($F \ \epsilon \ \{0, 1, ...\}$) that the company holds during the one period. The shareholder first decides whether to acquire the manager's private information in order to control the investment decision. Second, he chooses funding. His strategy set consists of two decisions:

1. investment in corporate governance (G): G is a binary decision variable. $G = 0$ indicates no investment in corporate governance. $G = \overline{G}$ indicates investment of $\overline{G}$ units of capital in corporate governance. $\overline{G}$ denotes the strictly positive costs for implementing an efficient level of corporate governance: $\overline{G} > 0$.

2. funding (DIV): DIV can take any integer. If $DIV \geq 0$, DIV is the proportion

of past-period wealth that the shareholder claims as a dividend. $DIV < 0$ denotes the injection of new capital. The funding offer can be thought of as the shareholder's dividend decision at the annual shareholders' meeting, which implicitly determines the initial level of cash at the reporting date (F^0) that the manager can dispose of, so $F^0 = I + F$. Hence, the shareholder can choose: $DIV \to F^0$.[3]

Technology. The firm's investment opportunities pay off at the end of the period. CF are the gross cash flows from investment in physical assets that accrue at the end of the period. I abstract from equilibrium considerations in the product market and normalize product prices to 1.

There is a good and a bad investment state. The realization of the random variable $\theta \in \{0; 1\}$ characterizes these fluctuations in investment opportunities by the following probability density function: $prob[\theta = 1] = p$ and $prob[\theta = 0] = (1 - p)$.

In a good investment state $(\theta = 1)$, $H > 1$ is the present value of the gross cash flow from the first unit of capital invested. In a bad investment state $(\theta = 0)$, this present value is $L < 1$. Any further unit of capital yields L in either state. Therefore, investing one unit of capital is efficient in the good, but inefficient in the bad state. The analysis concentrates on the parameter range $p(H - L) + L < 1$ in which the manager on average destroys firm value by investing both in the good and in the bad investment state. I define $\pi_G = p(H - 1)$ as the expected profits from investing only in the good investment state and $\pi_B = (1 - p)(1 - L)$ as the expected loss from investing only in the bad investment state.

The present value of gross cash flows that accrue at the end of the period is described as:

[3]For simplicity, I restrict the analysis to discrete monetary units. Analogous results, but mainly without additional insights, can be derived in a continuous setting.

$$PV\left[CF\left(I,\theta\right)\right]=I*L+1_{I\geq 1}\theta\left(H-L\right). \tag{III.1}$$

Capital goods are perishable and there are no interest expenses for holding cash.[4]

Objectives. The manager and the shareholder pursue different objectives.

The manager has a tendency to over-invest in physical assets. The manager's preference to control larger firms over smaller firms (empire-building preferences) is a standard assumption in the literature.[5] The manager derives private control benefits both from the level of physical assets (A) and from the level of financial assets (F) that the company holds during the period:

$$u=A+\left(1-\phi\right)F. \tag{III.2}$$

$\phi>0$ is the discount factor for holding financial assets as compared to physical assets. If $\phi=1$, the manager does not derive any control benefits from financial assets, but only from physical assets.

The manager's utility function is linear in the company's assets. This risk-neutrality is meant to restrain the differences between the shareholder's and the manager's objective functions to the fundamental empire-building preference. The risk-neutrality assumption is immaterial because production operates without uncertainty and, hence, $E\left\{u\right\}=u$, irrespective of the manager's risk attitude.

The manager can either accept the employment contract or search outside employment with exogenous utility of $\overline{u}$. Therefore, the shareholder's contract offer has to satisfy the manager's participation constraint:

[4] The optimal level of cash according to the static trade-off theory would already account for such interest expenses. Such an optimal level of cash could easily be incorporated into this analysis as a baseline level of cash.

[5] Preference for empire-building can be motivated by career prospects and compensation schemes that are typically rosier in larger firms. For a formal derivation of the empire-building motive, cf. e.g., Kanniainen (2000).

$$A + (1 - \phi) F \geq \overline{u}. \qquad \text{(III.3)}$$

The analysis assumes slack in the manager's participation constraint, by normalizing $\overline{u} = 0$. u always meets this reservation utility because A and F are non-negative. The assumption of slack in the participation constraint makes it more difficult to rationalize large cash holdings. In contrast, assuming a binding participation constraint, large cash holdings—instead of wage payments—could make the manager work in the company.[6]

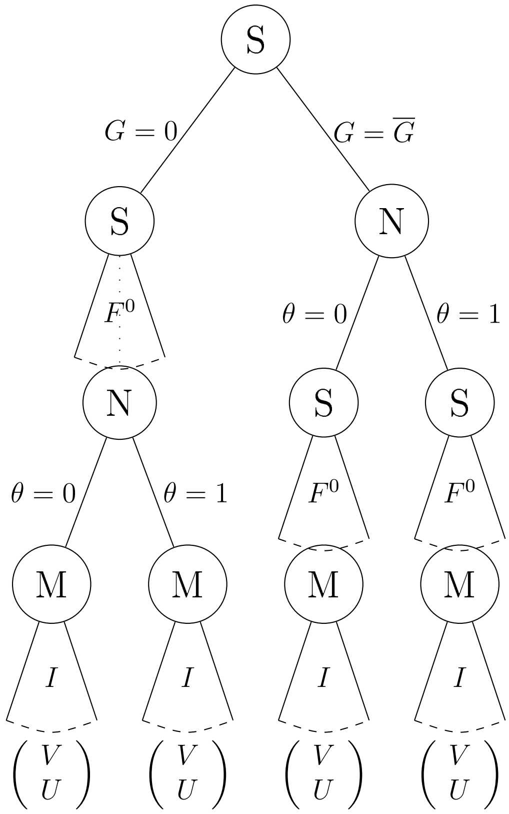
The shareholder maximizes the sum of the injection of capital at the beginning of the period and the expected value of his end-of-period (liquidating) dividends: $DIV + PV[CF(I, \theta)]$. Therefore, the shareholder wants to invest only in physical assets with positive net present value, i.e., he would like to choose $I = 1$ if $\theta = 1$, and $I = 0$ if $\theta = 0$. In a reduced asset valuation framework, firm value depends on the investment state (θ) and on the shareholder's funding decision (F^0), given the shareholder's optimal choice of corporate governance (G) and the manager's investment choice (I).

Feasible Contracts. The shareholder and the manager can negotiate their interaction under the following additional restrictions:

- The manager is wealth-constrained. Otherwise, standard results suggest it to be optimal to sell the entire firm to the risk-neutral manager.
- The shareholder has deep pockets and can lend any amount of money to the manager. This assumption allows the shareholder to inject any amount of capital: $DIV < 0$.

[6] A binding participation constraint could rationalize large cash holdings relatively easily (maybe even at the expense of the unrealistic result of negative wages). However, it does not explain the empirical observation that some firms hold large amounts of cash despite its negative marginal contribution to firm value.

Figure III.1: The Extensive Form of the Game



Notation: S stands for shareholder, N for nature, and M for manager

3.1.2 The Extensive Form of the Game

At the beginning of the period, the return on the firm's investment in physical assets has not yet been realized. It is negative in expectation over the bad and the good investment state. The shareholder and the manager move sequentially: The shareholder moves first. At the annual shareholder's meeting, he makes two decisions: He decides whether to invest in corporate governance $\left(G = \overline{G}\right)$, which allows him to observe the investment state of nature (θ). He then sets up the balance sheet of the company, i.e., determines the initial funding (F^0). An outside financial analyst can observe this balance sheet. After the balance sheet has been set up, the manager observes the investment state at no costs and decides about investment in physical assets. This investment decision determines the physical and the financial asset holdings of the firm during the period and hence the manager's private control benefits. At the end of the period, cash flows from investment in physical assets accrue. At this point, neither the manager, nor the shareholder take any action. The shareholder observes the deterministic cash flows and perfectly deduces the manager's investment decision at $t = 0$ (costless ex post information symmetry). An outside analyst can also value the assets of the firm and draw ex post conclusions about the value of the initial cash holdings (F^0) that the shareholder has left to the manager's discretion at the beginning of the period.

The exact time structure of the game and, hence, the information set of the shareholder depend on the investment in corporate governance.

No Investment in Corporate Governance. If $G = 0$, the shareholder has to decide about funding (DIV) before nature has drawn the realization of the investment state variable (θ). In other words, the information sets of the shareholder and of the manager diverge: The shareholder is not informed about the investment state before he makes his funding decision. (This case is described in the left-hand path of the game tree.)

Investment in Corporate Governance. If the shareholder invests $G = \overline{G}$, he is able to observe the realization of the random variable θ before his funding decision. Corporate governance conveys the manager's private information about the investment state to the shareholder. $G = \overline{G}$ mitigates the principal-agent conflict by reducing the information asymmetry between the shareholder and the manager. (This case is described in the right-hand path of the game tree.)

In both cases, the manager decides about the investment in physical assets after the shareholder's decision and after the move by nature. Any remaining funds that have not been invested in physical assets constitute cash holdings (F) during the period. Since these cash holdings do not earn any interest, their present value at $t = 0$ is just equal to one (per unit of cash).

3.2 Analysis

The one-period model yields an unsatisfactory result: If the shareholder does not invest in expensive corporate governance, he cannot exploit the positive investment opportunities in the good state. This result mirrors the predictions of Jensen's free-cash-flow-hypothesis: Firms with an unsolved principal-agent conflict should constrain the free cash left to the manager's discretion. In the one-period model, corporate governance increases firm value provided that the costs for implementing corporate governance are moderate.

I proceed in four steps: I present candidate equilibriums. I then analyze the optimization by the manager and the shareholder. This analysis allows to derive parameter ranges for the unique equilibrium and to draw conclusions about the value of cash in the one-period model.

3.2.1 Candidate Equilibriums

The equilibrium specifies strategy choices by the shareholder $(G^*;\ F^{0*})$ and by the manager (I^*) from which equilibrium payoffs to the shareholder (V^*) and to the manager (U^*) can be derived. A set of strategy choices $(G^*;\ F^{0*};\ I^*)$ constitutes a Nash equilibrium of the one-period model if $(G^*;\ F^{0*};\ I^*)$ is a mutual best response in the following sense:

$$U\left(G^*;\ F^{0*};\ I^*\right) \geq U\left(G^*;\ F^{0*};\ I\right) \forall\ I, \text{ and} \tag{III.4}$$

$$V\left(G^*;\ F^{0*};\ I^*\right) \geq V\left(G;\ F^{0};\ I^*\right) \forall\ \left(G;\ F^{0}\right). \tag{III.5}$$

The concept of a Nash equilibrium is refined by the notion of sub-game perfection, which requires Nash equilibriums in every proper sub-game. Any element of the feasible set of $G^* \in \left\{0; \overline{G}\right\} \times F^{0*} \in \{0, 1, ...\} \times I^* \in \{0, 1, ...F^{0*}\}$ could potentially be an equilibrium of the one-period model (cf. e.g., the description in Mailath and Samuelson, 2006).

3.2.2 The Manager's Optimization

I solve this sequential game by backward induction, starting with the manager, who moves second. The manager optimizes the private benefits from control:

$$\underset{I}{Max}\ \ u(A,F) = \underset{I}{Max}\left[A + (1-\phi)F\right] \text{ s.t. } \begin{cases} I = & A \\ F^0 = & I + F \end{cases}. \tag{III.6}$$

The manager's marginal utility from investment in physical assets $\left(\frac{\partial u(A,F)}{\partial I} = 1\right)$ always exceeds that from investment in financial assets $\left(\frac{\partial u(A,F)}{\partial F} = 1-\phi\right)$, both in the bad and in the good investment state. Therefore, any strategy $I < F^0$ is strictly dominated by $I = F^0$. $I = F^0$ is the manager's unique undominated strategy for all strategy choices $(G;\ F^0)$ by the shareholder. The manager's best response function follows immediately as:

$$I^* = F^0\ \forall\ \left(G\ \in\ \left\{0;\overline{G}\right\};\ F^0\ \in\ \{0,1,...\}\right). \tag{III.7}$$

3.2.3 The Shareholder's Optimization

The shareholder moves first and chooses G and F^0 to maximize the value of the firm $(V(I,F,\theta))$, which is the present value of the expected dividend (DIV). By the principle of iterated elimination of strictly dominated strategies, the shareholder's strategy is required to be undominated, given the manager's best response function: $I^* = F^0$ (cf. Mailath and Samuelson, 2006).

Lemma 1. *There are only two undominated strategy combinations in the one-period model:*

1."No Production": $G = 0$ and $F^0 = 0$

2."Corporate Governance": $G = \overline{G}$ and $F^0 = 0$ if $\theta = 0$

$F^0 = 1$ if $\theta = 1$.

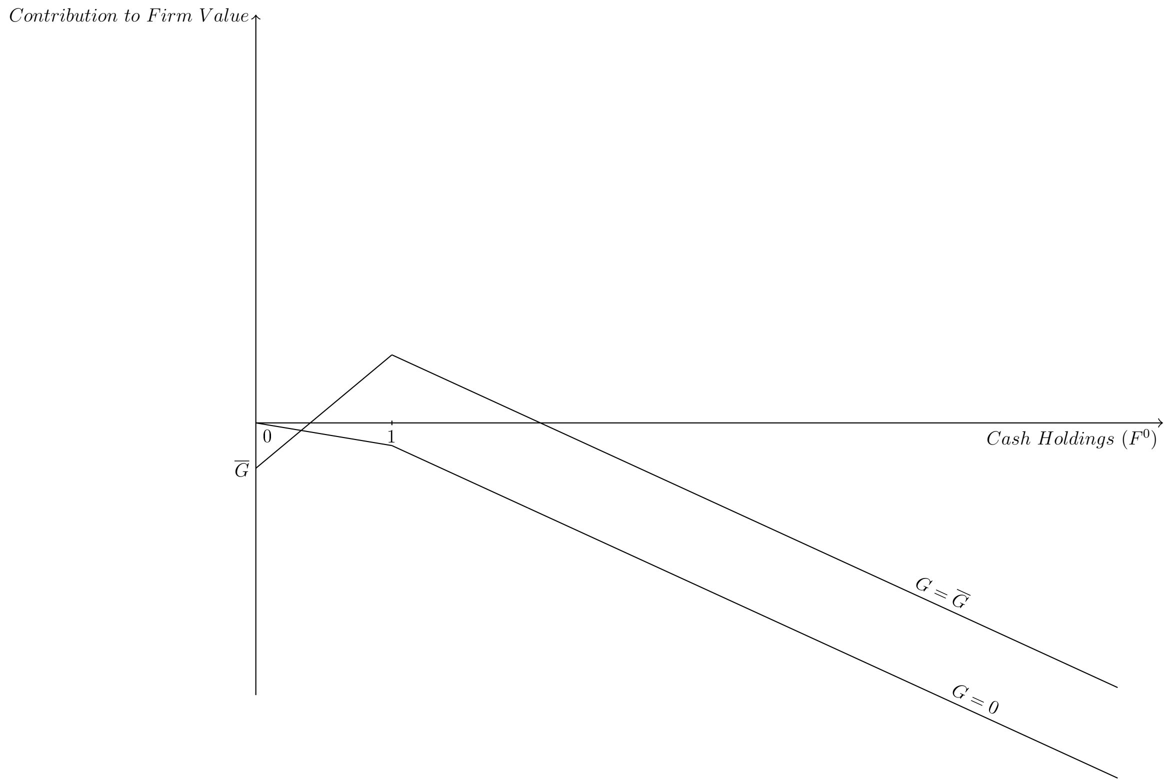
Proof. See Subsection A.1 in the appendix. □

The No-Production-Equilibrium formalizes the predictions of Jensen's free-cash-flow-hypothesis: In the presence of an unsolved principal-agent conflict, the shareholder optimally restrains cash ($F^0 = 0$) because the costs of free cash (due to the tendency to over-invest) exceed the benefits of free cash (the immediate availability of cash in an environment with fluctuating investment opportunities and endogenously rationed outside financing). The Corporate-Governance-Equilibrium shows that corporate governance increases firm value as long as the costs for implementing corporate governance are moderate: As long as $\overline{G}$ is not too high, firm value in the Corporate-Governance-Equilibrium exceeds that in the No-Production-Equilibrium.

Proposition 1. *In the one-period model, there is a unique equilibrium in pure strategies: For $\overline{G} > p(H-1)$, this equilibrium is the No-Production-Equilibrium with lax corporate governance ($G = 0$) and low levels of cash ($F^0 = 0$); for $\overline{G} < p(H-1)$, this equilibrium is the Corporate-Governance-Equilibrium with strict corporate governance $\left(G = \overline{G}\right)$ and moderate levels of cash (on average: $F^0 = p$).*

Proof. By Lemma 1, there are only two undominated strategy combinations: In the No-Production-Equilibrium, the value of the firm to the shareholder is equal to $V = 0$. In the Corporate-Governance-Equilibrium, the shareholder expects to earn net present value of $(H-1)$ in the good and 0 in the bad investment state. In either state, the shareholder has to invest $\overline{G}$ units of capital in corporate governance upfront. The value of the firm in the Corporate-Governance-Equilibrium is equal to $V = \pi_G - \overline{G}$ (where $\pi_G = p(H-1)$). The shareholder chooses the No-Production-Equilibrium if $\pi_G - \overline{G} < 0$, the Corporate-Governance-Equilibrium if $\pi_G - \overline{G} > 0$, and is indifferent between both equilibriums if $\pi_G - \overline{G} = 0$. □

Figure III.2: The Value of Cash: One-Period Model



Interpretation of Proposition 1. The one-period model describes a prisoner's dilemma: Both players would be better off if the shareholder did not invest in corporate governance ($G = 0$) and the manager invested funds efficiently. The shareholder is strictly better off. The manager derives the same utility as in the Corporate-Governance-Equilibrium with average utility level of $u = p$;[7] the manager derives strictly higher utility than in the No-Production-Equilibrium with utility level of $u = 0$. However, the parties cannot commit to this superior strategy combination in the one-period model because the manager has an incentive to deviate by over-investment in the bad investment state.

[7]In the Corporate-Governance-Equilibrium, the manager is endowed with one unit of capital in the good investment state (with $Prob\ (\theta = 1) = p$) and derives utility of $u = 1$. With probability $Prob\ (\theta = 0) = (1 - p)$, the manager is not endowed with any capital and derives utility of $u = 0$.

4 Multi-Period Model

The empirical literature struggles with the surprisingly large cash holdings of some firms. The one-period model can explain such large cash holdings only under the strong assumption that managers have the discretion to entrench cash from the distribution to the shareholders. Therefore, the one-period model needs to be scrutinized in its most striking assumption: The principal-agent relationship ends after one interaction.

4.1 Baseline Model

4.1.1 Changes in the Assumptions

In the multi-period set-up, the manager and the shareholder have long-term interests: The one-period model as the stage game is repeated infinitely. The change from the one-period to the multi-period model leads to changes in the main assumptions of the model: the technology, the players' objective functions, and the constraints to the set of feasible contracts.

Technology. The change in the production technology is immediate: Each period, the same production opportunities arise. The realization of θ_t is independent of the realizations of $\theta_{1,2,\ldots(t-1)}$.

Objectives. The manager derives private control benefits each period until infinity. The utility in future periods is discounted at the rate of β (the same discount factor for all players and all times). Given that $r = 0$, I require $\beta < \frac{1}{1+r} = 1$ in order to ensure convergence of the payoffs:

$$U = \sum_{t=0}^{\infty} \beta^t u_t = \sum_{t=0}^{\infty} \beta^t \left[A_t + (1 - \phi) F_t \right]. \tag{III.8}$$

The manager's budget constraint in the multi-period model is determined by the level of financial assets at the beginning of the period: $F_t^0 = I_t + F_t$.

The shareholder maximizes:

$$V\left(F_t,\ I_t,\ \theta_t\right) = \sum_{t=0}^{\infty} \beta^t DIV_t. \tag{III.9}$$

The shareholder's dividend decision is equivalent to the funding decision at the beginning of each period:

$$F_t^0 = F_{t-1} + CF_t - DIV_t. \tag{III.10}$$

Since the shareholder has deep pockets (DIV_t can be positive as well as negative), the funding decision (F_t^0) does not depend on past profits and is essentially the same as in the one-period model (F^0).

Feasible Contracts. I impose the same restrictions to the set of feasible contracts as in the one-period model: The shareholder cannot condition his funding decision on the current state of nature (θ_t), except if he invests in corporate governance. In order to simplify the presentation of the results, I restrict the attention to the case with prohibitively expensive corporate governance where the unique equilibrium from the one-period model is the No-Production-Equilibrium: $\overline{G} \geq \pi_G$.[8]

Even without investment in corporate governance the shareholder observes the realization of the random variable θ_t along with the manager's investment decision at the end of each period (costless ex post information symmetry). I assume that the shareholder cannot formally commit to long-term contracts: The shareholder has the right to withdraw funds each year at the shareholders' annual meeting and, thus, cannot make (credible) long-term funding promises.

[8]Almost the same results can be derived with the Corporate-Governance-Equilibrium as the unique equilibrium of the one-period model. Differences can arise in the extensions to this model (Subsections 4.2 and 4.3).

4.1.2 Changes in the Analysis

In the multi-period set-up, the shareholder can exploit the ex post costless information symmetry: The shareholder can induce cooperation by conditioning future funding on the manager's past performance. The long horizon aligns the interests of the manager and the shareholder. Despite an unsolved principal-agent conflict (lax corporate governance), the manager invests large amounts of cash holdings optimally.[9]

I proceed in the following steps, analogously to the one-period case: I present candidate equilibriums, analyze the manager's and the shareholder's optimization, derive best responses and give the parameter conditions for the equilibriums in the multi-period model.

Candidate Equilibriums. The equilibrium concept in the multi-period model is the same as in the one-period model: It specifies equilibrium strategy choices by the shareholder (G^*; F^{0*}) and by the manager (I^*) that constitute a Nash equilibrium in every proper sub-game.[10] I restrict the attention to stationary equilibriums in which both agents adopt the same strategy at each point in time. Since the game is worth exactly the same before the realization of θ_t at any t, it suffices to look at one representative period.

Manager's Optimization. In each period, the manager moves second. As in the one-period model, the participation constraint is assumed to be slack. The manager's optimal investment decision (I_t) depends on the way in which the shareholder conditions his future choice of corporate governance and funding (G_t, F_t^0) on the manager's past investment decisions I_τ with $\tau = 1, 2, ... (t-1)$. Therefore, all of

[9]This result formally requires the infinite time horizon. An infinite game does not necessarily require an infinite relationship in practice. If the relationship is finite, but its end is uncertain, the discount rate can be interpreted as the probability that the relationship ends in a given period (Mailath and Samuelson, 2006).

[10]In this game of asymmetric information, one period constitutes one sub-game.

the manager's strategy choices are undominated in the first step of the iterated procedure of eliminating strictly dominated strategies.

Shareholder's Optimization. I solve this game by letting the shareholder optimize over the set of contract offers $(G_t;\ F_t^0)$ that respect the manager's best response and his incentive compatibility constraint. Since the manager cannot commit to stay in the company forever due to inalienable human capital (as assumed, e.g., in Hart and Moore, 1994), the incentive compatibility constraint has to be satisfied at any point in time t.

Lemma 2. *For $\overline{G} \geq \pi_G$, the infinite repetition of the No-Production-Equilibrium from the one-period model constitutes a sub-game perfect equilibrium.*

Proof. I prove this lemma by showing that neither the manager, nor the shareholder have a profitable one-sided deviation: The manager cannot deviate at all: If $F_t^0 = 0$, his only feasible investment choice is $I_t = 0$. The shareholder can deviate by leaving $F_t^0 > 0$ to the manager and/or by investing in corporate governance $G_t = \overline{G}$.

$F_t^0 > 0$: Given the manager's proposed equilibrium strategy to always invest all available funds in physical assets, increasing cash holdings would be unprofitable on average because $\pi_G - \pi_B < 0$.

$G_t = \overline{G}$: Investment in corporate governance is not a profitable deviation due to the assumption that $\overline{G} \geq \pi_G$. □

The infinite repetition of the unique one-period equilibrium is not the unique equilibrium in the multi-period model. If the shareholder conditions future funding on the manager's past investment behavior, there are other candidate equilibriums with positive funding ($F_t^0 > 0$).[11] These candidate equilibriums consist of a cooperation phase and a potential punishment phase. During the cooperation phase, the shareholder employs a trigger strategy that leaves large cash holdings to the

[11] If the shareholder does not condition funding on the past, we are principally in the one-period case where the uniquely optimal funding with $G_t = 0$ is $F_t^0 = 0$.

manager's discretion without controlling the latter's investment decision ($G^* = 0$). In this phase, the shareholder expects the manager to invest one unit of capital in the good and not to invest at all in the bad investment state: $I^* = 1$ if $\theta_t = 1$ and $I^* = 0$ if $\theta_t = 0$. If the manager betrays the shareholder's trust by wasting funds on negative NPV projects, he triggers the punishment phase of the equilibrium strategy: the withdrawal of all funds in the future.[12] In this game with certain project returns, I restrict the attention to the most severe punishment strategy: The shareholder punishes any waste by the manager forever (grim trigger). Trigger strategies that allow the manager some waste are interior solutions to the shareholder's optimization and are thus strictly dominated because the shareholder has all the bargaining power in this game.

I prove that these candidate equilibriums are indeed Nash equilibriums by showing that neither the manager, nor the shareholder have an incentive to deviate.

Lemma 3. *The manager has no profitable deviation in the cooperation phase of the candidate Trigger-Equilibrium if $\phi \leq \beta$ or $F_t^0 \leq \frac{p\beta\phi}{\phi-\beta}$.*

Proof. See Subsection B.1 in the appendix. $\square$

The upper bound on the amount of cash that can be left to the manager's discretion depends on certain firm and manager characteristics:

The threshold exists only for $\phi > \beta$. If the future is important to the manager and/or the empire-building preferences are weak ($\beta > \phi$), the manager complies with the Trigger-Equilibrium at any level of cash (F_t^0) in order to derive utility in the future.

The threshold increases in the manager's care for the future, as $\frac{\delta\left(\frac{p\beta\phi}{\phi-\beta}\right)}{\delta\beta} = \frac{p\phi^2}{(\phi-\beta)^2} > 0$, and in the probability of a positive NPV project, as $\frac{\delta\left(\frac{p\beta\phi}{\phi-\beta}\right)}{\delta p} = \frac{\beta\phi}{\phi-\beta} > 0$. The threshold decreases in the manager's empire-building interests $\left(\frac{\delta\left(\frac{p\beta\phi}{\phi-\beta}\right)}{\delta\phi} = \frac{-p\beta^2}{(\phi-\beta)^2} < 0\right)$.

[12] The shareholder punishes the manager with the No-Production-Equilibrium (the unique equilibrium of the one-period model).

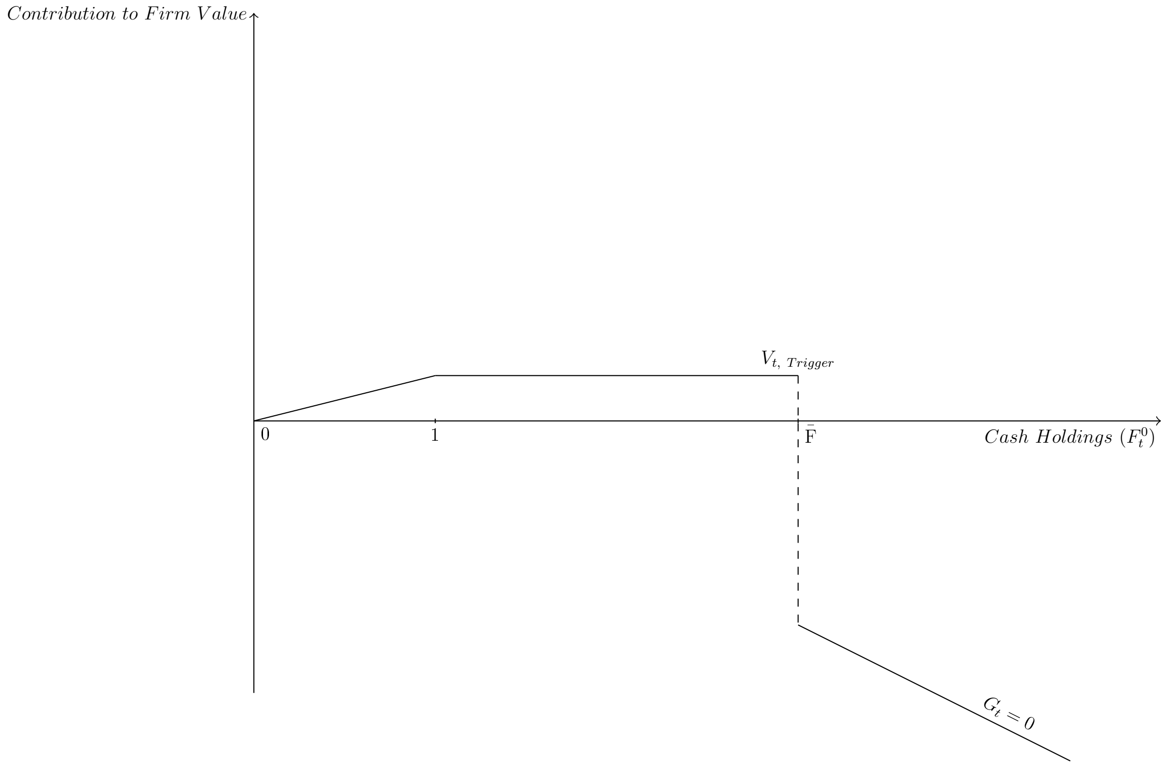
The shareholder compares firm values in the candidate Trigger-Equilibrium with the alternative firm value in the No-Production-Equilibrium. The firm value in the Trigger-Equilibrium is equal to $V = \sum_{j=0}^{\infty} \beta^j \pi_G = \frac{1}{1-\beta}\pi_G$; in the No-Production-Equilibrium, it is $V = 0$. The shareholder prefers the infinite Trigger-Equilibrium over the No-Production-Equilibrium because $\frac{1}{1-\beta}\pi_G \geq 0$ is true by assumption. Therefore, the shareholder has no profitable one-sided deviation.

Proposition 2. *In the multi-period model, there is a sub-game-perfect Trigger-Equilibrium in addition to the sub-game-perfect infinite repetition of the unique one-period equilibrium. In this additional equilibrium, a lenient payout policy that leaves the manager with a lot of cash within certain boundaries* $\left(F_t^0 \leq \frac{p\beta\phi}{\phi-\beta}\right)$ *can create optimal investment incentives despite lax corporate governance* ($G_t = 0$)*: The manager only invests in positive NPV projects.*

Proof. Lemma 2 proves the first part: The infinite repetition of the one-period equilibrium is sub-game perfect in the multi-period model. According to the principle of one-shot deviation, the trigger strategy is sub-game perfect if players do not have any profitable deviation from the equilibrium strategy.[13] Lemma 3 proves that the manager has no incentive to deviate in the cooperation phase of the Trigger-Equilibrium by over-investing in negative NPV projects as long as $F_t^0 \leq \frac{p\beta\phi}{\phi-\beta}$. The shareholder has no incentive to deviate because $\frac{1}{1-\beta}\pi_G \geq 0$ is true by assumption. In the punishment phase, there are no incentives to deviate, neither for the manager, nor for the shareholder, because the No-Production-Equilibrium is sub-game perfect by Lemma 2. □

[13] The principle of one-shot deviation is a critical insight from multi-period programming, first formulated by Blackwell (1965). It states that a strategy profile is sub-game perfect if and only if there are no profitable one-shot deviations. For a proof cf., for instance, Mailath and Samuelson (2006).

Figure III.3: The Value of Cash: Multi-Period Model



Interpretation of Proposition 2. The multi-period setting improves the situation of firms with high costs in corporate governance: In the Trigger-Equilibriums, the shareholder can exploit the manager's private information without investment in corporate governance. The immediate availability of cash has the same benefits as in the one-period world: Outside financing is restricted in the multi-period world because the length of the relationship between the firm (the manager and the shareholder) and any outside investors is still short-term. The costs to free cash that result from managerial discretion in the one-period setting can be avoided in the multi-period case: As long as the manager's incentive compatibility constraint is met, he does not waste any cash.

In the infinitely repeated game, there is a sub-game perfect Nash equilibrium with higher average discounted payoffs than in the infinitely repeated Nash equilibrium of the stage game. Long-term principal-agent relationships can overcome the prisoner's dilemma of the one-period model. This sub-game perfect Nash equilibrium results as an application of the Folk Theorem.[14]

The Trigger-Equilibrium can only be implemented if the shareholder can credibly commit to withdraw funds in the future. The outside financing constraints, which follow endogenously from the assumption that $\pi_G - \pi_B < 0$, serve as a commitment device as they bond the destiny of the shareholder to that of the manager: If—in a different set-up—investment of one unit of capital was profitable on average ($\pi_G - \pi_B \geq 0$), the shareholder could only credibly commit to punish the manager by withdrawing funds up to one unit of capital (1-Production-Equilibrium) because outside financing constraints would be less tight. In practice, the impact of outside financing constraints could be important for cross-country comparisons: In countries where capital markets are underdeveloped and funds are more restricted, compliance with the Trigger-Equilibrium may be easier to achieve because the manager is aware that his future utility depends on the availability of internal funds.[15]

In summary, the multi-period model sets the stage for large cash holdings that optimize firm value. It still cannot explain why large cash holdings are necessary.

4.2 Extension 1: Extreme Situations

The empirical literature does not only struggle with the large cash holdings of some firms, but more precisely cannot convincingly explain why shareholders leave large cash holdings to the managers' discretion although the latter waste free cash on

[14] This version of the Folk Theorem that concerns sub-game perfect Nash equilibriums is due to Friedman (1971).

[15] Overall, there are two changes as outside financing becomes available ($\pi_G - \pi_B \geq 0$):

1. Switching from the 0- to a 1-Production-Equilibrium increases the manager's utility from deviation by $\frac{\beta}{1-\beta}$. In the Trigger-Equilibrium, compliance has an ambiguous effect on the manager's utility: The upper bound on F_t^0 increases in p, but is unaffected by an increase in H.
2. The Corporate-Governance-Equilibrium becomes less attractive if the increase in $[p(H-L)+L]$ is due to an increase in p, compared to an increase in H: The difference in firm values between the Corporate-Governance-Equilibrium and the 1-Production-Equilibrium is decreasing in p and unaffected by a change in H.

value-destroying projects. The following extension to the multi-period model yields exactly this paradoxical result: It is in the best interest of the profit-maximizing, rational shareholder to leave large cash holdings to the manager, which the latter wastes on negative NPV projects with a certain probability.

4.2.1 Changes in the Assumptions

In the extension of the multi-period model, the company faces so-called periods of extreme situations: In such extreme situations, the company only survives if it gains considerable size or market position by large-scale investment in physical projects (infinite horizon). Otherwise, the life of the company and, thus, the shareholder-manager interaction ends (finite horizon). These extreme situations could be waves of corporate takeovers in which firms either grow or are taken over by competitors ("eat or be eaten"). Extreme situations could also be evoked by new technological standards, such as (at least ex ante) the UMTS-licenses: Either firms invest in these new technologies and acquire the option to continue to grow in the future, or they are driven out of the market.

Technology. Extreme situations have three characteristics: They require large investment outlays; they are not foreseen; they are overall negative NPV projects. The occurrence of an extreme situation depends on the realization of the random variable $\varphi_t \ \epsilon \ \{0;1\}$: If $\varphi_t = 0$, a one-time investment of x units of capital is required to continue production in the future. If $\varphi_t = 1$, which is the case with probability q, firms can continue production irrespective of the investment level. The required investment outlay x is so high that investment in x units of physical assets is an overall negative NPV project even though it allows to continue the production. In particular, $x > 1$. Therefore, it is first-best not to invest x units in physical assets. The realization of θ_t is independent of the realizations of $\theta_{1,2,...(t-1)}$ and $\varphi_{1,2,...t}$ and the realization of φ_t is independent of the realizations of $\varphi_{1,2,...(t-1)}$ and $\theta_{1,2,...t}$. The baseline multi-period model (cf. Subsection 4.1) is just the special case with $q = 1$. The shareholder can observe both the realization of θ_t and the realization of φ_t before his funding decision at the annual shareholders' meeting if he invests $G = \overline{G}$.

Objectives. The manager again moves second and chooses the per-period investment (I_t) that maximizes $U = \sum_{t=0}^{\infty} (\beta^t u_t)$. As before, the shareholder chooses the contract offer that maximizes firm value: $U = \sum_{t=0}^{\infty} \beta^t DIV_t$.

4.2.2 Changes in the Analysis

In the multi-period model with extreme situations, the shareholder can choose between an infinite horizon (which necessitates large-scale investments in extreme situations) and a finite horizon. Cooperation necessitates that the shareholder commits to an infinite horizon. From the manager, cooperation requires optimal investment decisions, except in extreme situations in which the manager ensures the survival of the company.

The analysis proceeds in four steps: I first present candidate equilibriums. Then, I analyze the optimality conditions of the infinite Trigger-Equilibrium ($F_t^0 \geq x$) for the manager and for the shareholder. Third, I analyze the respective conditions for the finite Trigger-Equilibrium ($F_t^0 < x$). Fourth, I compare the infinite and the finite Trigger-Equilibriums from the point of view of the manager and of the shareholder.

Candidate Equilibriums. In an extreme situation, the shareholder cannot prevent the manager from overinvestment: If the manager's funds are not sufficient to guarantee the continuation of the production ($F_t^0 < x$), his uniform best response is to spend all available funds on physical assets, equivalent to the one-period model. If $F_t^0 \geq x$, the manager spends at least x in order to guarantee the survival of the company. Whether or not the manager contents himself with investment of x units of capital or wastes all available funds on negative NPV projects, depends on the shareholder's punishment strategy: If investment of x units already triggers punishment (it is overall a negative NPV project), the manager chooses his best deviation and spends all available funds, that is F_t^0. If investment of x units is not punished in an extreme situation, but only investment of more than x units triggers punishment, the manager might be satisfied with investment of x units of capital. The analysis distinguishes between two alternatives:

1. $F_t^0 \geq x$: The shareholder provides cash in excess of x. These large cash holdings allow the manager to invest x if $\varphi_t = 0$ and to prolong the life of the company infinitely (infinite Trigger-Equilibrium).

2. $F_t^0 < x$: The shareholder provides cash below x; production ends if $\varphi_t = 0$ (finite Trigger-Equilibrium).

The shareholder's funding decision ($F_t^0 \geq x$ or $F_t^0 < x$) determines the length of the principal-agent relationship.

Infinite Trigger-Equilibrium. The manager's incentive compatibility constraint needs to be respected in equilibrium at any point in time, both in extreme situations and in normal situations, in the good as well as in the bad investment state. The incentive constraint is hardest to satisfy in normal situations and in the bad investment state. In extreme situations, the manager is allowed to spend x units of cash on physical assets and, in the good investment state, he is allowed to spend at least one unit of cash.

Lemma 4. *The manager complies with the infinite Trigger-Equilibrium if* $\phi - \beta \leq 0$ or $F_t^0 \leq \frac{\beta\{qp\phi+(1-q)x\phi\}}{\phi-\beta}$. *The infinite Trigger-Equilibrium does not exist if* $0 < \phi - \beta - (1-q)\,\beta\phi$ *and* $\frac{qp\beta\phi}{\phi-\beta-(1-q)\beta\phi} < x$.

Proof. See Subsection B.2 in the appendix. □

The upper bound on the amount of cash that can be left to the manager's discretion depends on certain firm and manager characteristics:

The threshold only exists for $\phi > \beta$. If the future is very important to the manager and/or the manager's tendency to over-invest is weak, the shareholder can leave any amount of cash to the manager.

The threshold increases in the probability of a positive NPV project, as $\frac{\delta\left(\frac{p\beta\phi}{\phi-\beta}\right)}{\delta p} = \frac{\beta q\phi}{\phi-\beta} > 0$; in the probability that an extreme situation occurs, as $\frac{\delta\left(\frac{p\beta\phi}{\phi-\beta}\right)}{\delta(1-q)} = \frac{\beta\phi(x-p)}{\phi-\beta} > 0$; in the manager's care for the future $\frac{\delta\left(\frac{\beta\{qp\phi+(1-q)x\phi\}}{\phi-\beta}\right)}{\delta\beta} = \frac{\beta\phi^2\{qp+(1-q)x\}}{(\phi-\beta)^2} > 0$; and in the size of the investment required in an extreme situation, as $\frac{\delta\left(\frac{p\beta\phi}{\phi-\beta}\right)}{\delta x} = \frac{\beta\phi(1-q)}{\phi-\beta} > 0$. The threshold decreases in the magnitude of the manager's empire-building interests, as $\frac{\delta\left(\frac{p\beta\phi}{\phi-\beta}\right)}{\delta\phi} = \frac{-\beta[\beta(1-q)x+qp\phi]}{(\phi-\beta)^2} < 0$.

Compared to the multi-period model without extreme situations $\left(F_t^0 \leq \frac{\beta p\phi}{\phi-\beta}\right)$, the upper bound on cash holdings is increased by the allowed waste of x, multiplied by the manager's preference for physical assets (ϕ), and multiplied by the probability of an extreme situation $(1-q)$.

The shareholder's optimal contract offer can be derived from comparing the value of the firm in the infinite Trigger-Equilibrium with the value of the firm in the alternative No-Production-Equilibrium.

Lemma 5. *The shareholder weakly prefers the infinite Trigger-Equilibrium over the No-Production-Equilibrium if* $(1-q)(x-p)(1-L) \leq \pi_G$ *, which is equivalent to* $x \leq \frac{\pi_G}{(1-q)(1-L)} + p$.

Proof. See Subsection B.3 in the appendix. □

The shareholder prefers the infinite Trigger-Equilibrium over the No-Production-Equilibrium if the waste that he has to allow in extreme situations is not too high on average over a positive and negative investment state: $(x-p)$ times the present value of the expected damage from investment in negative NPV projects $(1-L)$, multiplied by the probability of an extreme situation $(1-q)$, must not exceed the expected profits from investment in the good investment state. This condition yields an upper bound on x. This upper bound increases both in H and in L

$\left(\frac{\delta\left(\frac{p(H-1)}{(1-q)(1-L)}+p\right)}{\delta H} = \frac{p}{(1-q)(1-L)} > 0; \frac{\delta\left(\frac{p(H-1)}{(1-q)(1-L)}+p\right)}{\delta L} = \frac{p(H-1)}{(1-q)(1-L)^2} > 0\right)$: If the return on the positive NPV project increases, the shareholder is willing to accept higher waste in an extreme situation in order to establish the infinite Trigger-Equilibrium. Hence, dispersion in project returns (greater distance between H, the return on a positive NPV project, and L, the return on a negative NPV project) widens the range for the infinite Trigger-Equilibrium. Analogously, the upper bound on x increases in the probability of a good state $\left(\frac{\delta\left(\frac{p(H-1)}{(1-q)(1-L)}+p\right)}{\delta p} = \frac{(H-1)}{(1-q)(1-L)} + 1 > 0\right)$ and decreases in the probability of an extreme situation $\left(\frac{\delta\left(\frac{p(H-1)}{(1-q)(1-L)}+p\right)}{\delta(1-q)} = -\frac{p(H-1)}{(1-q)^2(1-L)} < 0\right)$.

Finite Trigger-Equilibrium. In a finite Trigger-Equilibrium, the manager always invests all available funds in physical assets in an extreme situation: The shareholder cannot satisfy the incentive compatibility constraint in extreme situations if $F_t^0 < x$. In a normal situation, the manager's incentive compatibility constraint is again hardest to satisfy in the bad investment state.

Lemma 6. *The manager complies with the finite Trigger-Equilibrium if $\phi \leq \beta$ or $F_t^0 \leq \frac{\beta q p \phi}{\phi-\beta}$. The finite Trigger-Equilibrium with $F_t^0 = 1$ does not exist if $\phi - \beta > 0$ and $\frac{qp\beta\phi}{\phi-\beta} < 1$.*

Proof. See Subsection B.4 in the appendix. □

Compared to the infinite Trigger-Equilibrium, the upper bound on cash holdings in the finite Trigger-Equilibrium is tighter: $F_t^0 \leq \frac{qp\beta\phi}{\phi-\beta}$ (finite), compared to $F_t^0 \leq \frac{\beta\{qp\phi+(1-q)x\phi\}}{\phi-\beta} = \frac{qp\beta\phi}{\phi-\beta} + \frac{(1-q)x\phi}{\phi-\beta}$ (infinite): The fact that the principal-agent relationship ends after an extreme situation (and, hence, the manager's chance of future benefits from control) decreases the manager's incentives to comply.

Lemma 7. *The shareholder weakly prefers the finite Trigger-Equilibrium over the No-Production-Equilibrium if $(1-q)\,\pi_B \leq \pi_G$.*

Proof. See Subsection B.5 in the appendix. □

This condition is almost the same as for the infinite Trigger-Equilibrium with the mere difference that the average waste in an extreme situation is only $(1-p)$, instead of $(x-p)$: The manager wastes free cash for sure if the survival of the company is at stake. The shareholder optimally sets $F_t^0 = 1$ to minimize the waste in extreme situations. In addition, smaller cash holdings help to satisfy the manager's incentive compatibility constraint.[16]

Infinite versus finite Trigger-Equilibriums. I assume that the continuation of the production in an extreme situation is a negative NPV project. This assumption makes the infinite Trigger-Equilibrium unattractive relative to the finite one because the former promises the infinite continuation of the production, but the latter does not.

Lemma 8. *The shareholder weakly prefers the infinite Trigger-Equilibrium over the finite one if* $\pi_G\left(\frac{1}{1-\beta}-\frac{1}{1-\beta q}\right) \geq (1-q)\left[\pi_B\left(\frac{1}{1-\beta}-\frac{1}{1-\beta q}\right)+\frac{1}{1-\beta}(x-1)(1-L)\right]$. *The infinite Trigger-Equilibrium does not exist, but the finite Trigger-Equilibrium exists if* $\frac{\beta q p \phi}{\phi-\beta} < 1 < x < \frac{\beta q p \phi}{\phi-\beta-\beta\phi(1-q)}$. *The finite Trigger-Equilibrium does not exist, but the infinite Trigger-Equilibrium exists if* $\phi-\beta-\beta(1-q)\phi < 0 < \phi-\beta$.

Proof. See Subsection B.6 in the appendix. □

On the one hand, the shareholder earns the same expected profits per period in the infinite as in the finite Trigger-Equilibrium, but for a longer period of time: $\left(\frac{1}{1-\beta}-\frac{1}{1-\beta q}\right)$. On the other hand, the costs to infinite horizons are higher because the shareholder has to accommodate investment of x units in extreme situations (instead of just 1 unit in the finite Trigger-Equilibrium). The waste in extreme situations occurs forever. As opposed to that, the waste in the finite Trigger-Equilibrium ends with the discontinuation of the production.

[16] In the infinite Trigger-Equilibriums, in contrast, any level of cash holdings $x \leq F_t^0 \leq \frac{\beta\{qp\phi+(1-q)x\phi\}}{\phi-\beta}$ is optimal.

If the extreme situation coincides with a good investment state, the finite Trigger-Equilibrium is always superior to the infinite Trigger-Equilibrium because there is no waste at all in the finite Trigger-Equilibrium, but there is some waste in the infinite one. If the extreme situation coincides with a bad investment state, the infinite Trigger-Equilibrium can yield higher firm value: In the finite Trigger-Equilibrium, the manager also wastes one unit of capital, but without receiving in return the prospects of future profits as in the infinite Trigger-Equilibrium.

One can imagine at least two additional reasons why the shareholder chooses the infinite Trigger-Equilibrium instead of the finite one:

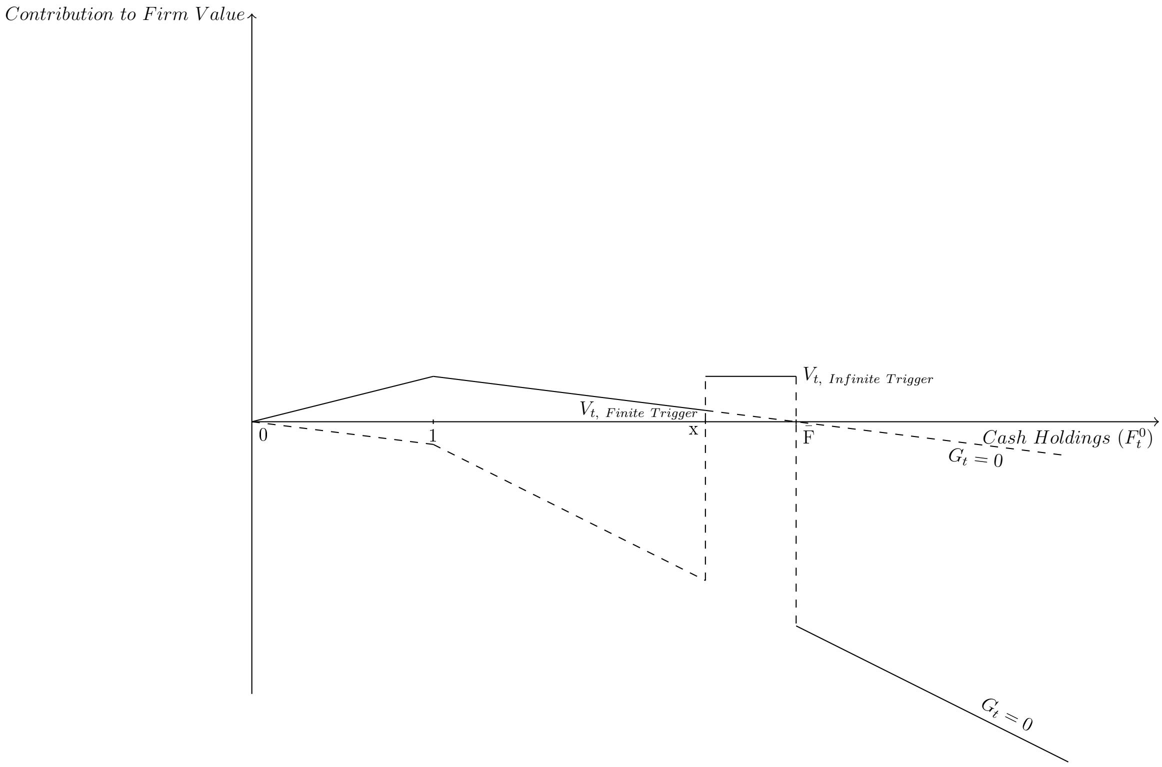
1. The infinite Trigger-Equilibrium gives higher private benefits from control to the manager $\left\{\frac{1}{1-\beta}\left[qp\phi + (1-q)\,x\phi + F_t^0\,(1-\phi)\right]\right\}$ than the finite Trigger-Equilibrium $\left\{\frac{1}{1-\beta q}\left[p\phi + (1-\phi)\right]\right\}$.

2. Long-term principal-agent relationships offer additional non-financial benefits that are higher with an infinite than with a finite horizon.

Proposition 3. *In the multi-period model with extreme situations, there are two kinds of Trigger-Equilibriums with lax corporate governance ($G_t = 0$): In the infinite Trigger-Equilibrium, the firm holds large cash holdings: $x \leq F_t^0 \leq \frac{\beta\{qp\phi+(1-q)x\phi\}}{\phi-\beta}$ if $\phi - \beta > 0$ and $x \leq F_t^0$ if $\phi - \beta \leq 0$. In the finite Trigger-Equilibrium, the firm holds moderate levels of cash ($F_t^0 = 1$). If $(1-q)\,\pi_B \leq \pi_G$, the shareholder weakly prefers the finite Trigger-Equilibrium over the No-Production-Equilibrium; if $(1-q)\,(x-p)\,(1-L) \leq \pi_G$, the infinite Trigger-Equilibrium over the No-Production-Equilibrium; if $\pi_G\left(\frac{1}{1-\beta} - \frac{1}{1-\beta q}\right) \geq (1-q)\left[\pi_B\left(\frac{1}{1-\beta} - \frac{1}{1-\beta q}\right) + \frac{1}{1-\beta}\,(x-1)\,(1-L)\right]$, the infinite over the finite Trigger-Equilibrium.*

Lemma 4 proves that the manager has no incentive to deviate in the cooperation phase of the infinite Trigger-Equilibrium as long as $F_t^0 \leq \frac{\beta\{qp\phi+(1-q)x\phi\}}{\phi-\beta}$ or $\phi-\beta < 0$. By Lemma 5, the shareholder weakly prefers the infinite Trigger-Equilibrium over the alternative No-Production-Equilibrium if $(1-q)(x-p)(1-L) \leq \pi_G$. The punishment phase is sub-game perfect by Lemma 2. Lemma 6 proves that the manager has no incentive to deviate in the cooperation phase of the finite Trigger-Equilibrium as long as $F_t^0 \leq \frac{qp\beta\phi}{\phi-\beta}$ or $\phi-\beta<0$. By Lemma 7, the shareholder prefers the finite Trigger-Equilibrium over the alternative No-Production-Equilibrium as long as $(1-q)\pi_B \leq \pi_G$. The punishment phase is sub-game perfect by Lemma 2. If $\pi_G\left(\frac{1}{1-\beta}-\frac{1}{1-\beta q}\right) \geq (1-q)\left[\pi_B\left(\frac{1}{1-\beta}-\frac{1}{1-\beta q}\right)+\frac{1}{1-\beta}(x-1)(1-L)\right]$, the shareholder prefers the infinite Trigger-Equilibrium over the finite Trigger-Equilibrium by Lemma 8.

Figure III.4: The Value of Cash: Multi-Period Model with Extreme Situations



Interpretation of Proposition 3. Finite Trigger-Equilibriums allow the manager certain waste in extreme situations, but not enough to guarantee the survival of the company. In contrast, infinite Trigger-Equilibriums accommodate the manager's wasteful investment of x units of capital in extreme situations in order to guarantee the survival of the company. Infinite Trigger-Equilibriums only exist if the shareholder credibly commits to infinite horizons. However, formal commitment to long-term funding strategies is not credible by assumption. Otherwise, neither the implementation of corporate governance, nor large cash holdings would be necessary to induce optimal investment incentives. Therefore, other commitment devices are necessary: High costs in corporate governance can commit the shareholder not to observe the realizations of the random variables θ_t and φ_t. After the shareholder has observed $\varphi_t = 0$, it is never optimal to continue the production. With $G_t = \overline{G}$, the Trigger-Equilibrium could still be a Nash-Equilibrium, but would not be subgame perfect. This time-inconsistency problem is solved by high $\overline{G}$ that makes the acquisition of information about the realization of φ_t too expensive. In this sense, high governance costs are a prerequisite for the infinite Trigger-Equilibrium to exist. This insight has practical implications: The Trigger-Equilibrium can only be implemented in firms that implement lax corporate governance because they cannot afford corporate governance. Country-wide corporate governance regulations with the goal to decrease $\overline{G}$ can hinder the otherwise optimal Trigger-Equilibrium and, thus, reduce firm value. High costs in corporate governance make the Trigger-Equilibrium attractive, not only for the shareholder, but also for the manager. Further, high $\overline{G}$ makes the Trigger-Equilibrium more likely: For $\overline{G} \geq \pi_G$, the punishment equilibrium is the No-Production-Equilibrium, not the Corporate-Governance-Equilibrium. The former offers lower utility for the manager in the punishment phase and, hence, more likely achieves cooperation.

4.3 Extension 2: Product Market Competition

The analysis so far shows: Large cash holdings can substitute for expensive corporate governance. Therefore, it can be optimal for the shareholder to leave large cash holdings to the manager's discretion at the expense that the latter wastes free cash on negative NPV projects in so-called extreme situations. The following extension adds product market competition to the multi-period model with extreme situations. The analysis of this extension yields an even more paradoxical result: Only the competitor with high costs in corporate governance can credibly commit to aggressive large-scale investment in extreme situations. The competitor with low costs in corporate governance has a competitive disadvantage that even results in a lower firm value.

4.3.1 Changes in the Model

There are two competing firms $(i = 1, 2)$. Each of them faces the multi-period principal-agent conflict with extreme situations as described in Section 4.2. The competitors move simultaneously and only differ in their costs for corporate governance, that is, in the ease with which the shareholders of the two firms control the managers: $\overline{G}_1 < \overline{G}_2$. I assume that

$$\begin{aligned}
q\beta\pi_G - \tfrac{1-q\beta}{1-\beta}\left\{\beta\pi_G - (1-q)(x-p)(1-L)\right\} &\leq \overline{G}_1, \\
\pi_{G,duopoly} - \tfrac{1-q\beta}{1-\beta}\left\{\pi_{G,duopoly} - (1-q)(x-p)(1-L)\right\} &> \overline{G}_1, \quad \text{and} \\
\pi_{G,duopoly} - \tfrac{1-q\beta}{1-\beta}\left\{\pi_{G,duopoly} - (1-q)(x-p)(1-L)\right\} &< \overline{G}_2 \qquad \text{(III.11)}
\end{aligned}$$

The asymmetry in the competitors' costs for corporate governance is important: If the competitors were completely identical, we would expect symmetric equilibriums in pure strategies (where either both firms invest or none of them invests) or in mixed strategies (where the two firms randomize with the same probabilities over investment and non-investment). With differences in $\overline{G}$, it is possible to analyze the impact of the costs for corporate governance on the product market competition. The extension of the model to product market competition leads to consecutive changes in the main assumptions of the model: the technology, the players' objectives, and the constraints to the set of feasible contracts.

Technology. Both firms own the right to invest in the same production technology. They share the exogenous investment opportunities. As before, the production technology is characterized by fluctuations in investment opportunities and by the occurrence of extreme situations. Product market competition materializes in both aspects. In the good investment state, both firms compete for the one positive NPV project (H): Firm 1 earns gross present value of H if firm 1 invests one unit, and firm 2 does not invest at all; if both firms invest, either firm earns half of the cash flows from the positive and half of the cash flows from a consecutive negative NPV project: $CF_{i,t} = \frac{1}{2}H + \frac{1}{2}L$. Furthermore, product market competition is material with respect to investment in extreme situations: If only one of the firms continues operations in the case of $\varphi_t = 0$ (asymmetric equilibrium), the surviving firm earns monopoly profits afterwards.

I again analyze the parameter range for which outside financing is endogenously restricted: $\pi_G + \pi_H < 0$. As before, I require that investment of one unit of capital is a positive NPV project in the good investment state and a negative NPV project in the bad investment state even if both competitors invest: $\frac{1}{2}(H + L) \geq 1$ and $L < 1$.[17] I define the expected profit from investing only in the good investment state as $\pi_{G,duopoly} = p\left[\frac{1}{2}(H + L) - 1\right]$. $\pi_{infinite,duopoly}$ describes the duopoly firm value in the infinite Trigger-Equilibrium; $\pi_{infinite,monopoly}$ describes the monopoly firm value in the infinite Trigger-Equilibrium.

Objectives. Product market competition does not change the shareholder's and manager's objective functions.

Feasible Contracts. For a meaningful analysis, I need to impose an additional constraint: The competing firms are not allowed to collude in order to form a

[17] This requirement simplifies the analysis because it allows for symmetric equilibriums in pure strategies. In contrast, for $\frac{1}{2}(H + L) < 1 \leq H$, symmetric equilibriums would only occur in mixed strategies. However, the analysis can easily be transferred to this latter parameter range and mixed-strategy equilibriums.

monopoly. The right to the production technology cannot be sold, but, of course, both firms can end the production at any point in time.

4.3.2 Changes in the Analysis

In extreme situations, firm 2, which is characterized by high costs in corporate governance, can drive the competing firm 1, characterized by low costs in corporate governance, out of the market by committing to aggressive large-scale investment. For a firm with high costs in corporate governance, such a commitment to large-scale investment and, hence, to long horizons is credible: Long horizons are necessary in order to solve the internal manager-shareholder conflict in the infinite Trigger-Equilibrium because costs for corporate governance are prohibitively high. In contrast, the competitor with low costs in corporate governance optimally solves the internal principal-agent conflict by implementing corporate governance, and, hence, lacks such a credible commitment device. Therefore, low costs in corporate governance lead to a strategic competitive disadvantage.

Lemma 9. *If* $\overline{G} < \pi_{G,duopoly} - \frac{1-q\beta}{1-\beta}\left\{\pi_{G,duopoly} - (1-q)(x-p)(1-L)\right\}$*, the shareholder strictly prefers the Corporate-Governance-Equilibrium over the infinite Trigger-Equilibrium if he can only earn duopoly profits after an extreme situation. If* $\overline{G} > q\beta\pi_G - \frac{1-q\beta}{1-\beta}\left\{\beta\pi_G - (1-q)(x-p)(1-L)\right\}$*, the shareholder strictly prefers the infinite Trigger-Equilibrium over the Corporate-Governance-Equilibrium if he can earn monopoly profits after an extreme situation.*

The threshold for $\overline{G}$ *is higher if the company can only earn duopoly profits after an extreme situation:*

$$\begin{aligned} \beta\pi_G - \tfrac{1-q\beta}{1-\beta}\left\{\beta\pi_G - (1-q)(x-p)(1-L)\right\} &< \\ \pi_{G,duopoly} - \tfrac{1-q\beta}{1-\beta}\left\{\pi_{G,duopoly} - (1-q)(x-p)(1-L)\right\} & \end{aligned} \qquad \text{(III.12)}$$

Firm value in the Corporate-Governance-Equilibrium with duopoly profits after an extreme situation equals: $\frac{1}{1-\beta}\left\{\pi_{G,duopoly} - (1-q)(x-p)(1-L)\right\}$*. Firm value* *in the infinite Trigger-Equilibrium with monopoly profits after an extreme situation equals:* $\frac{1}{1-\beta}\left\{\beta\pi_G-(1-q)(x-p)(1-L)\right\}+\frac{1}{1-q\beta}\left\{\pi_{G,duopoly}-q\beta\pi_G\right\}$*. Firm value in the Corporate-Governance-Equilibrium equals:* $\frac{1}{1-\beta q}\left\{\pi_{G,duopoly}-\overline{G}\right\}$.

Proof. See Subsection B.7 in the appendix. □

If the competitor continues operations after an extreme situation (duopoly), the shareholder of firm 1, with the lower costs in corporate governance, prefers to solve the principal-agent conflict between the shareholder and the manager by implementing corporate governance, which implies that production ends after an extreme situation. If the competitor discontinues operations after an extreme situation (monopoly), the shareholder of firm 1 prefers to solve this internal principal-agent conflict by implementing the infinite Trigger-Equilibrium.

Independent of the competitor's action, the shareholder of firm 2, with higher costs in corporate governance, strictly prefers to solve the internal principal-agent conflict by implementing the infinite Trigger-Equilibrium compared to investment in corporate governance. He credibly commits to aggressive large-scale investment in an extreme situation.

Proposition 4. *If* $x\leq\frac{\pi_{G,duopoly}}{(1-q)(1-L)}+p$*, the value of firm 2 with* $\overline{G}_2$ *exceeds the value of firm 1 with* $\overline{G}_1$*, where:*

$$\begin{aligned} q\beta\pi_G-\tfrac{1-q\beta}{1-\beta}\left\{\beta\pi_G-(1-q)(x-p)(1-L)\right\} &\leq \overline{G}_1, \\ \pi_{G,duopoly}-\tfrac{1-q\beta}{1-\beta}\left\{\pi_{G,duopoly}-(1-q)(x-p)(1-L)\right\} &> \overline{G}_1, \quad \text{and} \\ \pi_{G,duopoly}-\tfrac{1-q\beta}{1-\beta}\left\{\pi_{G,duopoly}-(1-q)(x-p)(1-L)\right\} &< \overline{G}_2 \end{aligned} \tag{III.13}$$

Proof. Analogous to Lemma 5, $x\leq\frac{\pi_{G,duopoly}}{(1-q)(1-L)}+p$ guarantees that the shareholder of firm 1 prefers the infinite Trigger-Equilibrium (with duopoly profits after an extreme situation) over the No-Production-Equilibrium. By Lemma 9, firm 2 with

$$\pi_{G,duopoly} - \frac{1-q\beta}{1-\beta}\left\{\pi_{G,duopoly} - (1-q)(x-p)(1-L)\right\} < \overline{G}_2 \tag{III.14}$$

strictly prefers the infinite Trigger-Equilibrium over the Corporate-Governance-Equilibrium, independent of firm 1's action.

By Lemma 9, firm 1 with

$$\begin{aligned} q\beta\pi_G - \frac{1-q\beta}{1-\beta}\left\{\beta\pi_G - (1-q)(x-p)(1-L)\right\} \leq & \quad \overline{G}_1, \text{ and} \\ \pi_{G,duopoly} - \frac{1-q\beta}{1-\beta}\left\{\pi_{G,duopoly} - (1-q)(x-p)(1-L)\right\} > & \quad \overline{G}_1 \end{aligned} \tag{III.15}$$

strictly prefers the Corporate-Governance-Equilibrium, given firm 2's choice of the infinite Trigger-Equilibrium. By Lemma 9, the value of firm 1 is equal to

$$V = \frac{1}{1-\beta q}\left\{\pi_{G,duopoly} - \overline{G}_1\right\}. \tag{III.16}$$

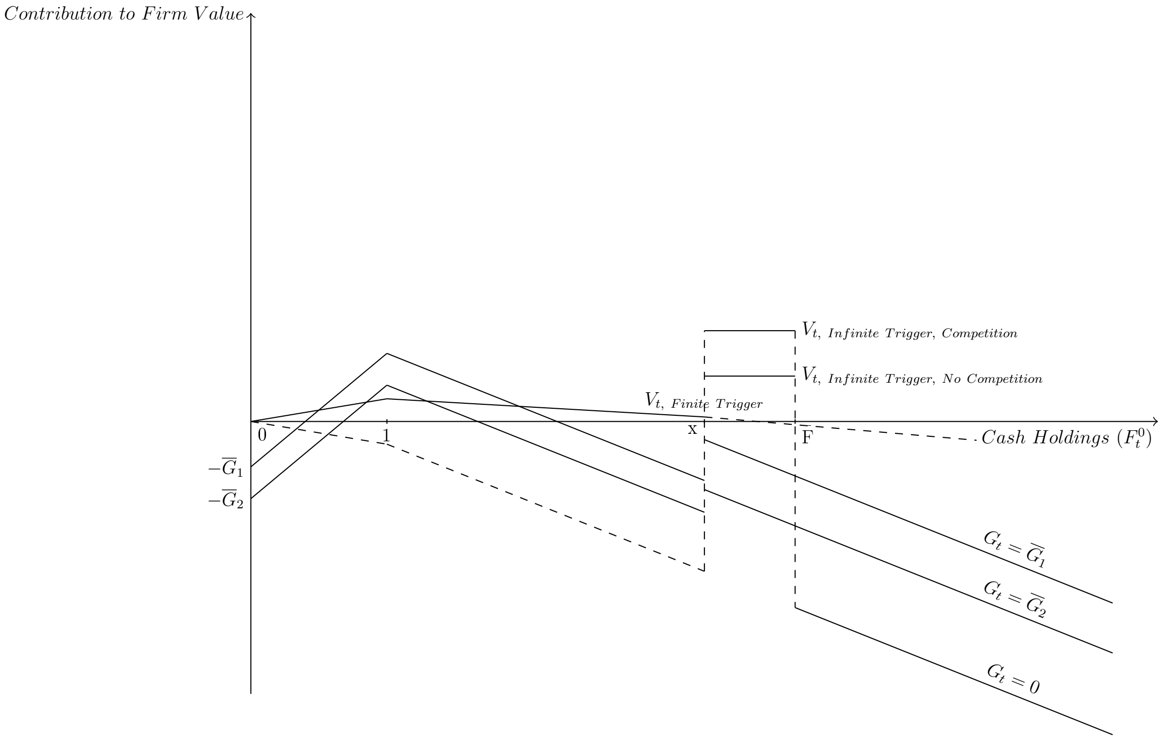
The value of firm 1 is lower than that of firm 2 equal to

$$\frac{1}{1-\beta}\left\{\beta\pi_G - (1-q)(x-p)(1-L)\right\} + \frac{1}{1-q\beta}\left\{\pi_{G,duopoly} - q\beta\pi_G\right\} \tag{III.17}$$

because firm 1 would also prefer the infinite Trigger-Equilibrium if it was able to earn monopoly profits after an extreme situation (by Lemma 9). □

Interpretation of Proposition 4. In the multi-period model with extreme situations and product market competition, firm 2 paradoxically benefits from high costs in corporate governance that are an unambiguous detriment to firm value in the one-period model. Large cash holdings serve two goals: First, they solve the internal

Figure III.5: The Value of Cash: Multi-Period Model with Competition



principal-agent conflict between the manager and the shareholder by establishing long horizons that align the conflicting interests of both parties. Second, large cash holdings in the hands of an empire-building manager serve as a threat to the competitor. High costs in corporate governance serve as a commitment device to aggressive investment behavior in extreme situations and, hence, earn firm 2 a strategic advantage over its competitor: They drive firm 1 out of the market.

5 Empirical Evidence

My model offers a framework in which otherwise puzzling empirical observations with respect to corporate cash holdings can be rationalized. Furthermore, the analysis of the model guides towards several testable predictions:

The Level of Cash Holdings. Empirical studies so far fail to convincingly explain why some firms hold surprisingly large cash holdings. These studies use traditional firm characteristics to explain the level of cash holdings. The analysis of my model shows that certain types of firms use large cash holdings to solve an internal principal-agent conflict between the shareholder and the manager of the firm. These firms are characterized by a particular interest in long-term principal-agent relationships and have typically high costs in corporate governance.

The Value of Cash Holdings. The marginal contribution of cash to firm value is often perceived to be negative, in particular for firms with large cash holdings. I offer a rational explanation why certain firms optimally hold large amounts of cash even if these cash holdings show a negative marginal contribution to firm value. The analysis of this model yields a Trigger-Equilibrium in which the manager of the firm is allowed to invest free cash in negative NPV projects from time to time, namely in so-called extreme situations. This controlled waste is costly and makes the marginal contribution of cash appear to be negative.

However, the value of cash in firms without any principal-agent conflict is the wrong point of comparison. The value of cash in trigger firms rather has to be compared with the value of cash in firms with a principal-agent problem. From this perspective, cash holdings contribute to firm value in a positive way.

The Impact of Corporate Governance. There is empirical evidence that corporate governance increases the value of cash, at least in some firms. However, in firms with extremely high cash holdings, corporate governance plays a negligible role for the manager's investment behavior. Exceptions are firms with lax corporate governance that spend more on (value-decreasing) acquisitions.

In the one-period version of my model, stricter corporate governance increases firm value, provided that the costs for corporate governance are moderate. In the multi-period version, corporate governance can even detriment firm value: Lax corporate governance may be necessary to commit to the long-term Trigger-Equilibrium. Anti-takeover provisions are a prominent measure of “good corporate governance” (cf. e.g., Dittmar and Mahrt-Smith, 2007) and also part of the widely used index by Gompers, Ishii, and Metrick (2003), used, for instance, in Bates, Kahle, and Stulz (2009). Anti-takeover provisions provide an example of corporate governance laws that harm firm value by hindering the Trigger-Equilibrium. If cash holdings are high, but valued below parity, as it can occur very well in the Trigger-Equilibrium, then the firm risks to be taken over and to lose private benefits of control. Anti-takeover provisions shield the manager from the scrutiny of outside capital markets. This type of lax corporate governance is an almost necessary concomitant measure to make the Trigger-Equilibrium possible because corporate take-overs endanger the manager’s control benefits needed to establish the long-term Trigger-Equilibrium.

Suggestions for Empirical Tests. Companies with a particular interest in long-term principal-agent relationships and companies with high costs for corporate governance should have higher levels of cash accompanied by lax corporate governance. An empirical test should, therefore, measure a firm’s interest in long-term relationships and its costs for corporate governance. A firm’s interest in long-term relationships can be originated in non-financial benefits: These benefits mainly arise from the relationship with other stakeholders, such as customers, suppliers, employees etc. Some firms rely on firm-specific investment, which is partly born by outside stakeholders, such as employees as far as investment in firm-specific human capital is concerned, customers as to their reliance on long-term customer care and suppliers as to their investment in firm-specific equipment. These stakeholders are more willing to invest in the relationship with the firm if they expect the firm to continue production for a long time. Studies already have linked the need for firm-specific investment (particularly with respect to the employee’s investment in firm-specific human capital) to corporate capital structure (e.g., Jaggia and Thakor, 1994; Titman, 1984). An analogous link could be drawn between the need for firm-specific investment and corporate cash holdings: In the Trigger-Equilibrium, high cash holdings can ensure that the company survives extreme situations. High costs in corporate governance could be measured at the country level as specific governance codes differ across countries.

The time-series dimension of cash holdings may turn out to be more important than the cross-section at one particular point in time. Firms with persistently high cash holdings and lax corporate governance are likely to be trigger firms with a relatively high value of cash holdings. Therefore, empirical tests should look at the dynamics in cash holdings, rather than the bare holding of cash (such as Mikkelson and Partch, 2003).

Firms with lax corporate governance should show more variation both in the level and in the value of cash. The analysis of the model shows that there are two sub-game perfect equilibriums for firms with high costs and, hence, optimally lax corporate governance: (1) Low levels of cash that restrict the managerial discretion and (2) high levels of cash in the Trigger-Equilibrium. For firms that choose to restrict the managerial discretion (1), the value of additional cash holdings is negative because the manager is going to waste any free cash. In contrast, the value of additional cash holdings in trigger firms is almost the same as in firms with strict corporate governance.

Measures of corporate governance should be divided into two categories: The first category comprises measures that reduce the "conflict of interest" between the principal and the agent. Measures of the second category reduce the "managerial discretion" that is necessary for the manager to pursue his own interests. Measures of this first category should have a positive impact on the value of cash holdings. Measures of the second category can detriment firm value, especially in firms with large cash holdings. If the firm has solved the conflict of interest between the shareholder and the manager by implementing measures of the first category, it is harmless to leave excessive cash to the manager's discretion. If measures of corporate governance only diminish asymmetric information between the principal and the agent and, thereby, the manager's discretion to pursue his own conflicting interests, then it may be necessary to tie such measures to low levels of cash, due to unsolved conflicts of interest. Putting it simply: It is always good to solve the conflict of interest if such a solution is not too expensive. It is not always good to solve the principal-agent problem by other measures of corporate governance: Control mechanisms that restrict the manager's discretion are not compatible with the Trigger-Equilibrium that relies on the virtue of excessive cash holdings.

6 Conclusions

My ultimate recommendation for corporate policy is to look at bundles of cash holdings and corporate governance, rather than to consider both choices in isolation. A unilateral decrease in the level of corporate cash holdings as well as a unilateral increase in the level of corporate governance can be harmful even if each of these measures seems appropriate in order to increase firm value: Corporate cash holdings often show a negative marginal value (at least in badly governed firms) and corporate governance should theoretically be appropriate to increase firm value as long as involved costs are not excessive. However, both measures can destroy the long-term Trigger-Equilibrium and, hence, destroy firm value. Therefore, I recommend to choose the level of cash holdings and the level of corporate governance simultaneously. If one cuts down cash holdings without implementing stricter corporate governance and ignores that cash holdings have been used as a substitute for corporate governance, one reduces firm value. If one implements stricter corporate governance without cutting down cash holdings and ignores that—despite its negative marginal contribution to firm value on the surface—cash is not wasted, exactly because corporate governance is lax, one reduces firm value as well. This decision is an "either-or" decision rather than a gradual choice: Either the shareholder decides to trust the manager and builds up a long-term relationship. Then, cash holdings have to be high and corporate governance lax. Or the shareholder decides to control the manager and to keep cash holdings tight. Getting "stuck in the middle" is most harmful to firm value.

Appendix

A Proofs: One-Period Model

A.1 Proof of Lemma 1

Kept separately, neither any choice of corporate governance $\left(G \in \{0; \overline{G}\}\right)$, nor any choice of corporate funding $(F^0 \in \{0, 1, ...\})$ are dominated. By the procedure of iterative elimination of strictly dominated strategies, I show that some combinations of G and F^0 are strictly dominated.

$G = \overline{G}$. Investment in corporate governance $\left(G = \overline{G}\right)$ enables the shareholder to observe the realization of θ before his funding decision. $G = \overline{G}$ only pays off if the shareholder puts this knowledge to use by conditioning funding (F^0) on the realization of θ. $G = \overline{G}$, combined with an unconditional funding strategy, is strictly dominated by $G = 0$ because investment in corporate governance is costly $\left(\overline{G} > 0\right)$. In particular, $G = \overline{G}$ and $F^0 = 0$ is not an equilibrium combination of strategies because this combination yields a negative firm value. In contrast, $G = 0$ and $F^0 = 0$ yields a firm value of 0. $F^0 = 0$ if $\theta = 0$, and $F^0 = 1$ if $\theta = 1$ is an equilibrium combination of strategies. It dominates any other funding strategy with $F^0 > 0$ if $\theta = 0$, and $F^0 > 1$ if $\theta = 1$ because these funding strategies allow investment in negative NPV projects.

$G = 0$. Without investment in corporate governance $(G = 0)$, $F^0 = 0$ is the unique equilibrium funding strategy, given the manager's best response is to invest all available funds in physical assets. $F^0 = 1$ is strictly dominated because investment in the production technology is a negative NPV project on average as $p\,(H - L) + L < 1$. $1 < F^0$ is also dominated because any investment in physical assets in excess of one unit reduces firm value $(L < 1)$.

B. Proofs: Multi-Period Model

B.1 Proof of Lemma 3

The manager's incentive compatibility constraint is more difficult to satisfy in the bad than in the good investment state. The utility from deviation is the same in both states, but the utility from compliance is lower in the bad investment state. The manager prefers investment in physical assets over cash holdings ($\phi > 0$). If $\theta = 1$, compliance with the candidate Trigger-Equilibrium requires that the manager invests one unit in physical assets. If $\theta = 0$, compliance requires that the manager does not invest at all in physical assets. As $\theta \sim iid$, the expected future utility is the same in both states. Therefore, it is sufficient to require compliance in the bad investment state.

In the bad investment state, the utility from compliance is the sum of two components:

1. $F_t^0 (1 - \phi)$: the utility from holding F_t^0 units of cash during the current period;
2. $\frac{\beta}{1-\beta} \{p\phi + F_t^0 (1 - \phi)\}$: the next-period value of the perpetuity of expected future per-period utility, where $p\phi$ is the product of the probability that $\theta = 1$ and ϕ, the additional utility from holding physical compared to financial assets; $F_t^0 (1 - \phi)$ are the private benefits from holding F_t^0 units of cash.

The utility from compliance results as:

$$F_t^0 (1 - \phi) + \frac{\beta}{1 - \beta} \left\{p\phi + F_t^0 (1 - \phi)\right\}. \tag{III.18}$$

The utility from deviation is the sum of the private benefits from spending all available funds on physical assets now (F_t^0) and getting 0 utility in all future periods (grim trigger punishment):[18]

[18]Since the shareholder is assumed to apply a grim trigger strategy that punishes any deviation infinitely, the manager's best deviation is to spend all available funds $\left(F_t^0\right)$ on physical assets.

$$F_t^0 + \frac{\beta}{1-\beta} * 0 = F_t^0. \tag{III.19}$$

The manager has no incentive to deviate if the utility from compliance in the bad investment state exceeds that from deviation:

$$\begin{aligned}
F_t^0 (1-\phi) + \tfrac{\beta}{1-\beta} \{p\phi + F_t^0 (1-\phi)\} &\geq F_t^0 \\
\tfrac{\beta}{1-\beta} * p\phi &\geq F_t^0 \left[1 - (1-\phi) - \tfrac{\beta}{1-\beta} (1-\phi)\right] \\
\tfrac{\beta}{1-\beta} * p\phi &\geq F_t^0 \left[1 - (1-\phi) - \tfrac{\beta}{1-\beta} (1-\phi)\right] \\
\tfrac{1}{1-\beta} * p\beta\phi &\geq F_t^0 \left[\tfrac{\phi-\beta\phi-\beta+\beta\phi}{1-\beta}\right] \\
\tfrac{1}{1-\beta} * p\beta\phi &\geq \tfrac{1}{1-\beta} F_t^0 (\phi - \beta) \\
\tfrac{1}{1-\beta} * p\beta\phi &\geq 0 \\
&\quad \text{if } \ \phi - \beta = 0 \\
\tfrac{p\beta\phi}{\phi-\beta} &\leq F_t^0 \\
&\quad \text{if } \ \phi - \beta < 0 \\
\tfrac{p\beta\phi}{\phi-\beta} &\geq F_t^0 \ \text{ if } \ \phi - \beta > 0.
\end{aligned} \tag{III.20}$$

If $\phi - \beta \leq 0$, the manager's incentive compatibility constraint is always satisfied because $\frac{1}{1-\beta} * p\beta\phi \geq 0$, $\frac{p\beta\phi}{\phi-\beta} < 0$, and $0 \leq F_t^0$.

B.2 Proof of Lemma 4

The manager's incentive compatibility constraint is more difficult to satisfy in the bad investment state than in the good investment state (cf. Lemma 3). Therefore, it is sufficient to require compliance in the bad investment state.

In the bad investment state, the utility from compliance is the sum of two components:

1. $F_t^0 (1-\phi)$: the utility from holding F_t^0 units of cash during the current period;
2. $\frac{\beta}{1-\beta} \{qp\phi + (1-q)\, x\phi + F_t^0 (1-\phi)\}$: the next-period value of the perpetuity

of expected future per-period utility, where $qp\phi$ is the product of the probability that $\varphi = 1$ and $\theta = 1$, and ϕ, the additional utility from holding physical compared to financial assets; $(1-q)\,x\phi$ is the product of the probability that $\varphi = 0$ and $x\phi$, the additional benefits from the allowed waste of x units on investment in physical assets; $F_t^0\,(1-\phi)$ are the private benefits from holding F_t^0 units of cash.

The utility from compliance results as:

$$F_t^0\,(1-\phi) + \frac{\beta}{1-\beta}\left\{qp\phi + (1-q)\,x\phi + F_t^0\,(1-\phi)\right\}. \tag{III.21}$$

As in the multi-period model without extreme situations, the utility from deviation is the sum of the private benefits from spending all available funds on physical assets now (F_t^0) and getting 0 utility in all future periods:

$$F_t^0 + \frac{\beta}{1-\beta} * 0 = F_t^0. \tag{III.22}$$

The manager has no incentive to deviate if the utility from compliance in the bad investment state exceeds that from deviation:

$$\begin{array}{rcc}
F_t^0\,(1-\phi) + \frac{\beta}{1-\beta}\left\{qp\phi + (1-q)\,x\phi + F_t^0\,(1-\phi)\right\} & \geq & F_t^0 \\
F_t^0\left(1-(1-\phi) - \frac{\beta}{1-\beta}\,(1-\phi)\right) & \leq & \frac{\beta}{1-\beta}\left\{qp\phi + (1-q)\,x\phi\right\} \\
F_t^0\left(\frac{\phi-\beta\phi-\beta+\beta\phi}{1-\beta}\right) & \leq & \frac{\beta\{qp\phi+(1-q)x\phi\}}{1-\beta} \\
\frac{1}{1-\beta}F_t^0\,(\phi-\beta) & \leq & \frac{1}{1-\beta}\beta\left\{qp\phi + (1-q)\,x\phi\right\} \\
0 & \leq & \frac{1}{1-\beta}\beta\left\{qp\phi + (1-q)\,x\phi\right\} \\
 & & \text{if } \ \phi-\beta = 0 \\
\frac{\beta\{qp\phi+(1-q)x\phi\}}{\phi-\beta} & \leq & F_t^0 \\
 & & \text{if } \ \phi-\beta < 0 \\
\frac{\beta\{qp\phi+(1-q)x\phi\}}{\phi-\beta} & \geq & F_t^0 \\
 & & \text{if } \ \phi-\beta > 0.
\end{array} \tag{III.23}$$

If $\phi - \beta \leq 0$, the manager's incentive compatibility constraint is always satisfied because $\frac{1}{1-\beta}\beta\left\{qp\phi + (1-q)\,x\phi\right\} \geq 0$, as well as $\frac{\beta\{qp\phi+(1-q)x\phi\}}{\phi-\beta} < 0$ and $0 \leq F_t^0$.

For certain parameter conditions, the infinite Trigger-Equilibrium is not feasible as it is not possible to set $F_t^0 \geq x$ (which is necessary to guarantee the survival in extreme situations) and to satisfy the manager's incentive compatibility constraint at the same time:[19]

$$x \leq F_t^0 \leq \frac{\beta\left\{qp\phi + (1-q)\,x\phi\right\}}{\phi - \beta}. \tag{III.24}$$

This range is empty for:

$$\begin{aligned} x &> \tfrac{\beta\{qp\phi+(1-q)x\phi\}}{\phi-\beta} \\ x\,(\phi-\beta) &< \beta\left\{qp\phi + (1-q)\,x\phi\right\} \\ &\quad \text{because } \phi - \beta < 0 \\ x\left[(\phi-\beta) - (1-q)\,\beta\phi\right] &< qp\beta\phi. \end{aligned} \tag{III.25}$$

If $\phi - \beta - (1-q)\,\beta\phi > 0 \rightarrow x < \frac{qp\beta\phi}{\phi-\beta-(1-q)\beta\phi}$. Otherwise, it is not possible to satisfy the manager's incentive compatibility constraint in the infinite Trigger-Equilibrium. If $\phi - \beta - (1-q)\,\beta\phi < 0 \rightarrow \frac{qp\beta\phi}{[\phi-\beta-(1-q)\beta\phi]} < 0 < x$ and, hence, the infinite Trigger-Equilibrium is feasible because it is always possible to set $F_t^0 \geq x$ and to satisfy the manager's incentive compatibility constraint.

B.3 Proof of Lemma 5

If $\varphi = 1$ and $\theta = 1$ (which is the case with $prob = qp$), the shareholder earns profits of $(H-1)$. If $\varphi = 0$ and $\theta = 1$ ($prob = (1-q)\,p$), the shareholder experiences a loss of $(H-1) - (x-1)(1-L)$. If $\varphi = 1$ and $\theta = 0$ ($prob = q\,(1-p)$), the shareholder earns 0 profits. If $\varphi = 0$ and $\theta = 0$ ($prob = (1-q)\,(1-p)$), the shareholder derives a loss of $x\,(L-1)$. Expected profits result as:

[19] I only consider the case of $\phi \leq \beta$ because for $\phi > \beta$, the incentive compatibility constraint is satisfied for all $F_t^0 \geq x$.

$$
\begin{aligned}
& qp * (H-1) + (1-q)\, p * [(H-1) + (x-1)(L-1)] + (1-q)(1-p)\, x\,(L-1) \\
=& q\pi_G + (1-q)\,\pi_G - (1-q)\, p\,(x-1)(1-L) - (1-q)(1-p)\, x\,(1-L) \\
=& \pi_G - (1-q)(1-L)\left[p\,(x-1) + (1-p)\, x\right] \\
=& \pi_G - (1-q)(1-L)\left[px - p + x - px\right] \\
=& \pi_G - (1-q)(x-p)(1-L)\,. \qquad \text{(III.26)}
\end{aligned}
$$

Firm value in the infinite Trigger-Equilibrium is the perpetuity of the expected per-period profits: $\frac{1}{1-\beta}\left\{\pi_G - (1-q)(x-p)(1-L)\right\}$. The shareholder prefers the infinite Trigger-Equilibrium over the No-Production-Equilibrium if this firm value exceeds the firm value of 0 (in the No-Production-Equilibrium):

$$
\begin{aligned}
\tfrac{1}{1-\beta}\left\{\pi_G - (1-q)(x-p)(1-L)\right\} &\geq 0 \\
\pi_G &\geq (1-q)(x-p)(1-L) \\
\tfrac{\pi_G}{(1-q)(1-L)} + p &\geq x. \qquad \text{(III.27)}
\end{aligned}
$$

B.4 Proof of Lemma 6

In the finite Trigger-Equilibriums, the manager derives utility from compliance of:

$$
F_t^0\,(1-\phi) + \frac{\beta}{1-\beta q}\left\{qp\phi + (1-q)\, F_t^0\phi + F_t^0\,(1-\phi)\right\}. \qquad \text{(III.28)}
$$

The manager's utility from deviation are the private benefits from spending all available cash on physical assets, but getting 0 utility in the future.

The manager has no incentive to deviate if the utility from compliance exceeds that from deviation:

$$
\begin{aligned}
F_t^0(1-\phi)+\tfrac{\beta}{1-\beta q}\left\{qp\phi+(1-q)\,\phi F_t^0+F_t^0(1-\phi)\right\} &\geq F_t^0\\
F_t^0(1-\phi)-F_t^0+F_t^0\tfrac{\beta}{1-\beta q}\left\{(1-q)\,\phi+(1-\phi)\right\} &\geq -\tfrac{\beta}{1-\beta q}qp\phi\\
F_t^0\left[1-\phi-1+\tfrac{\beta}{1-\beta q}(1-q)\,\phi+\tfrac{\beta}{1-\beta q}(1-\phi)\right] &\geq -\tfrac{\beta}{1-\beta q}qp\phi\\
F_t^0\left[\tfrac{\beta q\phi-\phi}{1-\beta q}+\tfrac{\beta\phi-\beta q\phi}{1-\beta q}+\tfrac{\beta-\beta\phi}{1-\beta q}\right] &\geq -\tfrac{\beta}{1-\beta q}qp\phi\\
F_t^0\left[\tfrac{\beta-\phi}{1-\beta q}\right] &\geq -\tfrac{\beta}{1-\beta q}qp\phi\\
0 &\geq -\tfrac{\beta}{1-\beta q}qp\phi \;\text{ if }\; \phi-\beta=0\\
F_t^0 &\geq \tfrac{\beta qp\phi}{\phi-\beta} \;\text{ if }\; \phi-\beta<0\\
F_t^0 &\leq \tfrac{\beta qp\phi}{\phi-\beta} \;\text{ if }\; \phi-\beta>0.
\end{aligned}
\tag{III.29}
$$

If $\phi-\beta<0$, the manager's incentive compatibility constraint is always satisfied because $0 \geq -\frac{\beta}{1-\beta q}qp\phi$, $\frac{\beta qp\phi}{\phi-\beta}<0$, and $F_t^0 \geq 0$. The finite Trigger-Equilibrium with $F_t^0=1$ does not exist if $\phi-\beta>0$ and $\frac{qp\beta\phi}{\phi-\beta}<1$.

B.5 Proof of Lemma 7

In the finite Trigger-Equilibrium, the manager wastes cash for sure if the survival of the company is at stake because he knows that the principal-agent relationship ends after the period. Therefore, the shareholder optimally sets $F_t^0=1$ to minimize the waste in extreme situations. In addition, small cash holdings make it easier to satisfy the manager's incentive compatibility constraint with. If $\theta=1$ ($prob=p$), the shareholder earns profits of $(H-1)$, independent of the realization of φ. If $\theta=0$ and $\varphi=1$ ($prob=q\,(1-p)$), the shareholder earns 0 profits. If $\theta=0$ and $\varphi=0$ ($prob=(1-q)\,(1-p)$), the shareholder derives a loss of $(1-L)$. Expected profits result as:

$$
\begin{aligned}
&p * (H-1) + q\,(1-p) * 0 - (1-q)\,(1-p)\,(1-L) \\
=&\pi_G - (1-q)\,\pi_B. \qquad \text{(III.30)}
\end{aligned}
$$

Firm value in the finite Trigger-Equilibrium is the present value of the expected per-period profits that accrue as long as $\varphi = 1$: $\frac{1}{1-\beta q}\left\{\pi_G - (1-q)\,\pi_B\right\}$. If this firm value exceeds the firm value of 0 in the No-Production-Equilibrium, the shareholder prefers the finite Trigger-Equilibrium over the No-Production-Equilibrium:

$$
\begin{aligned}
\frac{1}{1-\beta q}\left\{\pi_G - (1-q)\,\pi_B\right\} &\geq 0 \\
\pi_G &\geq (1-q)\,\pi_B. \qquad \text{(III.31)}
\end{aligned}
$$

B.6 Proof of Lemma 8

Firm value in the infinite Trigger-Equilibrium is: $\frac{1}{1-\beta}\left\{\pi_G - (1-q)\,(x-p)\,(1-L)\right\}$ (cf. Lemma 5). Firm value in the finite Trigger-Equilibrium is: $\frac{1}{1-\beta q}\left\{\pi_G - (1-q)\,\pi_B\right\}$ (cf. Lemma 7). The shareholder prefers the infinite over the finite Trigger-Equilibrium if:

$$
\begin{aligned}
\tfrac{1}{1-\beta q}\left\{\pi_G - (1-q)\,\pi_B\right\} &\geq \tfrac{1}{1-\beta}\left\{\pi_G - (1-q)\,(x-p)\,(1-L)\right\} \\
\pi_G\left(\tfrac{1}{1-\beta} - \tfrac{1}{1-\beta q}\right) &\geq \tfrac{1}{1-\beta}\,(1-q)\,(x-p)\,(1-L) \\
&\quad -\tfrac{1}{1-\beta q}\,(1-q)\,(1-p)\,(1-L) \\
\pi_G\left(\tfrac{1}{1-\beta} - \tfrac{1}{1-\beta q}\right) &\geq (1-q)\left[\pi_B\left(\tfrac{1}{1-\beta} - \tfrac{1}{1-\beta q}\right) + \tfrac{1}{1-\beta}\,(x-1)\,(1-L)\right].
\end{aligned}
\qquad \text{(III.32)}
$$

For certain parameter conditions, the infinite Trigger-Equilibrium does not exist, but the finite Trigger-Equilibrium with $F_t^0 = 1$ does, and vice versa. By Lemma

4, for $0 < \phi - \beta - (1-q)\,\beta\phi$ the infinite Trigger-Equilibrium is only feasible if $x \leq \frac{qp\beta\phi}{\phi-\beta-\beta(1-q)\phi}$. By Lemma 6, for $0 < \phi - \beta$, the finite Trigger-Equilibrium (with $F_t^0 = 1$) is only feasible if $1 \leq \frac{qp\beta\phi}{\phi-\beta}$.

The infinite Trigger-Equilibrium does not exist, but the finite Trigger-Equilibrium with $F_t^0 = 1$ exists if $0 < \phi - \beta - (1-q)\,\beta\phi$ (which implies that $0 < \phi - \beta$) and $\frac{qp\beta\phi}{\phi-\beta-(1-q)\beta\phi} < x$, but $1 \leq \frac{qp\beta\phi}{\phi-\beta}$. Such a parameter constellation is possible:

$\frac{qp\beta\phi}{\phi-\beta-\beta(1-q)\phi} < x \rightarrow qp\beta\phi < x\,[\phi - \beta - (1-q)\,\beta\phi]$; $\frac{qp\beta\phi}{\phi-\beta} \leq 1 \rightarrow qp\beta\phi \leq \phi - \beta$. Hence, $\phi - \beta \leq qp\beta\phi < x\,[\phi - \beta - (1-q)\,\beta\phi]$ has to be possible. This condition is equivalent to the requirement that there are parameter values for ϕ, β, q, p such that $\frac{\phi-\beta}{[\phi-\beta-\beta\phi(1-q)]} \leq \frac{qp\beta\phi}{[\phi-\beta-\beta\phi(1-q)]} < x$. $\frac{\phi-\beta}{[\phi-\beta-\beta\phi(1-q)]} \leq \frac{qp\beta\phi}{[\phi-\beta-\beta\phi(1-q)]}$ is possible for small $(\phi-\beta)$; $\frac{\beta qp\phi}{[\phi-\beta-\beta\phi(1-q)]} < x$ is possible at least for large x.

The finite Trigger-Equilibrium with $F_t^0 = 1$ does not exist, but the infinite Trigger-Equilibrium exists if $\phi - \beta - (1-q)\,\beta\phi \leq 0 < \phi - \beta$ and $\frac{\beta qp\phi}{\phi-\beta} < 1$.

B.7 Proof of Lemma 9

Firm value in the infinite Trigger-Equilibrium is independent of the costs for corporate governance $\left(\overline{G}\right)$. With monopoly profits after an extreme situation, it is the sum of three components:

1. $-\frac{1}{1-\beta}\,(1-q)\,(x-p)\,(1-L)$: the perpetuity of the product of the probability that $\varphi_t = 0$ and the expected loss in extreme situations $(-\,(x-p)\,(1-L))$;

2. $\frac{1}{1-q\beta}\pi_{G,duopoly}$: the expected duopoly profits from investing only in the good state $(\pi_{G,duopoly})$ this period for sure and for all future periods as long as $\varphi_t = 1$ for the first time;

3. $\left(\frac{\beta}{1-\beta} - \frac{q\beta}{1-q\beta}\right)\pi_G$: the next-period value of the perpetuity of the expected monopoly profits from investing only in the good state $\left(\frac{\beta}{1-\beta}\pi_G\right)$, minus the next-period value of these profits if $\varphi_t = 1$ for all past periods until period t, where the firm has only been able to earn duopoly profits.

$$
\begin{aligned}
&-\frac{1}{1-\beta}\left(1-q\right)\left(x-p\right)\left(1-L\right)+\frac{1}{1-q\beta}\pi_{G,duopoly}+\left(\frac{\beta}{1-\beta}-\frac{q\beta}{1-q\beta}\right)\pi_G \\
=&\frac{1}{1-\beta}\left\{\beta\pi_G-\left(1-q\right)\left(x-p\right)\left(1-L\right)\right\}+\frac{1}{1-q\beta}\left\{\pi_{G,duopoly}-q\beta\pi_G\right\}. \qquad \text{(III.33)}
\end{aligned}
$$

Analogously, firm value in the infinite Trigger-Equilibrium with duopoly profits after an extreme situation is the sum of two components:

1. $-\frac{1}{1-\beta}\left(1-q\right)\left(x-p\right)\left(1-L\right)$;

2. $\frac{1}{1-\beta}\pi_{G,duopoly}$: the perpetuity of the expected duopoly profits from investment in the good state ($\pi_{G,duopoly}$):

$$
\begin{aligned}
&\frac{1}{1-\beta}\left(1-q\right)\left(x-p\right)\left(L-1\right)+\frac{1}{1-\beta}\pi_{G,duopoly} \\
&=\frac{1}{1-\beta}\left\{\pi_{G,duopoly}-\left(1-q\right)\left(x-p\right)\left(1-L\right)\right\}. \qquad \text{(III.34)}
\end{aligned}
$$

Firm value in the Corporate-Governance Equilibrium depends on $\overline{G}$: It is the perpetuity of the duopoly profits minus the costs for corporate governance as long as only normal situations occur $\frac{1}{1-q\beta}\left\{\pi_{G,duopoly}-\overline{G}\right\}$.

The shareholder strictly prefers the infinite Trigger-Equilibrium (with monopoly profits after an extreme situation) over the Corporate-Governance-Equilibrium if:

$$
\begin{aligned}
\tfrac{1}{1-\beta}\left\{\beta\pi_G-(1-q)(x-p)(1-L)\right\}+\tfrac{1}{1-q\beta}\left\{\pi_{G,duopoly}-q\beta\pi_G\right\} &> \\
\tfrac{1}{1-q\beta}\left\{\pi_{G,duopoly}-\overline{G}\right\} & \\
\tfrac{1}{1-\beta}\left\{\beta\pi_G-(1-q)(x-p)(1-L)\right\}+\tfrac{1}{1-q\beta}\left\{-q\beta\pi_G+\overline{G}\right\} &> 0 \\
\tfrac{1}{1-\beta}\left\{\beta\pi_G-(1-q)(x-p)(1-L)\right\} &> \tfrac{1}{1-q\beta}\left(q\beta\pi_G-\overline{G}\right) \\
\tfrac{1-q\beta}{1-\beta}\left\{\beta\pi_G-(1-q)(x-p)(1-L)\right\} &> q\beta\pi_G-\overline{G} \\
q\beta\pi_G-\tfrac{1-q\beta}{1-\beta}\left\{\beta\pi_G-(1-q)(x-p)(1-L)\right\} &< \overline{G}.
\end{aligned}
\tag{III.35}
$$

The shareholder strictly prefers the infinite Trigger-Equilibrium (with duopoly profits after an extreme situation) over the Corporate-Governance-Equilibrium if:

$$
\begin{aligned}
\tfrac{1}{1-\beta}\left\{\pi_{G,duopoly}-(1-q)(x-p)(1-L)\right\} &> \tfrac{1}{1-q\beta}\left\{\pi_{G,duopoly}-\overline{G}\right\} \\
\tfrac{1-q\beta}{1-\beta}\left\{\pi_{G,duopoly}-(1-q)(x-p)(1-L)\right\} &> \pi_{G,duopoly}-\overline{G} \\
\pi_{G,duopoly}-\tfrac{1-q\beta}{1-\beta}\left\{\pi_{G,duopoly}-(1-q)(x-p)(1-L)\right\} &< \overline{G}.
\end{aligned}
\tag{III.36}
$$

Of course, the threshold for $\overline{G}$ is higher if the company can only earn duopoly profits after an extreme situation:

$$
\begin{aligned}
\pi_{G,duopoly}-\tfrac{1-q\beta}{1-\beta}\left\{\pi_{G,duopoly}-(1-q)(x-p)(1-L)\right\} &> \\
q\beta\pi_G-\tfrac{1-q\beta}{1-\beta}\left\{\beta\pi_G-(1-q)(x-p)(1-L)\right\} & \\
\pi_{G,duopoly}-\tfrac{1-q\beta}{1-\beta}\pi_{G,duopoly} &> q\beta\pi_G-\tfrac{1-q\beta}{1-\beta}\beta\pi_G \\
\left(\tfrac{1-\beta-1+q\beta}{1-\beta}\right)\pi_{G,duopoly} &> \left(\tfrac{q-q\beta-1+q\beta}{1-\beta}\right)\beta\pi_G \\
-\left(\tfrac{1-q}{1-\beta}\right)\beta\pi_{G,duopoly} &> -\left(\tfrac{1-q}{1-\beta}\right)\beta\pi_G \\
\pi_G &> \pi_{G,duopoly}.
\end{aligned}
\tag{III.37}
$$

Chapter IV

Financial Development and Intersectoral Growth: The Capital Reallocation Hypothesis

1 Introduction

1.1 Summary

There is hardly any doubt that well-developed financial systems often can be found in countries with considerable economic growth. Nevertheless, after decades of ongoing debate, there is no consensus about the mechanisms that connect a well-developed financial system and economic growth. This study contributes to bridging this gap. In this study, I describe a specific channel through which a well-developed financial system promotes economic growth: this channel can provide external financing at low costs, following shifts in demand or supply, and reallocate that capital to industries where it can be used more productively (the so-called capital reallocation hypothesis).

The empirical literature has approached this capital reallocation hypothesis in two main ways (cf. review in Subsection 1.2.2): According to one approach, a well-developed financial system facilitates the reallocation of capital towards any industry that shows positive investment opportunities (Ciccone and Papaioannou, 2006; Fisman and Love, 2004b). Another approach focuses on industries that—for technological reasons—typically depend on external financing (Rajan and Zingales, 1998).[1]

Ambiguity has risen about the interdependence of these two approaches: do they exclude each other, does one approach comprise the other one, or do they essentially test the same? I propose that, under certain conditions, both are conceptually distinct. The two approaches implicitly assume that the different natures of growth opportunities cause the need to reallocate capital: one approach refers to temporary and at the same time stochastic natures, the other one to persistent and at the same time deterministic natures.

In order to derive this conclusion, I develop a formal model with two firms a and b. They are assumed to be located in two economies with identical investment opportunities, but differently developed financial systems: In contrast to firm b, firm a has to pay a premium for raising external financing. The degree of development of the financial system does not affect internal financing. Internal financing is, however, only available to the extent that the firms have accumulated past profits. Internal profit accumulation requires the owners of the firms to leave funds to the discretion of the managers that creates a potential corporate governance problem in both firm a and firm b. Although the managers are better informed about stochastic growth opportunities, they have no incentive to give up the control of funds. In this framework, I compare capital reallocation towards firms a and b as following temporary and stochastic or following persistent and deterministic investment opportunities.[2]

Regarding temporary demand shifts, the model predicts that firm a will exploit both positive and negative investment opportunities less than firm b. The develop-

[1]An industry technologically depends on external financing if it has higher need for capital than can be financed by operating cash flow.

[2]In my partial equilibrium model, it is irrelevant whether these investment opportunities are due to shifts in demand or supply; commodity prices and interest rates are assumed to be exogenous in either case. It appears more reasonable to associate temporary (and stochastic) investment opportunities with the demand side and persistent (and deterministic) investment opportunities with the supply side. For this reason, I contrast temporary (and stochastic) demand shifts with persistent (and deterministic) supply shifts.

ment of the financial system has a steady-state impact on capital growth rates, even though firm a is technologically independent of external financing in that phase.

Regarding persistent supply shifts, the model predicts that firm a will allocate less capital to the production of the commodity at early stages of firm a's life when it has not yet been able to accumulate enough past profits (technological dependence on external financing). However, even at these early stages, financial development only impacts the growth rates of capital if the premium for external financing itself is a function of firm a's demand for external financing. Under that assumption, firm a can exploit investment opportunities less than firm b if firm b technologically depends on external financing. Hence, in the presence of persistent supply shifts there is an impact of firm a's technological dependence on external financing, both on the level of and the growth rates of capital.

The analysis of the model shows that the development of the financial system influences capital growth rates. However, for temporary and persistent growth opportunities, the impact is different.

This finding has large-scale implications for empirical tests of the capital reallocation hypothesis: It establishes the need to develop different tests for temporary and persistent types of growth opportunities. Assuming that firm a is a representative firm of a particular industry in country a (less-developed financial system) and firm b is a representative firm of the same industry in country b (perfectly developed financial system), the tests for temporary and for persistent growth opportunities have to differ in the following ways:

- An industry's (technological) dependence on external financing is important for persistent supply shifts, but not for temporary demand shifts. This distinction can be tested using a regression specification that comprises the product of the financial development in country a and capital growth rates in country b, as well as the interaction between financial development in country a, capital growth rates in country b, and the increase in an industry's financial dependence. The impact of the second product should be statistically insignificant regarding temporary demand shifts, but statistically significant and positive regarding persistent supply shifts.

- The development of the financial system impacts the steady-state growth rates of industries that are subject to temporary demand shifts. Regarding persistent supply shifts, in contrast, financial development only affects the growth rates of industries at early stages in their growth cycle.

- Financial development has only a weak impact on the level of capital allocation towards industries with temporary demand shifts. As opposed to that, an economy with a well-developed financial system specializes in those industries in which persistent supply shifts lead to technological dependence on external financing, even in a steady-state.

The analysis of the model shows that the concept of technological, financial dependence is relevant only with respect to persistent supply shifts. However, not only technological factors determine financial dependence, but also the design of external financing contracts, in particular as to the repayment modalities. Therefore, this finding suggests that the model could be extended by using a distinction between two types of contracts that specify different repayment modalities. The analysis of this extension uncovers a further difference between the first approach towards the capital reallocation hypothesis (that refers to temporary investment opportunities) and the second approach (regarding persistent investment opportunities): If a well-developed financial system influences capital growth rates in the way described by the first approach, the industry is in a steady-state. However, in a steady-state temporary demand shifts cause a need for short-term external financing. If, on the other hand, a well-developed financial system influences capital growth rates in the way of the second approach, the industry is still at an early stage in the growth cycle, when persistent supply shifts cause a need for long-term external financing. This conclusion has an important consequence for the empirical literature on the capital reallocation hypothesis: An empirical test regarding temporary demand shifts should measure the development of a financial system in a different manner than a test regarding persistent supply shifts. So far, however, the empirical tests following the first approach use the same measures of financial development as the empirical tests following the second approach.

My model must assume that the international integration of financial systems is not perfect. If, instead, firms can raise external financing abroad, then the national financial system can impact growth in the respective economy less. It is likely that international integration has a different effect on the components of a financial system that provide short-term financing and on those that provide long-term financing. Since temporary demand shifts cause a need for short-term financing and persistent supply shifts cause a need for long-term financing, international integration will likely change the importance of the two origins of growth in the future: temporary or persistent growth opportunities.

The motivation for this study is the inadequateness of the empirical evidence on the role of financial development for the intersectoral reallocation of capital in an economy. In particular, this inadequateness reflects on our understanding of the interdependence of the two prominent approaches towards the capital reallocation hypothesis. In the following, I derive my research question in detail and show where my results add necessary precision to this strand of the empirical literature.

1.2 Derivation of the Research Question

1.2.1 Studies at the Macroeconomic Level

The empirical literature tries to pin down a causal relation between the degree of development of a financial system and the economic growth rates of the respective country. Earlier studies approach the relation between finance and growth at a macroeconomic level:[3] They compare cross-country differences in overall economic growth rates with the development of the respective financial system.[4] These studies struggle with two main problems.

First, it is likely that there are omitted factors driving both the development of a financial system and economic growth (such as the availability of human capital or of a good infrastructure).

Second, causality can work in both directions, finance leading to growth and vice versa: On the one hand, following Schumpeter (1949) one can emphasize that any entrepreneurial activity requires the ex ante availability of credit (this implies that finance leads growth). On the other hand, following Robinson (1952), p. 86 one can argue that reverse causality is also possible ("where enterprise leads, finance follows").

Modern econometrics offer partial solutions to the problems of omitted variables and reverse causality (for instance, the use of lagged or instrumental variables, vector auto-regression or fixed effects estimation). But studies at the macroeconomic level do not satisfy completely because results on the question of causality are not unanimous, and none of these studies accurately shows the mechanisms of how financial development promotes growth within the respective economy.

1.2.2 Studies at the Microeconomic Level: The Concept of the Capital Reallocation Hypothesis

In contrast, microeconomic studies do not address separately the questions of whether and of how a well-developed financial system promotes economic growth. As opposed to the studies at the macroeconomic level, these studies at the microeconomic level "look into the black box" (Wachtel, 2004, p. 43) and test specific channels through

[3] As an example for such an early study, Goldsmith (1969) finds such a correlation between the degree of development of a financial system and economic growth at the macroeconomic level.

[4] The appendix gives a broad review of the existing studies at the macroeconomic level in Section A. For a more comprehensive review of the empirical literature cf. e.g., Ang (2008), Wachtel (2004) or Carlin and Mayer (2003).

which a well-developed financial system can generate economic growth. This restriction to specific channels of influence reduces the impact of issues such as reverse causality and omitted variables. Consequently, the microeconomic perspective is the preferable approach. However, it can only unfold its advantages if the channel through which a well-developed financial system can promote economic growth is defined as precisely as possible.

My study contributes to the understanding of one such microeconomic channel, the capital reallocation hypothesis.

1.2.3 Two Approaches to the Capital Reallocation Hypothesis

In empirical studies, two approaches to this capital reallocation hypothesis have emerged. They identify different industry characteristics that determine whether and to what extent the development of a financial system affects industry growth rates within an economy.

First Approach: Industries with Investment Opportunities. One approach relates to industries with investment opportunities (hereinafter, "first approach").

According to Ciccone and Papaioannou (2006) and Fisman and Love (2004b), the degree of financial development of a country (F_c) promotes growth in all industries i of that country c ($Growth_{ic}$) that show positive growth opportunities:

$$Growth_{ic} = \alpha Z_{ic} + \beta F_c * Growth\ \ Opportunity_i + \varepsilon_{ic}. \tag{IV.1}$$

This specification implies that the product of financial development and the industry's growth opportunities has a positive impact on realized growth rates ($\beta > 0$). In other words, an industry can exploit positive growth opportunities better in an economy with a well-developed financial system than in an economy with a less-developed financial system.

This expectation matches the results of Ciccone and Papaioannou (2006) and

Fisman and Love (2004b): a well-developed financial system has a significantly positive impact on the output growth in sectors with positive measures of global investment opportunities.[5]

Second Approach: Industries with Dependence on External Financing. This approach relates to industries that depend on external financing (hereinafter, "second approach").

According to Rajan and Zingales (1998), the degree of financial development of a country (F_c) promotes growth in those industries i of country c ($Growth_{ic}$) that are dependent on external financing:

$$Growth_{ic} = \alpha Z_{ic} + \beta F_c * Financial\ \ Dependence_i + \varepsilon_{ic}. \qquad \text{(IV.2)}$$

This specification implies that the product of the degree of financial development and the industry's financial dependence has a positive impact on realized growth rates ($\beta > 0$). In other words, an industry's growth rates are higher in an economy with a well-developed financial system than in an economy with a less-developed one, to the extent that the industry depends on external financing.

This expectation matches the results of Rajan and Zingales (1998) (and as well those of Fisman and Love, 2007): They confirm a significantly positive impact of a well-developed financial system on the output growth in sectors with particular dependence on external financing.[6]

[5] Similarly, Wurgler (2000) finds that the more developed the financial system, the more the respective economies increase investments in growing industries, and the more they decrease investments in declining industries. For the special case of China, a country with high growth and low levels of financial development, Allen, Qian, and Qian (2005) confirm the role of financial development for economic growth, but only for listed as well as state-owned firms. If firms are privately held, other financing channels (such as reputation and relationship lending) substitute for financial development.

[6] Similarly, Cetorelli and Gambera (2001) find a positive impact of the concentration of competition in the banking sector on the growth of those industries that rely on external financing, especially if they are young. Beck and Levine (2002) show a positive growth impact of overall financial development for financially dependent industries, but do not find different effects for market- and bank-based financial systems. Carlin and Mayer (2003) encounter a strong link between industry characteristics (such as the reliance on bank or market sources of financing and the reliance on skilled labor) and the specific characteristics of a financial system. Kroszner,

1.2.4 Interdependence between the Two Approaches

Manifest Aspects of Interdependence between the Two Approaches. However, both approaches of the capital reallocation hypothesis still show a lack of precision: they do not sufficiently characterize the industries that benefit from a well-developed financial system. This flaw has lead to ambiguity about the interdependence of the two approaches. Insofar, there are two evident conclusions:

1. Both approaches are essentially the same: Positive investment opportunities cause an increase in the demand for external financing and, hence, an increase in the dependence on external financing. Following this conclusion, Rajan and Zingales (1998)'s measure of the dependence on external financing is no more than a measure of investment opportunities.

2. According to another conclusion, the second approach is restricted specifically to the narrow channel of external financing, but the first approach more generally comprises all functions of a financial system (such as information acquisition and dispersion, risk diversification, or monitoring; cf. Fisman and Love, 2004a). This is the conclusion of Fisman and Love (2007), who empirically test both interpretations against each other. They find support for both and, notably, they find weaker support for the second approach. Including both the measure of investment opportunities (in the sense of the first approach) and the measure of financial dependence (in the sense of the second approach) into one regression, they find that financial development has more explanatory power for capital growth rates in industries with investment

Leaven, and Klingebiel (2007) find that, particularly in financially better developed countries, industries depending on external financing decline during a banking crisis because preceding the crisis, industries in such countries have accessed external financing to a particular extent. Developing this approach, a number of further studies apply this measure of dependence on external financing to firm-level data: On this basis, Demirgüç-Kunt and Maksimovic (1998) can confirm the results at the firm level by finding that active (though not necessarily large) stock markets as well as a large banking sector are associated with externally financed firm growth. Demirgüç-Kunt and Maksimovic (2002) show that there is a different impact of bank- and market-based financial systems on economic growth, especially for long-term external financing. The latter fact is in contrast to the results of studies using macroeconomic data (Levine, 2002).

opportunities (first approach) than for capital growth rates in financially dependent industries (second approach). In particular, the impact of the latter is statistically less significant and of lower economic magnitude.

The Paramount Aspect of Interdependence between the Two Approaches. However, these two conclusions are not the only possible ones. My study proposes another view of the interdependence between the two approaches of the capital reallocation hypothesis: both interpretations are substantially distinct. The first approach refers to temporary growth opportunities that are fluctuating (that is, they are positive in some and negative in other periods); the second approach refers to persistent growth opportunities. I show that both interpretations refer to different stages in an industry growth cycle—the first one to industries in their steady-state, the second one to industries at an early stage in the growth cycle. The different natures of growth opportunities have different financing needs and, hence, relate to different aspects of a financial system: Industries in their steady-state require short-term financing, while industries at an early stage in their growth cycle require long-term financing. Consequently, these two different aspects of a financial system can have a different impact on economic growth in the respective country.

Both approaches refer to the same kind of financial friction: less-developed financial systems provide external financing only at additional costs; in contrast, the degree of development of the financial system does not affect internal financing. However, internal financing works differently well when financing different types of growth opportunities: For persistent, deterministic growth opportunities (second approach), internal funds perfectly substitute for external funds, but may typically not be available (technological dependence on external financing). For temporary, stochastic growth opportunities (first approach), internal financing may typically be available (no technological dependence on external financing), but may be too inertial to meet the fluctuating financing needs of this type of growth opportunities.

My conclusions are not self-evident. Their basis comes from an analysis of a formal model for which I proceed in the following steps: Section 2 reviews the theoretical foundations of the capital reallocation hypothesis that are important for my model. In Section 3, I develop a formal model of two firms with identical investment opportunities, but with different costs in external financing. The analysis in Section 4 compares the capital reallocation in both firms, following temporary, stochastic demand shifts and persistent, deterministic supply shifts and extends the model through a distinction between different types of external financing contracts. Section 5 concludes by giving an outlook on the changing role of financial development for capital allocation in the light of international integration.

2 Literature Review

The following section reviews the theoretical foundations for my model of the capital reallocation hypothesis. First, it describes how an individual firm's decision to use capital impacts macroeconomic growth rates (investment). Second, it describes how this decision to use capital by the individual firm depends on the degree of development of the financial system it has access to (finance).

2.1 Investment

For the sake of simplicity, the growth rates of value added in an economy follow a simple AK-growth model. In such a framework, economic growth can either be generated by capital accumulation (K) or by improved capital productivity (A).

My model disregards growth via capital accumulation (K). It assumes a constant savings ratio, irrespective of the costs for external financing (where the substitution effect of an increased capital return equals the income effect).[7]

[7] The difficulties of this type of studies in deriving a substantial impact on growth rates merely from capital accumulation justify such an assumption (Levine, 2005). Wachtel (2004) emphasizes that capital productivity is more important than capital accumulation giving the examples of countries that show similar levels of overall capital investment, but have widely diverse growth

In contrast, my model concentrates on capital productivity (A). If financial development leads to an efficient capital allocation, it improves capital productivity. Thus, A is increasing. The role of financial development regarding allocative efficiency has been highlighted, for instance, by Greenwood and Jovanovic (1990): In their model, capital can be invested either in safe, low-yield or in high-risk, high-yield projects; they find that financial intermediaries unscramble productivity shocks and reduce individual investors' risks, thereby allowing to fund riskier projects. In the model by Bencivenga and Smith (1991), financial intermediaries cushion individual households' liquidity shocks: Intermediaries improve allocative efficiency and, thereby, avoid an inefficiently early project liquidation. Levine (1991), on the other hand, finds that security markets buffer liquidity shocks.

The question whether a well-developed financial system promotes overall economic growth is only a consequence of my primary research objective. Primarily, I focus on the impact of financial development on the capital (re-)allocation itself. For a particular industry i, I also assume sectoral AK-growth models. In such models, financial development impacts economic growth by exploiting exogenous growth opportunities: Sectoral capital productivity is driven either by exogenous technological progress (change in A_i) or by exogenous changes in demand (change in p_i). Exogenous growth opportunities determine the capital productivity of all firms within one industry (industry-level data).

The ultimate question (and challenge) of the model is to derive an impact of financial development not just on the level of capital, but also on the growth rates.[8]

experiences.

[8]Pagano (1993), p. 613 opposes the level and the growth effect of financial development: "In traditional growth theory, financial intermediation could be related to the level of the capital stock per worker or to the level of productivity, but not to their respective growth rates. The latter were ascribed to exogenous technological progress." Recent endogenous growth models show that financial development can impact economic growth. My approach is a combination of both: At the sectoral level, I only allow for exogenous growth and analyze whether financial development helps to exploit growth opportunities and leads to different growth rates across sectors. At the level of the whole economy, I allow endogenous growth: Efficient capital reallocation between sectors can impact the capital productivity and change the A in the AK-growth model for the economy as a whole (cf. Pagano, 1993).

2.2 Finance

The degree of development of the financial system determines the wedge between the costs for external and the costs for internal financing. Therefore, it can impact the individual firm's use of capital and hence the allocative efficiency in the respective country.

A profit-maximizing firm decides to use an amount of capital that equates the marginal productivity and the marginal costs for capital. The marginal productivity of capital is determined by firm, industry or country characteristics. As to the marginal costs for capital, my model distinguishes between internal and external financing. Therefore, the marginal costs for capital have the following two dimensions: (1) the costs for external capital, relevant for firms that demand external financing; (2) the opportunity costs for internal capital, relevant for firms that supply external financing.

According to the capital reallocation hypothesis, a well-developed financial system reduces frictions to the flow of capital. Such frictions can cause the marginal productivity of capital in different countries to differ across sectors and across time. Financial frictions create a wedge between the costs for internal and external capital. Whether financial frictions increase the costs for external capital or decrease the opportunity costs for internal capital depends on the elasticities of capital demand and supply. My model assumes such a friction only for external financing.

Next, I list commonly identified financial frictions, and afterwards, I point at commonly identified functions of a well-developed financial system to reduce financial frictions (or the negative consequences thereof).

Levine (1997) distinguishes between three types of financial frictions: Transaction costs, information costs, and enforcement costs. Transaction costs hinder the transfer of capital from the lender to the borrower. Bencivenga, Smith, and Starr (1996) point at the direct and indirect growth implications of transaction costs: Directly, they reduce the level of productive capital supply. Indirectly, they distort the reallocation of capital between sectors in favor of investments in place and to the disadvantage of new (innovative) investments. Information costs due to problems of adverse selection or moral hazard are typically associated with external rather than with internal financing and, hence, hinder the transfer of capital from a firm with excess funds to a firm that needs funds. Enforcement costs, associated with the obligations from external financing contracts, are a general hurdle to external financing.

Financial development tackles frictions, such as asymmetric information, directly, or indirectly, by preparing the grounds for contracts that work well under the given financial frictions or by implementing control mechanisms etc. Therefore, financial development decreases an existing wedge between the costs for external and internal financing and smoothes the transfer of funds from lenders to borrowers.

In particular, a well-developed financial system reduces transaction, information, and enforcement costs. The financial system reduces transaction costs by mobilizing and pooling small savings that allow the financing of investment projects at an efficient scale (King and Levine, 1993b; Levine, 1997; Levine, 2005; Wachtel, 2004).

It directly reduces ex ante information asymmetries by acquiring and transmitting information about the quality of investment projects. The reduction of information asymmetries helps to allocate capital to those sectors where it can be used more productively (cf. inter alia Arestis, Demetriades, and Luintel, 2001; Greenwood and Jovanovic, 1990; Levine, 2003; Rajan and Zingales, 1998; Wachtel, 2004). Financial intermediaries and financial markets reduce information costs in a different way: Intermediaries use their expertise in project evaluation and take advantage of fixed cost degression (Boyd and Prescott, 1986; King and Levine, 1993b; Levine, 1997; Wachtel, 2004). In contrast, markets generate information, mainly by setting publication requirements for market participants, or by giving incentives to others to acquire private information (Levine and Zervos, 1998) that is then made public via prices (in information-efficient markets).[9] A financial system, especially financial intermediaries, directly reduce ex interim information asymmetries by controlling the manager's actions and, more broadly, by any measures of corporate governance (Arestis, Demetriades, and Luintel, 2001; Levine, 1997, 2005; Levine and Zervos, 1998; Wachtel, 2004).

Finally, a financial system reduces enforcement costs via institutions and, e.g., codes of conduct.

Some of these functions are rather ascribed to financial intermediaries, others rather to financial markets.[10] A remarkable number of studies has been devoted to the question whether a bank-based or a market-based financial system (often linked to debt versus equity contracts) is more adequate to overcome certain financial frictions.[11]

Whereas the investment side can be argued to be common to all firms within a particular industry (industry-level data), financial development determines the costs for capital for all firms within one country (country-level data).

3 Model

In my model, there are two firms a and b that are located in two different countries. Both firms start operations in period $t = 0$ and operate forever. Each firm behaves competitively and is owned by one individual.

[9] Wurgler (2000) emphasizes the role of secondary markets as public price signals and of banks in the aggregation of information about investment prospects.

[10] King and Levine (1993b) attempt to give a broad categorization.

[11] A financial system fulfills other functions that do not directly impact the wedge between the costs for external and internal financing and that are, hence, not considered in my model. They can, nevertheless, impact the capital (re-)allocation between sectors, such as by facilitating trade, by allowing to diversify liquidity, production and inter-temporal risk, by organizing the flow of cash that accompanies any flow of goods and services etc. (Bencivenga and Smith, 1991; Levine, 1991).

3.1 Investment

The two firms a and b produce the same commodity with the identical production function:

$$f(K_t) = A_t K_t^{\alpha}, \tag{IV.3}$$

where K_t is the unique input factor capital, A_t is the technology parameter and $0 < \alpha < 1$. This Cobb-Douglas production function satisfies the so-called Inada conditions (cf. Inada, 1963).

Decreasing returns to scale allow the firms to make profits. Capital depreciates completely at the end of the period. The production cycle takes one period, from t to $t+1$, and causes a time lag between the investment outlay of K_t and the cash flowing back from operating activity. Cash flow from operating activity is equal to $p_t A_t K_t^{\alpha}$. Product markets are perfectly internationally integrated and, hence, the exogenous world market price for the commodity (p_t) is the same in both countries, i.e., the same for firms a and b.

There are exogenous demand shifts. They are reflected in the commodity price (p_t): $p_t = p + \tilde{\varepsilon}_t$ with $p = E(p_t) = const$ over time and $\tilde{\varepsilon}_t \sim iid$

with $\tilde{\varepsilon}_t = \begin{cases} +\varepsilon & Prob = \frac{1}{2} \\ -\varepsilon & Prob = \frac{1}{2} \end{cases}$.

I denote $p_{high} = p + \varepsilon$ and $p_{low} = p - \varepsilon$.

The shifts in demand are temporary: They only occur for one period and do not impact the expected price of the commodity in the future.

In addition to these temporary demand shifts, there are persistent shifts in supply conditions. Such supply shifts are reflected in a change in the technology parameter (A_t). A_t is deterministic, i.e., the productivity path is known for all future periods at the beginning of the firms' operations (at $t = 0$).

3.2 Finance

Firms can finance investments either with funds from internal sources (IK_t) or with funds from external sources. The conditions for firms to raise external financing differ in both countries: Firm b has access to a perfectly developed financial system, where it can raise external financing at costs of r (the exogenous world market interest rate in all periods t). Let $r > 1$. In contrast to firm b, firm a only has access to a less-developed financial system: In addition to the interest rate r, firm a has to pay a constant premium of $f > 0$ for each unit of external financing. The premium for external financing can be motivated, e.g., by asymmetric information between the firm and outside investors (cf. Section 2.2 and the motivation in Rajan and Zingales, 1998). The premium for external financing is assumed to be sufficiently small relative to the firms' ability to make profits $r - f \geq \alpha$ and relative to the size of the stochastic demand shift $\frac{p_{high}}{p_{low}} \geq \frac{r+f}{r-f}$.

In period t, the levels of internal and external financing are determined sequentially in each of the two firms: First, the owners of the firms decide about the required distribution (d_t) and, hence, about internal financing (IK_t). Nature draws, second, the realization of $\tilde{\varepsilon}_t$, which determines the commodity price (p_t). Third, the firms determine the levels of capital (K_t) allocated to the production of the commodity by their decision to raise external financing ($K_t - IK_t$).

3.2.1 Internal Financing

Funds from internal sources (IK_t) are the firms' past accumulated profits. Internal funds result from two components: Technologically, IK_t depends on the firms' ability to make profits (π_t). Profits are equal to operating cash flows minus the required remuneration for external financing:

$$\pi_{t,a} = p_t A_t K_{t,a}^{\alpha} - (r+f)\left(K_{t,a} - IK_{t-1,a}\right), \text{ and} \tag{IV.4}$$

$$\pi_{t,b} = p_1 A_t K_{t,b}^{\alpha} - r\left(K_{t,b} - IK_{t,b}\right). \tag{IV.5}$$

Another component that determines IK_t is the profit distribution to the owners of the firms: After the cash flows from operating activity have accrued and the required remunerations to the providers of external financing have been paid out, the owners of the firms decide to what extent to allow profit accumulation inside the firm. Alternatively, the owners can earn r per unit of capital in the external capital market.

The owners of the two firms choose an infinite sequence of control variables $\{d_t, IK_{t+1}\}_{t=0}^{\infty}$ to maximize

$$E_0 \sum_{t=0}^{\infty} \left(\frac{1}{r}\right)^t d_t, \tag{IV.6}$$

subject to the starting value for internal funds of IK_0. The transition law for IK_t is equal to: $IK_{t+1} = \pi_t - d_t$. In addition, the non-negativity constraints apply: $0 \leq d_t$ and $0 \leq IK_t$.

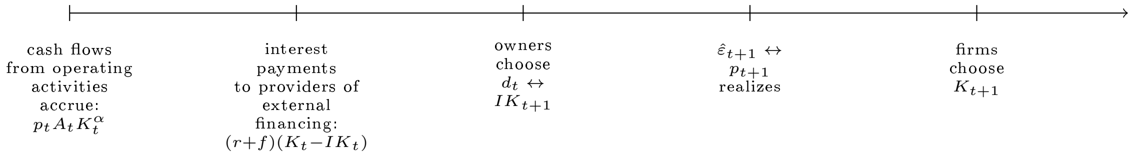
3.2.2 External Financing

After the realization of $\tilde{\varepsilon}_t$, the firms decide about the levels of capital (K_t) allocated to the production of the commodity with the objective to maximize profits:

$$\underset{K_t}{Max}\,(\pi_t) \text{ s.t. } K_t \geq IK_t. \tag{IV.7}$$

The constraint $(K_t \geq IK_t)$ restricts both firms to use available funds only for the production of the commodity. In contrast to the owners, the firms cannot earn r in the outside capital market. Consequently, they always employ at least IK_t in

Figure IV.1: Time Line



the production process. This restriction ensures that the capital allocation decision ultimately lies in the hands of the owners of capital: The owners decide whether to leave funds inside the firms or to devote them to alternative investment projects. Once they leave the funds to the control of the (managers of the) firms, the (managers of the) firms have no incentive to give up control until the next balance-sheet day. This lack of control is the dark side of internal funds.[12]

4 Analysis

I analyze the levels of capital that firms a and b devote to the production of the commodity over time. Since the firms face completely identical investment conditions in both countries, any difference in the levels of capital allocated towards firms a and b can be traced back to cross-country differences in the firms' costs for external financing.

4.1 Principles of Capital Allocation

I first present the mechanisms of profit distribution and capital allocation in both firms, which I will apply throughout the later analysis.

In period t, there are two sequential decisions in each firm: First, the owners choose the level of distribution (d_t) and, hence, the firm's internal financing capacity

[12]The restriction that firms can only invest in the production of the commodity is in line with the related ideas in the empirical literature: Rajan and Zingales (1998) define their measure of financial dependence as capital expenditures minus cash flows that accrue from investments in the same industry segment, divided by capital expenditures. Thus, they exclude any cross-subsidization within conglomerates.

for the next period (IK_{t+1}); second, the firms decide about the optimal capital stock for the next period (K_{t+1}) and, thus, the demand for external financing $(K_{t+1} - IK_{t+1})$. I solve this sequential optimization problem by backward induction, starting with the firms. Both firms know the realizations of p_t before their capital allocation decision.

Firm a maximizes its current profits, given its internal financing capacity $(IK_{t,a})$: $\underset{K_{t,a}}{Max}\,(\pi_{t,a})$ s.t. $K_{t,a} \geq IK_{t,a}$ where $\pi_{t,a} = p_t A_t K_{t,a}^{\alpha} - (r+f)\,(K_{t,a} - IK_{t,a})$.

Off corners, the first-order condition is equal to: $\alpha p_t A_t K_{t,a}^{\alpha-1} - (r+f) = 0$. The optimal capital allocation rule for firm a follows immediately as:

$$K_{t,a} = Max\left(IK_{t,a};\left(\frac{\alpha p_t A_t}{r+f}\right)^{\frac{1}{1-\alpha}}\right). \tag{IV.8}$$

According to this optimal capital allocation rule, firm a employs all available internal funds and, in addition, raises outside funds as long as the marginal productivity of capital $\left(\alpha p_t A_t K_{t,a}^{\alpha-1}\right)$ exceeds its marginal costs: $r+f$.

From the perspective of the owner of firm a, the capital allocation $(K_{t,a})$ is a function of the state of internal funds $(IK_{t,a})$ and the realization of p_t. Hence, profits are equal to:

$$\pi_{t,a} = Max\left[p_t A_t\,(IK_{t,a})^{\alpha}\,; p_t A_t\left(\frac{\alpha p_t A_t}{r+f}\right)^{\frac{\alpha}{1-\alpha}} - (r+f)\left(\left(\frac{\alpha p_t A_t}{r+f}\right)^{\frac{1}{1-\alpha}} - IK_{t,a}\right)\right]. \tag{IV.9}$$

Therefore, the sequential optimization problem can be reduced to the following dynamic optimization problem: The owner of firm a chooses the infinite sequence of controls

$\{d_{t,a}, IK_{t+1,a}\}_{t=0}^{\infty}$ to maximize $E_0 \sum\limits_{t=0}^{\infty}\left(\frac{1}{r}\right)^t d_{t,a}$ subject to

- $IK_0 \geq 0$ given,
- $IK_{t+1,a} + d_{t,a} = \pi_{t,a}$ (transition law),

- $d_{t,a} \geq 0$ and $IK_{t+1,a} \geq 0 \; \forall \; t \geq 0$.

The dynamic optimization problem is characterized by the parameter r, the owner's linear utility function ($U\left(d_{t,a}\right) = d_{t,a}$), which maps from $R_{+} \rightarrow R$, the profit function $\pi_{t,a}\left(IK_{t,a}\right)$, which maps from $R_{+} \rightarrow R_{+}$, and the initial state of internal funds IK_0. Similarly to Stokey and Lucas (1989), I summarize the following properties of the utility function and the profit function to which I need to refer in the later analysis:

- $(U1)$ $0 < \frac{1}{r} < 1$ (by assumption).
- $(U2)$ The linear utility function (U) is continuous.
- $(U3)$ U is strictly increasing in $d_{t,a}$ (with slope equal to 1).
- $(U4)$ U is weakly concave.
- $(U5)$ U is continuously differentiable (with slope equal to 1 everywhere).
- $(P1)$ $\pi_{t,a}$ is continuous: At $IK_{t,a} = \left(\frac{\alpha p_t A_t}{r+f}\right)^{\frac{1}{1-\alpha}}$, $\pi_{t,a} = p_t A_t \left(\frac{\alpha p_t A_t}{r+f}\right)^{\frac{\alpha}{1-\alpha}}$ from above and below.
- $(P2)$ At $IK_{t,a} = 0$, $\pi_{t,a} = p_t A_t \left(\frac{\alpha p_t A_t}{r+f}\right)^{\frac{\alpha}{1-\alpha}} - (r+f)\left(\frac{\alpha p_t A_t}{r+f}\right)^{\frac{1}{1-\alpha}} > 0$ as $\alpha < 1$ by assumption. There exists a maintainable internal funding capacity $\overline{IK}_{t,a}$, such that $IK_{t,a} \leq E\pi_{t,a}\left(IK_{t,a}\right) \leq \overline{IK}_{t,a}$ for all $0 \leq IK_{t,a} \leq \overline{IK}_{t,a}$, and $E\pi_{t,a}\left(IK_{t,a}\right) < IK_{t,a}$ for all $IK_{t,a} > \overline{IK}_{t,a}$ (cf. similarly Stokey and Lucas, 1989).
- $(P3)$ $\pi_{t,a}$ is strictly increasing: For $IK_{t,a} < \left(\frac{\alpha p_t A_t}{r+f}\right)^{\frac{1}{1-\alpha}}$, $\frac{\delta \pi_{t,a}}{\delta IK_{t,a}} = r + f$. For $IK_{t,a} \geq \left(\frac{\alpha p_t A_t}{r+f}\right)^{\frac{1}{1-\alpha}}$, $\frac{\delta \pi_{t,a}}{\delta IK_{t,a}} = \alpha p_t A_t IK_{t,a}^{\alpha-1}$.
- $(P4)$ $\pi_{t,a}$ is weakly concave. In the first phase (for $IK_{t,a} < \left(\frac{\alpha p_t A_t}{r+f}\right)^{\frac{1}{1-\alpha}}$), $\pi_{t,a}$ is weakly concave; in the second phase (for $IK_{t,a} \geq \left(\frac{\alpha p_t A_t}{r+f}\right)^{\frac{1}{1-\alpha}}$), $\pi_{t,a}$ is strictly concave.

- $(P5)$ $\pi_{t,a}$ is continuously differentiable: $\pi_{t,a}\left(IK_{t,a}\right)$ is continuously differentiable with respect to $IK_{t,a}$:

$$\lim_{IK_{t,a} \overset{>}{\rightarrow} \left(\frac{\alpha p_t A_t}{r+f}\right)^{\frac{1}{1-\alpha}}} \left(\frac{\delta \pi_{t,a}}{\delta IK_{t,a}}\right) = \alpha p_t A_t \left(\frac{\alpha p_t A_t}{r+f}\right)^{\frac{\alpha-1}{1-\alpha}} = (r+f) \text{ and}$$

$$\lim_{IK_{t,a} \overset{<}{\rightarrow} \left(\frac{\alpha p_t A_t}{r+f}\right)^{\frac{1}{1-\alpha}}} \left(\frac{\delta \pi_{t,a}}{\delta IK_{t,a}}\right) = -\left(r+f\right)\left(-1\right) = \left(r+f\right).$$

Corresponding to this problem, I write the functional equation that reformulates the problem in a recursive way. For this purpose, I define a return function as: $r\left(IK_{t,a}, IK_{t+1,a}, \tilde{\varepsilon}_t\right) = \pi_{t,a}\left(IK_{t,a}, \tilde{\varepsilon}_t\right) - IK_{t+1,a}$. Let IK denote the set of possible values for the state variable $IK_{t,a}$. The constraint correspondence $\Gamma : IK \rightarrow IK$ describes the set of feasible values for $IK_{t,a}$. The graph of Γ is described by $\left\{\left(IK_{t+1,a}, IK_{t,a}\right) : 0 \leq IK_{t+1,a} \leq \pi_{t,a} - d_{t,a}, d_{t,a} \in R_0^+\right\}$.

The maximum value function for firm a can be written in the form of the Bellman equation:

$$V\left(IK_{t,a}\right) = \max_{d_{t,a}, IK_{t+1,a}} \left\{d_{t,a} + \frac{1}{r} V\left(IK_{t+1,a}\right)\right\} \tag{IV.10}$$

$$\text{s.t. } d_{t,a}, IK_{t+1,a} \geq 0 \ \ \forall \ \ t \geq 0$$

$$IK_{t+1,a} \leq \pi_{t,a} - d_{t,a}.$$

According to Stokey and Lucas (1989), such a reformulation requires the problem to be well-behaved, which is satisfied if:

1. Γ is non-empty.

2. $\lim\limits_{T\rightarrow\infty} \left(\frac{1}{r}\right)^T r\left(IK_{t,a}, IK_{t+,a}\right)$ exists.

I will verify these conditions for each of the analyzed cases separately (cf. Subsections 4.3, 4.4, and 4.5).

In contrast to firm a, firm b can raise external financing frictionless, at costs of r. Therefore, firm b: $\underset{K_{t,b}}{Max}\left(\pi_{t,b}\right)$ s.t. $K_{t,b} \geq IK_{t,b}$ where $\pi_{t,b} = p_t A_t K_{t,b}^{\alpha} -$

$r\left(K_{t,b} - IK_{t,b}\right)$. The off-corner first-order condition is equal to: $\alpha p_t A_t K_{t,b}^{\alpha-1} = r$. The optimal capital allocation rule for firm b follows immediately as:

$$K_{t,b} = Max\left(IK_{t,b}; \left(\frac{\alpha p_t A_t}{r}\right)^{\frac{1}{1-\alpha}}\right). \tag{IV.11}$$

Firm b employs all available internal funds and, in addition, raises outside funds as long as the marginal productivity of capital exceeds its marginal costs (r).

Analogously to firm a, the owner of firm b chooses the infinite sequence of controls $\{d_{t,b}, IK_{t+1,b}\}_{t=0}^{\infty}$ to maximize $E_0 \sum_{t=0}^{\infty} \left(\frac{1}{r}\right)^t d_{t,b}$ subject to

- $IK_0 \geq 0$ given
- $IK_{t+1,b} + d_{t,b} = \pi_{t,b}$ (transition law)
- $d_{t,b} \geq 0$ and $IK_{t+1,b} \geq 0 \;\forall\; t \geq 0$

where $\pi_{t,b} = Max\left[p_t A_t \left(IK_{t,a}\right)^{\alpha}; p_t A_t \left(\frac{\alpha p_t A_t}{r}\right)^{\frac{\alpha}{1-\alpha}} - r\left(\left(\frac{\alpha p_t A_t}{r}\right)^{\frac{1}{1-\alpha}} - IK_{t,b}\right)\right]$.

4.2 Benchmark Case: Efficient Capital Allocation

As a benchmark case, I consider the capital allocation of firm b. The owner of firm b is indifferent between financing the optimal capital stock internally or externally because external funds are provided frictionless. Given firm b's capital allocation rule (cf. equation IV.11), the owner with rational expectations leaves funds inside the firm up to the amount that is optimal in the case of a negative demand shift: $0 \leq IK_{t,b} \leq \left(\frac{\alpha p_{low} A_t}{r}\right)^{\frac{1}{1-\alpha}}$. The following range of $d_{t,b}$ results as optimal: $d_{t,b}$ indeterminate $\in \left[\pi_{t,b} - \left(\frac{\alpha p_{low} A_t}{r}\right)^{\frac{1}{1-\alpha}}; \pi_{t,b}\right]$. Therefore, firm b always employs the efficient capital stock:

$$K_{t,b} = \left(\frac{\alpha p_t A_t}{r}\right)^{\frac{1}{1-\alpha}}. \tag{IV.12}$$

The capital growth rate in firm b (efficient capital growth rate) follows immediately as:

$$\frac{K_{t,b}}{K_{t-1,b}} = \left(\frac{p_t}{p_{t-1}}\right)^{\frac{1}{1-\alpha}} \left(\frac{A_t}{A_{t-1}}\right)^{\frac{1}{1-\alpha}}. \tag{IV.13}$$

4.3 Capital Allocation without Exogenous Growth Opportunities

For firm a, I first analyze the capital allocation in an environment without exogenous growth opportunities: There are neither stochastic demand shifts ($\varepsilon = 0$ and, hence, $p_t = p = const$), nor persistent shifts in supply ($A_t = A = const$).

I use dynamic programming techniques to solve the owner's optimization problem. The requirements for using dynamic programming techniques (non-empty Γ and existence of $\lim\limits_{T\to\infty} \left(\frac{1}{r}\right)^T r\left(IK_{t,a}, IK_{t+,a}\right)$) are satisfied because Γ and r have the following properties (cf. Stokey and Lucas, 1989):

1. Γ is a compact set. Similar to Stokey and Lucas (1989), I restrict the set of possible choices ($IK_{t+1,a}$) to firm a's maintainable internal funding capacity: $IK = \left[0; \overline{IK}\right]$ with $\overline{IK} = (pA)^{\frac{1}{1-\alpha}} = const.$[13] Therefore, the constraint correspondence Γ that maps from the closed interval IK into the closed interval IK (constraining $0 \leq IK_{t+1,a} \leq \pi_{t,a}\left(IK_{t,a}\right) - d_{t,a}$) is a compact set. In addition, $\Gamma : IK \rightarrow IK$ is clearly non-empty, compact-valued and continuous.

2. r is bounded. Even though the owner's linear utility function U is unbounded, the return function r is bounded because it is continuous and maps from the compact state space IK into the real numbers.[14] In addition, $r > 1$ by assumption.

From (1) and (2), I conclude that the solution to the original dynamic optimization problem and the solution to the (recursive) functional equation coincide exactly

[13]Such a restriction is justified by properties ($U3$) and ($P3$) that preclude optimal free disposal of funds.

[14]A sequence is said to be bounded if there is a number B such that $|x_n| \leq B$ for all n (cf. the definition by Simon and Blume, 1994).

(for a proof cf. Stokey and Lucas, 1989), and, in addition, that a solution to this problem in fact exists. Therefore, I can proceed by solving the functional equation. Substituting the transition law $d_{t,a} = \pi_{t,a} - IK_{t+1,a}$ into the Bellman equation gives:

$$V\left(IK_{t,a}\right) = \underset{0 \leq IK_{t+1,a} \leq \pi_{t,a}}{max} \left\{ \left(\pi_{t,a} - IK_{t+1,a}\right) + \frac{1}{r} V\left(IK_{t+1,a}\right) \right\}. \tag{IV.14}$$

Firm a is defined as technologically dependent on external financing if $\left(\frac{\alpha p A}{r}\right)^{\frac{1}{1-\alpha}} > \pi_{t,a}$. Depending on firm a's technological dependence on external financing, I suggest an optimal policy function ($d_{t,a}$ or equivalently $IK_{t+1,a}$) and verify afterwards that it in fact satisfies the Bellman equation.

Phase 1: $\pi_{t,a} < \left(\frac{\alpha p A}{r}\right)^{\frac{1}{1-\alpha}}$

- $d_{t,a} = 0$, or equivalently: $IK_{t+1,a} = \pi_{t,a}$.

Phase 2: $\left(\frac{\alpha p A}{r}\right)^{\frac{1}{1-\alpha}} \leq \pi_{t,a}$

- $d_{t,a} = \pi_{t,a} - \left(\frac{\alpha p A}{r}\right)^{\frac{1}{1-\alpha}}$, or equivalently: $IK_{t+1,a} = \left(\frac{\alpha p A}{r}\right)^{\frac{1}{1-\alpha}}$.

Two additional properties of Γ and r guarantee that the value function is differentiable off-corners (cf. Benveniste and Scheinkman, 1979 and Stokey and Lucas, 1989 for detailed results on the differentiability of the value function):

- Γ is convex. Convexity requires that $IK_{t+1,a} \in \Gamma\left(IK_{t,a}\right)$ and $IK'_{t+1,a} \in \Gamma\left(IK'_{t,a}\right)$ imply that $aIK_{t+1,a} + (1-a)\, IK'_{t+1,a} \in \Gamma\left(aIK_{t,a} + (1-a)\, IK'_{t,a}\right)$ whenever $IK_{t,a}, IK'_{t,a} \in \left[0; \overline{IK}_{t,a}\right]$ and $a \in [0,1]$ (cf. e.g., the definitions in Mas-Colell, Whinston, and Green, 1995; Stokey and Lucas, 1989). By $(P4)$, $\pi_{t,a}$ (which is the upper bound on $IK_{t+1,a}$) is weakly concave. At $IK_{t,a} = \left(\frac{\alpha p A}{r+f}\right)^{\frac{1}{1-\alpha}}$, $\pi_{t,a}$ is differentiable, by $(P5)$. Therefore, the constraint set is convex.

- $r(IK_{t,a}, IK_{t+1,a}) = \pi_{t,a}(IK_{t,a}) - IK_{t+1,a}$ is concave. Concavity requires that

$$\begin{aligned} r\left(a\left(IK_{t,a}, IK_{t+1,a}\right) + (1-a) * \left(IK'_{t,a}, IK'_{t+1,a}\right)\right) &\geq \\ a * r\left(IK_{t,a}, IK_{t+1,a}\right) + (1-a) * r\left(IK'_{t,a}, IK'_{t+1,a}\right) & \end{aligned} \tag{IV.15}$$

whenever $IK_{t,a},\ IK'_{t,a} \in \left[0; \overline{IK}\right]$ and $a \in [0,1]$ (cf. e.g., the definitions in Simon and Blume, 1994; Stokey and Lucas, 1989). For $IK_{t,a} \geq \left(\frac{\alpha pA}{r+f}\right)^{\frac{1}{1-\alpha}}$, the inequality even holds strictly if $IK_{t,a} \neq IK'_{t,a}$ because returns to IK_t are decreasing on that interval.

Benveniste and Scheinkman (1979) give the envelope condition for $V'(IK_{t,a})$:[15]

$$V'(IK_{t,a}) = \frac{\delta\left(\pi_{t,a} - IK_{t+1,a}\right)}{\delta IK_{t,a}} = \begin{cases} (r+f) & \text{if } \pi_{t-1,a} < \left(\frac{\alpha pA}{r+f}\right)^{\frac{1}{1-\alpha}} \\ \alpha pA\left(IK_{t,a}\right)^{\alpha-1} & \text{if } \pi_{t-1,a} \geq \left(\frac{\alpha pA}{r+f}\right)^{\frac{1}{1-\alpha}} \end{cases}. \tag{IV.16}$$

Off-corner differentiability is not sufficient because the non-negativity constraint $d_{t,a} \geq 0$ (or equivalently: $IK_{t+1,a} \leq \pi_{t,a}$) can be binding. In fact, I even suggest the boundary solution to be optimal in phase 1 (for $\pi_{t,a} < \left(\frac{\alpha pA}{r}\right)^{\frac{1}{1-\alpha}}$).[16]

Standard results on the differentiability of the value function rely on the interiority of the optimal policy function. Rincón-Zapatero and Santos (2009) extend these standard results to boundary solutions. In particular, they provide conditions under which the value function is differentiable even at the boundary, for concave,

[15] I have already shown above that the profit function is differentiable at $IK_{t,a} = \left(\frac{\alpha pA}{r+f}\right)^{\frac{1}{1-\alpha}}$ ($P5$)—and so is the value function: $\lim_{IK_{t,a} \to \left(\frac{\alpha pA}{r+f}\right)^{\frac{1}{1-\alpha}}} \frac{\delta(\pi_{t,a} - IK_{t+1,a})}{\delta IK_{t,a}} = (r+f)$ from below and $\lim_{IK_{t,a} \to \left(\frac{\alpha pA}{r+f}\right)^{\frac{1}{1-\alpha}}} \frac{\delta(\pi_{t,a} - IK_{t+1,a})}{\delta IK_{t,a}} = \alpha pA\left(IK_{t+1,a}\right)^{\alpha} = (r+f)$ from above.

[16] In contrast, the non-negativity constraint for internal funds ($IK_{t+1,a} \geq 0$) is never binding: Given the owner's linear utility function, the marginal costs for increasing internal funds are equal to $= -1$ for any $IK_{t,a}$. At $IK_{t,a} = 0$, the marginal benefits of increasing internal funds are (smaller or) equal to: $\frac{\frac{\delta \pi_{t+1,a}}{\delta IK_{t+1,a}}}{r} = \left(\frac{r+f}{r}\right)$, where the increase in next-period profits is discounted at the rate of r. Since $f > 0$, $\frac{\frac{\delta \pi_{t+1,a}}{\delta IK_{t+1,a}}}{r}$ exceeds one. Therefore, the constraint $IK_{t,a} \geq 0$ is never binding and can be ignored.

not necessarily strict concave optimization. Analogous to their example, I need to ensure that the optimal path of the owner's distribution policy eventually reaches an interior (first-best) solution. Then, applying Benveniste and Scheinkman (1979), the derivative of the value function always exists, even at the boundary. Therefore, I need to ensure that firm a reaches phase 2 at some finite point in time τ. In an environment without exogenous growth opportunities, this condition is met: $\left(\frac{\alpha pA}{r}\right)^{\frac{1}{1-\alpha}}$ stays constant over time. In contrast, $\pi_{t,a}$ increases over time because, with $\alpha < 1$, firm a makes profits and accumulates these profits as internal funds, according to the suggested optimal distribution policy. Therefore, there is a finite point in time τ, where $\left(\frac{\alpha pA}{r}\right)^{\frac{1}{1-\alpha}} \leq \pi_{\tau,a}$, and, hence, the optimal policy reaches the interior. According to the suggested optimal policy function, $\pi_{t,a}$ is constant for all periods following τ, i.e., non-decreasing. Therefore, firm a never enters phase 1 with the boundary solution after τ.

I last verify the optimality of the suggested policy function. The optimal policy has to satisfy the first-order necessary condition of the Bellman equation:

$$-1 + \left(\frac{1}{r}\right) V'\left(IK_{t+1,a}\right) = 0. \tag{IV.17}$$

The envelope condition gives the value for $V'\left(IK_{t+1,a}\right)$:

$$V'\left(IK_{t+1,a}\right) = \begin{cases} (r+f) & \text{if } \pi_{t,a} < \left(\frac{\alpha pA}{r+f}\right)^{\frac{1}{1-\alpha}} \\ \alpha pA\left(IK_{t+1,a}\right)^{\alpha-1} & \text{if } \pi_{t,a} \geq \left(\frac{\alpha pA}{r+f}\right)^{\frac{1}{1-\alpha}} \end{cases}. \tag{IV.18}$$

Together, these two conditions yield the Euler equation:

$$\begin{aligned} &\text{if } \pi_{t,a} < \left(\frac{\alpha pA}{r+f}\right)^{\frac{1}{1-\alpha}} \rightarrow \left(\frac{1}{r}\right)(r+f) = 1; \\ &\text{if } \pi_{t,a} \geq \left(\frac{\alpha pA}{r+f}\right)^{\frac{1}{1-\alpha}} \rightarrow IK_{t+1,a} = \left(\frac{\alpha pA}{r}\right)^{\frac{1}{1-\alpha}}. \end{aligned} \tag{IV.19}$$

For $\pi_{t,a} < \left(\frac{\alpha p A}{r+f}\right)^{\frac{1}{1-\alpha}}$, the condition never holds with equality: The marginal costs for increasing internal funds (r) are always lower than the respective marginal benefits ($r + f$). Therefore, the suggested boundary solution of $IK_{t+1,a} = \pi_{t,a}$ is optimal. If $\pi_{t,a} \geq \left(\frac{\alpha p A}{r+f}\right)^{\frac{1}{1-\alpha}}$, where the return function is strictly concave in $IK_{t,a}$, $IK_{t+1,a} = \left(\frac{\alpha p A}{r}\right)^{\frac{1}{1-\alpha}}$(or equivalently $d_{t,a} = \pi_{t,a} - \left(\frac{\alpha p A}{r}\right)^{\frac{1}{1-\alpha}}$) is the unique solution. This solution is only feasible if $\pi_{t,a} \geq \left(\frac{\alpha p A}{r}\right)^{\frac{1}{1-\alpha}}$. For $\left(\frac{\alpha p A}{r+f}\right)^{\frac{1}{1-\alpha}} \leq \pi_{t,a} < \left(\frac{\alpha p A}{r}\right)^{\frac{1}{1-\alpha}}$, the boundary solution of $IK_{t+1,a} = \pi_{t,a}$ is still optimal.

Ultimately, I am interested in the effect of the owner's optimal internal funding policy on the capital allocation $K_{t,a}$. I distinguish between the following phases:

Phase 1.a: $\pi_{t,a} < \left(\frac{\alpha p A}{r+f}\right)^{\frac{1}{1-\alpha}}$

- $K_{t+1,a} = \left(\frac{\alpha p A}{r+f}\right)^{\frac{1}{1-\alpha}}$.

Phase 1.b: $\left(\frac{\alpha p A}{r+f}\right)^{\frac{1}{1-\alpha}} \leq \pi_{t,a} < \left(\frac{\alpha p A}{r}\right)^{\frac{1}{1-\alpha}}$

- $K_{t+1,a} = \pi_{t,a}$.

Phase 2: $\left(\frac{\alpha p A}{r}\right)^{\frac{1}{1-\alpha}} \leq \pi_{t,a}$

- $K_{t+1,a} = \left(\frac{\alpha p A}{r}\right)^{\frac{1}{1-\alpha}}$.

At the early stages of firm a's life (phases 1.a and 1.b), past accumulated profits are insufficient to cover the efficient capital stock (cf. equation IV.12). Firm a is technologically dependent on external financing. Since the owner of firm a cannot inject funds ($d_{t,a} \geq 0$) and because of the premium for external financing (f), firm a allocates less capital than efficient to the production of the commodity. Without exogenous growth opportunities, firm a gets independent of external financing at some finite point in time τ. From that time on, $\left(\frac{\alpha p A}{r}\right)^{\frac{1}{1-\alpha}} \leq \pi_{t,a}$ allows firm a to operate at the efficient scale, completely financed by internal funds.

The comparison of the capital allocation in firms a and b allows conclusions about the relevance of financial development.

Corollary 1. *With $\varepsilon = 0$ and $A_t = A = const$, the degree of financial development impacts the allocation of capital only temporarily at an early stage of firm a's life, as long as $\pi_{t,a} < \left(\frac{\alpha p A}{r}\right)^{\frac{1}{1-\alpha}}$ (phases 1.a and 1.b). If $\pi_{t,a} < \left(\frac{\alpha p A}{r+f}\right)^{\frac{1}{1-\alpha}}$ (phase 1.a),*

$$K_{t,a} = \left(\frac{r}{r+f}\right)^{\frac{1}{1-\alpha}} * K_{t,b} \tag{IV.20}$$

$$\frac{K_{t,a}}{K_{t-1,a}} = \frac{K_{t,b}}{K_{t-1,b}} = 1, \tag{IV.21}$$

where $\frac{K_{t,a} - IK_{t,a}}{K_{t,a}}$ is decreasing.

Proof. This relation follows immediately from comparing the level and growth rate of capital in firm a with the level and growth rate of capital in firm b (cf. equations IV.12 and IV.13). □

Interpretation of Corollary 1. Firm a has access to a less-developed financial system than firm b: It can raise external financing only at the premium f. Firm a can compensate this comparative disadvantage by accumulating internal funds. Without exogenous growth opportunities ($\varepsilon = 0$ and $A_t = A = const$), internal funds increase over time. In the steady-state, firm a has accumulated enough internal funds to be (technologically) independent of external financing and there is no impact of the degree of financial development, neither on the level, nor on the growth rates of capital.

4.4 Capital Allocation with Stochastic, Temporary Growth Opportunities

I now analyze the capital allocation in both firms if there are temporary demand, but no persistent supply shifts, i.e., for the parameter values: $\varepsilon > 0$ and $A_t = A = const$.

Analogously to the benchmark case without exogenous growth opportunities, I restrict the set of possible state variables to $IK = \left[0; (p^{+}A)^{\frac{1}{1-\alpha}}\right]$, which is even larger than the expected maintainable capital stock. As before, Γ is non-empty, compact-valued and continuous; r is bounded on the compact set $IK = \left[0; (p^{+}A)^{\frac{1}{1-\alpha}}\right]$. In addition, following the reasoning in Ljungqvist and Sargent (2004), with $\tilde{\varepsilon}_t \sim iid$ the optimization problem continues to have a recursive structure because controls dated t affect returns in later, but not in earlier periods.

Therefore, the solution to the original dynamic optimization problem and the functional equation coincide exactly. Substituting the transition law $d_{t,a} = \pi_{t,a} - IK_{t+1,a}$ into the Bellman equation gives:

$$EV\left(IK_{t,a}\right) = \underset{0 \leq IK_{t+1,a} \leq \pi_{t,a}}{max} \left\{ \left(\pi_{t,a} - IK_{t+1,a}\right) + \frac{1}{r} EV\left(IK_{t+1,a}\right) \right\}. \tag{IV.22}$$

With temporary demand shifts, firm a is defined to technologically depend on external financing if $\left(\frac{\alpha p_{low} A}{r-f}\right)^{\frac{1}{1-\alpha}} > \pi_{t,a}$. Depending on firm a's technological, financial dependence, I suggest an optimal distribution policy ($d_{t,a}$ or equivalently $IK_{t+1,a}$) and verify afterwards that it satisfies the Bellman equation.

Phase 1: $\pi_{t,a} < \left(\frac{\alpha p_{low} A}{r-f}\right)^{\frac{1}{1-\alpha}}$

- $d_{t,a} = 0$, or equivalently $IK_{t+1,a} = \pi_{t,a}$.

Phase 2: $\pi_{t,a} \geq \left(\frac{\alpha p_{low} A}{r-f}\right)^{\frac{1}{1-\alpha}}$

- $d_{t,a} = \pi_{t,a} - \left(\frac{\alpha p_{low} A}{r-f}\right)^{\frac{1}{1-\alpha}}$, or equivalently $IK_{t+1,a} = \left(\frac{\alpha p_{low} A}{r-f}\right)^{\frac{1}{1-\alpha}}$.

As before, convexity of Γ and concavity of r guarantee the differentiability of the value function off-corners. As in the benchmark case, the suggested policy function reaches an interior solution (phase 2) at some finite point in time τ: $\left(\frac{\alpha p_{low} A}{r-f}\right)^{\frac{1}{1-\alpha}}$ stays constant over time, but $\pi_{t,a}$ is increasing because firm a accumulates profits internally as long as $\left(\frac{\alpha p_{low}A}{r-f}\right)^{\frac{1}{1-\alpha}} > \pi_{t,a}$. For all periods following τ, $IK_{t+1,a} = \left(\frac{\alpha p_{low}A}{r-f}\right)^{\frac{1}{1-\alpha}}$. By firm a's capital allocation rule (cf. equation IV.8), $K_{t+1,a} = \left(\frac{\alpha p_{low}A}{r-f}\right)^{\frac{1}{1-\alpha}}$ if $\tilde{\varepsilon_t} = -\varepsilon$ because $\left(\frac{\alpha p_{low}A}{r-f}\right)^{\frac{1}{1-\alpha}} > \left(\frac{\alpha p_{low}A}{r+f}\right)^{\frac{1}{1-\alpha}}$. $K_{t+1,a} = \left(\frac{\alpha p_{high}A}{r+f}\right)^{\frac{1}{1-\alpha}}$ if $\tilde{\varepsilon_t} = +\varepsilon$ because $\left(\frac{\alpha p_{high}A}{r+f}\right)^{\frac{1}{1-\alpha}} > \left(\frac{\alpha p_{low}A}{r-f}\right)^{\frac{1}{1-\alpha}}$ as $\frac{p_{high}}{p_{low}} > \frac{r+f}{r-f}$ by assumption. Since $(r-f) \geq \alpha$ (by assumption), $\pi_{t+1,a} \geq \left(\frac{\alpha p_{low}A}{r-f}\right)^{\frac{1}{1-\alpha}}$ for all periods following τ and hence firm a never enters phase 1 (with the boundary solution) again.

I last verify the optimality of the suggested policy function. The optimal policy has to satisfy the first-order necessary condition of the Bellman equation:

$$-1 + \left(\frac{1}{r}\right) EV'\left(IK_{t+1,a}\right) = 0. \tag{IV.23}$$

Benveniste and Scheinkman (1979) give the envelope condition for $EV'\left(IK_{t+1,a}\right)$:

$$EV'\left(IK_{t+1,a}\right) = \frac{1}{2}\frac{\delta\pi_{high,t+1,a}}{\delta IK_{t+1,a}} + \frac{1}{2}\frac{\delta\pi_{low,t+1,a}}{\delta IK_{t+1,a}}, \tag{IV.24}$$

where $\frac{\delta\pi_{low,t+1,a}}{\delta IK_{t+1,a}} = \begin{cases} (r+f) & if \;\; \pi_{t,a} < \left(\frac{\alpha p_{low}A}{r+f}\right)^{\frac{1}{1-\alpha}} \\ \frac{1}{2}\alpha pA\left(IK_{t+1,a}\right)^{\alpha-1} & if \;\; \pi_{t,a} \geq \left(\frac{\alpha p_{low}A}{r+f}\right)^{\frac{1}{1-\alpha}} \end{cases}$ and $\frac{\delta\pi_{high,t+1,a}}{\delta IK_{t+1,a}} = (r+f)$.

Therefore:

$$EV'\left(IK_{t+1,a}\right) = \frac{1}{2}(r+f) + \frac{1}{2} * \begin{cases} (r+f) & \text{if} \quad \pi_{t,a} < \left(\frac{\alpha p_{low}A}{r+f}\right)^{\frac{1}{1-\alpha}} \\ \frac{1}{2}\alpha p_{low}A\left(IK_{t+1,a}\right)^{\alpha-1} & \text{if} \quad \pi_{t,a} \geq \left(\frac{\alpha p_{low}A}{r+f}\right)^{\frac{1}{1-\alpha}} \end{cases}. \tag{IV.25}$$

Together, these two conditions yield the Euler equation:

$$\text{if } \pi_{t,a} < \left(\frac{\alpha p_{low} A}{r+f}\right)^{\frac{1}{1-\alpha}} \rightarrow \left(\frac{1}{r}\right)(r+f) = 1;$$
$$\text{if } \pi_{t,a} \geq \left(\frac{\alpha p_{low} A}{r+f}\right)^{\frac{1}{1-\alpha}} \rightarrow IK_{t+1,a} = \left(\frac{\alpha p_{low} A}{r-f}\right)^{\frac{1}{1-\alpha}}. \tag{IV.26}$$

For $\pi_{t,a} < \left(\frac{\alpha p_{low} A}{r+f}\right)^{\frac{1}{1-\alpha}}$, the condition never holds with equality. Therefore, the boundary solution of $IK_{t+1,a} = \pi_{t,a}$ is optimal in that phase. For $\pi_{t,a} \geq \left(\frac{\alpha p_{low} A}{r+f}\right)^{\frac{1}{1-\alpha}}$, $IK_{t+1,a} = \left(\frac{\alpha p_{low} A}{r-f}\right)^{\frac{1}{1-\alpha}}$ is the unique solution. This solution is only feasible if $\pi_{t,a} \geq \left(\frac{\alpha p_{low} A}{r-f}\right)^{\frac{1}{1-\alpha}}$. For $\left(\frac{\alpha p_{low} A}{r+f}\right)^{\frac{1}{1-\alpha}} \leq \pi_{t,a} < \left(\frac{\alpha p_{low} A}{r-f}\right)^{\frac{1}{1-\alpha}}$, the boundary solution of $IK_{t+1,a} = \pi_{t,a}$ is still optimal.

Given the owner's optimal internal funding policy, $K_{t,a}$ differs throughout the following phases:

Phase 1.a: $\pi_{t,a} < \left(\frac{\alpha p_{low} A}{r+f}\right)^{\frac{1}{1-\alpha}}$

- $K_{t+1,a} = \left(\frac{\alpha p_t A}{r+f}\right)^{\frac{1}{1-\alpha}}$.

Phase 1.b: $\left(\frac{\alpha p_{low} A}{r+f}\right)^{\frac{1}{1-\alpha}} \leq \pi_{t,a} < \left(\frac{\alpha p_{low} A}{r-f}\right)^{\frac{1}{1-\alpha}}$

- $K_{t,a} = \begin{cases} \pi_{t,a} \;\; if & \tilde{\varepsilon}_t = -\varepsilon \\ \left(\frac{\alpha p_{high} A}{r+f}\right)^{\frac{1}{1-\alpha}} \;\; if & \tilde{\varepsilon}_t = +\varepsilon \end{cases}.$

Phase 2: $\left(\frac{\alpha p_{low} A}{r-f}\right)^{\frac{1}{1-\alpha}} \leq \pi_{t,a}$

- $K_{t,a} = \begin{cases} \left(\frac{\alpha p_{low} A}{r-f}\right)^{\frac{1}{1-\alpha}} \;\; if & \tilde{\varepsilon}_t = -\varepsilon \\ \left(\frac{\alpha p_{high} A}{r+f}\right)^{\frac{1}{1-\alpha}} \;\; if & \tilde{\varepsilon}_t = +\varepsilon \end{cases}.$

Regarding temporary demand shifts, there is the same (transitional) effect of the degree of financial development on the capital allocation as in the benchmark case: Firm a initially needs external financing because past accumulated profits are insufficient to cover the efficient capital stock (cf. equation IV.12). As formulated in

Corollary 1, there is no effect on capital growth rates during that phase. In addition, firm a permanently needs funds from external sources, even in a steady-state (phase 2), where it is technologically independent of external financing: The owner restricts firm a's internal funding capacity to $\left(\frac{\alpha p_{low} A}{r-f}\right)^{\frac{1}{1-\alpha}}$ because of a corporate governance problem: In contrast to the owner, the (manager of the) firm observes the realization of the stochastic demand shift before the investment decision, but has no incentive to give up control of internal funds (lack of outside investment opportunities). With this (optimal) restriction of internal funds, firm a only demands external financing in order to adjust to positive investment opportunities. Hence, $\frac{K_{t,a}-IK_{t,a}}{K_{t,a}}$ is the same in each period where demand is positively shocked. If $\left(\frac{\alpha p_{low} A}{r-f}\right)^{\frac{1}{1-\alpha}} > \frac{1}{2}\left(\frac{\alpha p_{low} A}{r}\right)^{\frac{1}{1-\alpha}} + \frac{1}{2}\left(\frac{\alpha p_{high} A}{r}\right)^{\frac{1}{1-\alpha}}$, the owner of firm a allows capital hoarding, in the sense that the level of internal funds exceeds the average efficient level of capital.

Proposition 1. *With $\varepsilon > 0$ and $A_t = A = const$, the degree of financial development impacts the allocation of capital persistently. If $\left(\frac{\alpha p_{low} A}{r-f}\right)^{\frac{1}{1-\alpha}} \leq \pi_{t,a}$ (phase 2),*

$$K_{t,a} = \begin{cases} \left(\frac{r}{r-f}\right)^{\frac{1}{1-\alpha}} K_{t,b} & \textit{if } \tilde{\varepsilon}_t = -\varepsilon \\ \left(\frac{r}{r+f}\right)^{\frac{1}{1-\alpha}} K_{t,b} & \textit{if } \tilde{\varepsilon}_t = +\varepsilon \end{cases} \tag{IV.27}$$

$$\frac{K_{t,a}}{K_{t-1,a}} = \begin{cases} \frac{K_{t,b}}{K_{t-1,b}} = 1 & \textit{if } \tilde{\varepsilon}_t = \tilde{\varepsilon}_{t-1} \\ \left(\frac{r}{r+f}\right)^{\frac{1}{1-\alpha}} \frac{K_{t,b}}{K_{t-1,b}} & \textit{if } \tilde{\varepsilon}_t = +\varepsilon \textit{ and } \tilde{\varepsilon}_{t-1} = -\varepsilon \\ \left(\frac{r}{r-f}\right)^{\frac{1}{1-\alpha}} \frac{K_{t,b}}{K_{t-1,b}} & \textit{if } \tilde{\varepsilon}_t = -\varepsilon \textit{ and } \tilde{\varepsilon}_{t-1} = +\varepsilon \end{cases} \tag{IV.28}$$

where $\frac{K_{t,a}-IK_{t,a}}{K_{t,a}}$ is constant.

Proof. This relation follows immediately from comparing the level and the growth rate of capital in firm a with the level and growth rate of capital in firm b (cf. equations IV.12 and IV.13). □

Interpretation of Proposition 1. The owner of firm a only expects, but does not observe the temporary shifts in demand. If firm a is technologically independent of external financing, the owner of firm a can partially provide for positive demand shifts by allowing the hoarding of capital. However, such a substitution of external with internal financing comes at the expense of lower flexibility: Internal funds are inertial because they are adjusted only once per period, before the realization of the demand shift. Therefore, even in a steady-state, firm a demands external financing in order to adjust to positive demand shifts.[17]

Empirical Implication of Proposition 1. Proposition 1 suggests an econometrical test that is very close to that by Ciccone and Papaioannou (2006) and Fisman and Love (2007) (cf. their specification in Subsection 1.2.3).

I interpret firm a as the representative firm of a particular industry in country a (with the less-developed financial system) and firm b as the representative firm of the same industry in country b (perfectly developed financial system). Applying Proposition 1, the financially less-developed country a shows lower capital growth rates than country b in those sectors that are subject to positive demand shifts. Analogously, sectors that are subject to negative demand shifts shrink less in country a than in country b. This implication is in line with Ciccone and Papaioannou (2006) and Fisman and Love (2007) who predict that the interaction between growth opportunities and the degree of financial development is positively associated with realized capital growth rates. In contrast to the impact on capital growth rates, the

[17] Since shocks are only temporary, one can compare capital growth rates in firms a and b without separating the adjustment to contemporaneous shifts from the lagged adjustment to past demand shifts. If capital adjustment was overlapping, the econometrical procedure by Fisman and Love (2004b) would be preferable to the one by Ciccone and Papaioannou (2006): They relate correlations in capital growth rates for different countries to similar degrees of financial development.

degree of financial development only leads to small differences in the average levels of capital in both countries: Due to capital hoarding, the average capital stock of an industry subject to temporary demand shifts in country a may even exceed that of the same industry in country b.

Furthermore, the analysis shows that the specification regarding temporary, stochastic demand shifts only applies to certain industries. Such industries are in the steady-state of their growth cycle and subject to volatile investment opportunities.

4.5 Capital Allocation with Deterministic, Persistent Growth Opportunities

I now analyze the capital allocation in both firms if there are no temporary demand shifts ($\varepsilon > 0$), but persistent shifts in supply, i.e., A_t changes over time. I consider a specific productivity growth cycle. At stage 1 in this growth cycle ($t \leq t_1$), $0 < \frac{A_t}{A_{t-1}} < \frac{A_{t+1}}{A_t}$; at stage 2 ($t_1 < t \leq t_2$), $\frac{A_{t+1}}{A_t} < \frac{A_t}{A_{t-1}}$; at stage 3 ($t_2 < t$), $\frac{A_{t+1}}{A_t} = const$ with $1 \leq \frac{A_{t+1}}{A_t} \leq r^{1-\alpha}$.

In contrast to the cases analyzed before, with sustained economic growth (due to persistent supply shifts) it is not natural to restrict the set of possible internal funding capacities to a compact set. Consequently, the return function r is unbounded. Uniformly bounded growth rates still allow to meaningfully analyze the supremum of the value of the firm.

By the usual contractive arguments, Stokey and Lucas (1989) establish conditions under which the solution to the (recursive) functional equation coincides with the supremum of the firm value. In order to apply their reasoning, I need to show that

- $\Gamma(IK) = [0, \pi_{t,a}) \neq \{\}$ (which is clearly the case), and
- $\lim_{\tau \to \infty} \left(\frac{1}{r}\right)^{\tau} r\left(IK_{t,a}, IK_{t+,a}\right)$ exists and there is an upper bound to the supremum of the value of firm a: $V(IK) \leq B$.

I show below that the second condition is satisfied. Substituting the transition law $d_{t,a} = \pi_{t,a} - IK_{t+1,a}$ into the Bellman equation gives:

$$V\left(IK_{t,a}\right) = \underset{0 \leq IK_{t+1,a} \leq \pi_{t,a}}{max} \left\{ \left(\pi_{t,a} - IK_{t+1,a}\right) + \frac{1}{r} V\left(IK_{t+1,a}\right) \right\}. \tag{IV.29}$$

If $\left(\frac{\alpha p A_{t+1}}{r}\right)^{\frac{1}{1-\alpha}} > \pi_{t,a}$, I define firm a as technologically independent of external financing. Depending on firm a's technological, financial dependence, I suggest an optimal distribution policy ($d_{t,a}$ or equivalently $IK_{t+1,a}$) and verify its optimality.

Phase 1: $\pi_{t,a} < \left(\frac{\alpha p A_{t+1}}{r}\right)^{\frac{1}{1-\alpha}}$

- $d_{t,a} = 0$, or equivalently: $IK_{t+1,a} = \pi_{t,a}$.

Phase 2: $\left(\frac{\alpha p A_{t+1}}{r}\right)^{\frac{1}{1-\alpha}} \leq \pi_{t,a}$

- $d_{t,a} = \pi_{t,a} - \left(\frac{\alpha p A_{t+1}}{r}\right)^{\frac{1}{1-\alpha}}$, or equivalently: $IK_{t+1,a} = \left(\frac{\alpha p A_{t+1}}{r}\right)^{\frac{1}{1-\alpha}}$.

As in the cases before, I verify that firm a reaches the interior solution in phase 2 at some finite point in time τ. As long as $\pi_{t,a} < \left(\frac{\alpha p A_t}{r+f}\right)^{\frac{1}{1-\alpha}}$, the owner of firm a allows to accumulate all profits inside the firm. From the assumption that $\frac{A_{t+1}}{A_t} \leq r^{1-\alpha}$, which implies that $\frac{A_{t+1}}{A_t} \leq \left(\frac{r+f}{\alpha}\right)^{1-\alpha}$, and from $\alpha < 1$ it follows for $t > t_2$ that internal funds (past accumulated profits) grow more than the current efficient capital stock (cf. equation IV.12). Therefore, there will be a finite point in time τ, where $\pi_{t,a} \geq \left(\frac{\alpha p A_t}{r+f}\right)^{\frac{1}{1-\alpha}}$. As $\frac{A_{t+1}}{A_t} \leq r^{1-\alpha}$, internal funds are thereafter increasing more than the current efficient capital stock such that there will be a finite point in time τ, where $\pi_{t,a} \geq \left(\frac{\alpha p A_t}{r+f}\right)^{\frac{1}{1-\alpha}}$. Firm a will never enter phase 1 again as $\frac{A_{t+1}}{A_t} < r^{1-\alpha}$ and, hence, $\frac{A_{t+1}}{A_t} < \left(\frac{r}{\alpha}\right)^{1-\alpha}$. Therefore, at $t = \tau$ the policy function reaches an interior solution.

The solution to the recursive functional equation coincides with that to the initial dynamic optimization problem if $\underset{\tau \to \infty}{lim} \left(\frac{1}{r}\right)^{\tau} r\left(IK_{t,a}, IK_{t+1,a}\right)$ exists and there is an upper bound to the supremum of the firm value: $V(IK) \leq B$. At τ, firm a enters phase 2 with $A_\tau < \infty$ and $IK_{\tau,a} < \infty$. For all $t \geq \tau$, any feasible path satisfies: $\pi_{t,a} \leq p^{1+\alpha+...+\alpha^{(t-\tau)}} A_\tau^{1+\alpha+...+\alpha^{(t-\tau)}} r^{(t-\tau)(1-\alpha)+(t-\tau-1)(1-\alpha)\alpha+...+(1-\alpha)\alpha^{(t-\tau-1)}} IK_{\tau,a}^{\alpha^{(t-\tau+1)}}$ as $r^{(1-\alpha)}$ bounds growth rates. $r(IK_{t,a}, IK_{t+1,a}) \leq r(IK_{t,a}, 0)$ and $r(IK_{t,a}, 0) = \pi_{t,a}$. $\left(\frac{1}{r}\right)^t r(IK_{t,a}, IK_{t+1,a}) \leq p^{1+\alpha+...+\alpha^{(t-\tau)}} A_\tau^{1+\alpha+...+\alpha^{(t-\tau)}} r^{-t+...+(1-\alpha)\alpha^{(t-\tau-1)}} IK_{\tau,a}^{\alpha^{(t-\tau+1)}}$. Applying the convergence results for finite geometric sequences,

$$-t + (t-\tau)(1-\alpha) + (t-\tau-1)(1-\alpha)\alpha + ... + (1-\alpha)\alpha^{(t-\tau-1)}$$
$$= -t + (1-\alpha)\left[(t-\tau)\left(1 + ... + \alpha^{(t-\tau-1)}\right) - \left(\alpha + ... + (t-\tau-1)\alpha^{(t-\tau-1)}\right)\right]$$
$$= t + (t-\tau)\left(1 - \alpha^{(t-\tau-1+1)}\right) - \frac{\alpha^{(t-\tau-1+2)} - (t-\tau-1+1)\alpha^{t-\tau-1+1} + \alpha}{1-\alpha} = \frac{\tau\alpha^{t-\tau+1} - \tau\alpha^{t-\tau} - \alpha}{1-\alpha}.$$

This term converges to $\frac{-\alpha}{1-\alpha}$ as $t \to \infty$.

Therefore, $\lim_{t\to\infty} \left(\frac{1}{r}\right)^t r(IK_{t,a}, IK_{t+1,a}) \leq p^{\left(\frac{1}{1-\alpha}\right)} A_\tau^{\left(\frac{1}{1-\alpha}\right)} \left(\frac{1}{r^{\frac{\alpha}{1-\alpha}}}\right)$. Hence, there is a convergent upper bound to the supremum of the value of firm a: $V(IK) \leq p^{\left(\frac{1}{1-\alpha}\right)} A_\tau^{\left(\frac{1}{1-\alpha}\right)} \left(\frac{1}{r^{\frac{\alpha}{1-\alpha}}}\right)$.[18]

As in the cases analyzed before, Γ is convex and r is concave.

I last verify the optimality of the suggested distribution policy. The optimal policy has to satisfy the first-order necessary condition of the Bellman equation:

$$-1 + \left(\frac{1}{r}\right) V'(IK_{t+1,a}) = 0. \tag{IV.30}$$

Benveniste and Scheinkman (1979) give the envelope condition for $V'(IK_{t+1,a})$ as:

$$V'(IK_{t+1,a}) = \begin{cases} (r+f) & \text{if } \pi_{t,a} < \left(\frac{\alpha p A_{t+1}}{r+f}\right)^{\frac{1}{1-\alpha}} \\ \alpha p A_{t+1} (IK_{t+1,a})^{\alpha-1} & \text{if } \pi_{t,a} \geq \left(\frac{\alpha p A_{t+1}}{r+f}\right)^{\frac{1}{1-\alpha}} . \end{cases} \tag{IV.31}$$

Together, these two conditions yield the Euler equation:

[18] For details on a similar proof cf. Stokey and Lucas, 1989.

$$\text{if } \pi_{t,a} < \left(\frac{\alpha p A_{t+1}}{r+f}\right)^{\frac{1}{1-\alpha}} \to \left(\frac{1}{r}\right)(r+f) = 1;$$
$$\text{if } \pi_{t,a} \geq \left(\frac{\alpha p A_{t+1}}{r+f}\right)^{\frac{1}{1-\alpha}} \to IK_{t+1,a} = \left(\frac{\alpha p A_{t+1}}{r}\right)^{\frac{1}{1-\alpha}}. \qquad \text{(IV.32)}$$

For $\pi_{t,a} < \left(\frac{\alpha p A_{t+1}}{r+f}\right)^{\frac{1}{1-\alpha}}$, the condition never holds with equality. Therefore, the boundary solution of $IK_{t+1,a} = \pi_{t,a}$ is optimal in that phase. If $\pi_{t,a} \geq \left(\frac{\alpha p_{low} A}{r+f}\right)^{\frac{1}{1-\alpha}}$, $IK_{t+1,a} = \left(\frac{\alpha p A_{t+1}}{r}\right)^{\frac{1}{1-\alpha}}$ is the unique solution. This solution is only feasible if $\pi_{t,a} \geq \left(\frac{\alpha p A_{t+1}}{r}\right)^{\frac{1}{1-\alpha}}$. For $\left(\frac{\alpha p A_{t+1}}{r+f}\right)^{\frac{1}{1-\alpha}} \leq \pi_{t,a} < \left(\frac{\alpha p A_{t+1}}{r}\right)^{\frac{1}{1-\alpha}}$, the boundary solution of $IK_{t+1,a} = \pi_{t,a}$ is still optimal.

Given the owner's optimal internal funding policy, $K_{t,a}$ differs throughout the following phases:

Phase 1.a: $\pi_{t,a} < \left(\frac{\alpha p A_{t+1}}{r+f}\right)^{\frac{1}{1-\alpha}}$

- $K_{t+1,a} = \left(\frac{\alpha p A_t}{r+f}\right)^{\frac{1}{1-\alpha}}$.

Phase 1.b: $\left(\frac{\alpha p A_{t+1}}{r+f}\right)^{\frac{1}{1-\alpha}} \leq \pi_{t,a} < \left(\frac{\alpha p A_{t+1}}{r}\right)^{\frac{1}{1-\alpha}}$

- $K_{t+1,a} = \pi_{t,a}$.

Phase 2: $\left(\frac{\alpha p A_{t+1}}{r}\right)^{\frac{1}{1-\alpha}} \leq \pi_{t,a}$

- $K_{t+1,a} = \left(\frac{\alpha p A_{t+1}}{r}\right)^{\frac{1}{1-\alpha}}$.

Since growth opportunities are deterministic (no information asymmetry between the owner and the manager of the firm), internal funds are perfect substitutes for external funds. Therefore, the owner's optimal policy during phases 1.a and 1.b is to allow the accumulation of profits until the firm has reached the efficient capital stock (cf. equation IV.12). At stage 1 in the firm's growth cycle ($t < t_1$), firm a will never be able to reach the efficient capital stock because it grows faster than profits from operating activities, which lag one period. At that stage, relative demand for external financing $\left(\frac{K_{t,a}-IK_{t,a}}{K_{t,a}}\right)$ is increasing: $\frac{K_{t,a}-IK_{t,a}}{K_{t,a}} < \frac{K_{t+1,a}-IK_{t+1,a}}{K_{t+1,a}}$ implies that $\frac{pA_{t-1}\left(\frac{\alpha pA_{t-1}}{r+f}\right)^{\frac{\alpha}{1-\alpha}}}{\left(\frac{\alpha pA_t}{r+f}\right)^{\frac{1}{1-\alpha}}} > \frac{pA_t\left(\frac{\alpha pA_t}{r+f}\right)^{\frac{\alpha}{1-\alpha}}}{\left(\frac{\alpha pA_{t+1}}{r+f}\right)^{\frac{1}{1-\alpha}}}$, which implies that $\left(\frac{A_t}{A_{t-1}}\right)^{\frac{1}{1-\alpha}} < \left(\frac{A_{t+1}}{A_t}\right)^{\frac{1}{1-\alpha}}$ or $\frac{A_t}{A_{t-1}} < \frac{A_{t+1}}{A_t}$. In phase 2, firm a is technologically independent of external financing and, hence, finances the efficient capital stock completely using internal funds.

Proposition 2. *With $\varepsilon = 0$ and $0 < \frac{A_t}{A_{t-1}} < \frac{A_{t+1}}{A_t}$ for $t \leq t_1$, $\frac{A_{t+1}}{A_t} < \frac{A_t}{A_{t-1}}$ for $t_1 < t \leq t_2$ and $\frac{A_{t+1}}{A_t} = const$ with $1 \leq \frac{A_{t+1}}{A_t} \leq r^{1-\alpha}$ for $t > t_2$: The degree of financial development impacts the allocation of capital temporarily at an early stage in the growth cycle as long as $\left(\frac{\alpha pA_{t+1}}{r}\right)^{\frac{1}{1-\alpha}} \leq \pi_{t,a}$. If $t \leq t_1$,*

$$K_{t,a} = \left(\frac{r}{r+f}\right)^{\frac{1}{1-\alpha}} * K_{t,b}; \tag{IV.33}$$

$$\frac{K_{t,a}}{K_{t-1,a}} = \frac{K_{t,b}}{K_{t-1,b}} = \left(\frac{A_t}{A_{t-1}}\right)^{\frac{1}{1-\alpha}}, \tag{IV.34}$$

where $\frac{K_{t,a}-IK_{t,a}}{K_{t,a}}$ is increasing.

Proof. This relation follows immediately from comparing the level and growth rate of capital in firm a with the level and growth rate of capital in firm b (cf. equations IV.12 and IV.13). □

Interpretation of Proposition 2. If exogenous growth opportunities are persistent, sustained economic growth induces technological dependence on external financing at least as long as the efficient capital stock grows faster than operating profits (stage 1 in the growth cycle). Given technological dependence on external financing during that early stage in the firm's growth cycle, the degree of financial development impacts the realized capital stock. Such an impact of financial development is of transitional nature and only occurs at early stages in the firm's growth cycle. Assuming a constant premium for external financing (f), the degree of financial development only impacts the level, but not the growth rates of capital at this stage because it impacts the capital allocation at t in the same way as the capital allocation at $t-1$.

4.6 Extension 1: Financial Development as a Function of Varying Firm Characteristics

The analysis so far shows: Only with temporary demand shifts and in a firm's steady-state, the degree of financial development has the expected impact on capital growth rates (in the way described by Ciccone and Papaioannou, 2006). In this steady-state, the firm is technologically independent of external financing, but still needs external financing in order to adjust fast to stochastic demand shifts. In contrast, Rajan and Zingales (1998) argue that the degree of financial development is particularly important for industries that technologically depend on external financing. In the analysis so far, financial development matters for the level of capital, but not for the growth rates of capital. The reason for this preliminary result is that the degree of financial development has the same impact on the capital allocation in periods t and $t-1$: However, a constant industry characteristic only impacts the level of capital, but not the growth rates of capital. The crucial driver of this preliminary result is the assumption that the premium for external financing (f) has been assumed to be constant. Consequently, I analyze how the main results change if I assume that f is an increasing function of firm a's demand for external financing relative to its capital stock $\left(\frac{K_{t,a}-IK_{t,a}}{K_{t,a}}\right)$, where $f \rightarrow 0$ as $\frac{IK_{t,a}}{K_{t,a}} \rightarrow 1$.[19]

The first change in the analysis lies in the capital allocation decision by firm a. Given $IK_{t,a}$, firm a $\underset{K_{t,a}}{Max}\,(\pi_{t,a})$ s.t. $K_{t,a} \geq IK_{t,a}$ where $\pi_{t,a} = p_t A_t K_{t,a}^{\alpha} -$

[19] One simple functional form of f that satisfies these requirements is $f = c * \left(\frac{K_{t,a}-IK_{t,a}}{K_{t,a}}\right)$, where $c = const.$

$(r+f)(K_{t,a}-IK_{t,a})$ and f now depends on $\left(\frac{K_{t,a}-IK_{t,a}}{K_{t,a}}\right)$ in the way described above. For the range $K_{t,a} > IK_{t,a}$, the first-order condition with respect to $K_{t,a}$ is equal to:

$$\alpha p_t A_t K_{t,a}^{\alpha-1} = (r+f) - \frac{\delta f}{\delta\left(\frac{K_t - IKt_t}{K_t}\right)} \frac{IK_t}{K_t^2}. \tag{IV.35}$$

I now analyze how the assumption of a varying f changes the main insights of Propositions 1 and 2.

4.6.1 Stochastic, Temporary Growth Opportunities

According to Proposition 1, the adjustments to exogenous shifts in demand in the sense of Ciccone and Papaioannou (2006) occur in a phase where the demand for external financing is exclusively due to the stochastic nature of demand shifts, which have the same size each period. Therefore, $\frac{K_{t,a}-IK_{t,a}}{K_{t,a}}$ is constant. If f is increasing in $\frac{K_{t,a}-IK_{t,a}}{K_{t,a}}$, the results of Proposition 1 remain unchanged, with the equilibrium premium for external financing (f^*) replacing the constant premium of f.

4.6.2 Deterministic, Persistent Growth Opportunities

In contrast, according to Proposition 2, financial development has an impact on the exploitation of persistent supply shifts only at an early stage of the firm's life. However, at these early stages, $\frac{K_{t,a}-IK_{t,a}}{K_{t,a}}$ is not constant. In particular, at the first stage in the growth cycle ($t < t_1$), $\frac{K_{t,a}-IK_{t,a}}{K_{t,a}}$ is increasing (cf. Proposition 2). Since $\frac{K_{t,a}-IK_{t,a}}{K_{t,a}}$ is systematically changing in those phases where financial development impacts the exploitation of persistent growth opportunities, the functional form of f is crucial for this type of growth opportunities.

The analysis is modified as follows. As before, $\Gamma(IK) = [0, \pi_{t,a})$ is non-empty, compact-valued and continuous. Γ is also convex: For $\pi_{t,a} < \left(\frac{\alpha p A_t}{r}\right)^{\frac{1}{1-\alpha}}$, $\pi_{t,a}$ is concave; as $IK_{t,a}$ increases, profits increase at a decreasing rate because the increase in profits (due to the lower premium for external financing with a higher level of internal funds) decreases as the relative demand for external financing $\frac{K_{t,a}-IK_{t,a}}{K_{t,a}}$ and, hence, f shrink. For $\pi_{t,a} \geq \left(\frac{\alpha p A_t}{r}\right)^{\frac{1}{1-\alpha}}$, $\pi_{t,a}$ is (strictly) concave due to the decreasing returns to scale. At $IK_{t,a} = \left(\frac{\alpha p A}{r}\right)^{\frac{1}{1-\alpha}}$, $\pi_{t,a}$ is differentiable as $IK_{t,a} \rightarrow \left(\frac{\alpha p A}{r}\right)^{\frac{1}{1-\alpha}}$ implies that $f \rightarrow 0$. r is unbounded, but $\underset{\tau\rightarrow\infty}{lim} \left(\frac{1}{r}\right)^{\tau} r\left(IK_{t,a}, IK_{t+,a}\right)$ exists, and there is an upper bound to the supremum of the value of firm a: $V\left(IK\right) \leq B$. In addition, r is concave. Firm a reaches an interior solution at some finite point in time τ. After that point in time τ, firm a never enters phase 1 again.

Therefore, the solution exists and is equivalent to the solution of the (recursive) functional equation, as well as the initial dynamic optimization problem.

Phase 1: $\pi_{t,a} < \left(\frac{\alpha p A_t}{r}\right)^{\frac{1}{1-\alpha}}$

- $d_{t,a} = 0$ (equivalent to $IK_{t,a} = \pi_{t,a}$).

Phase 2: $\pi_{t,a} \leq \left(\frac{\alpha p A_t}{r}\right)^{\frac{1}{1-\alpha}}$

- $d_{t,a} = \pi_{t,a} - \left(\frac{\alpha p A_t}{r}\right)^{\frac{1}{1-\alpha}}$ (equivalent to $IK_{t,a} = \left(\frac{\alpha p A_t}{r}\right)^{\frac{1}{1-\alpha}}$).

I last verify the optimality of the suggested policy function. The optimal policy has to satisfy the first-order necessary condition of the Bellman equation:

$$-1 + \left(\frac{1}{r}\right) V'\left(IK_{t+1,a}\right) = 0. \tag{IV.36}$$

Benveniste and Scheinkman (1979) give the envelope condition for $V'\left(IK_{t+1,a}\right)$:

$$V'\left(IK_{t+1,a}\right) = \begin{cases} \frac{\delta \pi_{t+1,a}}{\delta IK_{t+1,a}} & \text{if } \pi_{t,a} < \left(\frac{\alpha p A_{t+1}}{r}\right)^{\frac{1}{1-\alpha}} \\ \alpha p A_{t+1}\left(IK_{t+1,a}\right)^{\alpha-1} & \text{if } \pi_{t,a} \geq \left(\frac{\alpha p A_{t+1}}{r}\right)^{\frac{1}{1-\alpha}} \end{cases}. \tag{IV.37}$$

Together, these two conditions yield the Euler equation:

$$\text{if } \pi_{t,a} < \left(\frac{\alpha p A_{t+1}}{r}\right)^{\frac{1}{1-\alpha}} \rightarrow r = \frac{\delta \pi_{t+1,a}}{\delta IK_{t+1,a}};$$
$$\text{if } \pi_{t,a} \geq \left(\frac{\alpha p A_{t+1}}{r}\right)^{\frac{1}{1-\alpha}} \rightarrow IK_{t+1,a} = \left(\frac{\alpha p A_{t}}{r}\right)^{\frac{1}{1-\alpha}}, \qquad \text{(IV.38)}$$

where $\frac{\delta \pi_{t+1,a}}{\delta IK_{t+1,a}}$ captures the varying premium for external financing that the firm saves by increasing internal funds. For $\pi_{t,a} < \left(\frac{\alpha p A_{t+1}}{r}\right)^{\frac{1}{1-\alpha}}$, a marginal increase in internal funds increases operating profits due to decreased costs for external financing for this marginal unit $(r + f^*)$ and due to decreased costs for external financing for all units of external financing.

The case distinction is at $\pi_{t,a} = \left(\frac{\alpha p A_{t+1}}{r}\right)^{\frac{1}{1-\alpha}}$, not at $\pi_{t,a} = \left(\frac{\alpha p A_{t+1}}{r+f}\right)^{\frac{1}{1-\alpha}}$ as before, because $f \rightarrow 0$ as $\frac{IK_{t,a}}{K_{t,a}} \rightarrow 1$ by assumption. The condition never holds with equality if $\pi_{t,a} < \left(\frac{\alpha p A_{t+1}}{r}\right)^{\frac{1}{1-\alpha}}$ because $f > 0 \, \forall \, \frac{K_{t,a} - IK_{t,a}}{K_{t,a}}$, so $f^* > 0$. The boundary solution of $IK_{t+1,a} = \pi_{t,a}$ is optimal in the first phase. In the second phase, $IK_{t+1,a} = \left(\frac{\alpha p A_t}{r}\right)^{\frac{1}{1-\alpha}}$ is the unique solution, which is always feasible as $\pi_{t,a} \geq \left(\frac{\alpha p A_t}{r}\right)^{\frac{1}{1-\alpha}}$. Let $K^*_{t,a} = \underset{K_{t,a}}{argmax} \left[p_t A_t \left(IK_{t,a}\right)^{\alpha}; p_t A_t \left(\frac{\alpha p_t A_t}{r+f}\right)^{\frac{\alpha}{1-\alpha}} - (r+f) \left(\left(\frac{\alpha p_t A_t}{r+f}\right)^{\frac{1}{1-\alpha}} - IK_{t,a} \right) \right]$. The allocation of capital differs according to the following phases:

Phase 1: $\pi_{t,a} < \left(\frac{\alpha p A_t}{r}\right)^{\frac{1}{1-\alpha}}$

- $K_{t+1,a} = K^*_{t+1,a}$

Phase 2: $\left(\frac{\alpha p A_t}{r}\right)^{\frac{1}{1-\alpha}} \leq \pi_{t,a}$

- $K_{t+1,a} = \left(\frac{\alpha p A_t}{r}\right)^{\frac{1}{1-\alpha}}$

Importantly, $K^*_{t,a}$ is increasing in f , which—in turn—is increasing in $\frac{K_{t,a} - IK_{t,a}}{K_{t,a}}$. Therefore, as $\frac{K_{t,a} - IK_{t,a}}{K_{t,a}}$ is increasing during the first stage in the growth cycle $(t < t_1)$ (cf. Proposition 4.5), firm a can exploit less and less of the increasing exogenous supply shifts.

Proposition 3. *With* $\varepsilon = 0$ *and* $0 < \frac{A_t}{A_{t-1}} < \frac{A_{t+1}}{A_t}$ *for* $t \leq t_1$, $\frac{A_{t+1}}{A_t} < \frac{A_t}{A_{t-1}}$ *for* $t_1 < t \leq t_2$, *and* $\frac{A_{t+1}}{A_t} = const$ *(with* $1 \leq \frac{A_{t+1}}{A_t} \leq r^{1-\alpha}$*), for* $t > t_2$*: The degree of financial development impacts the allocation of capital temporarily at an early stage in the growth cycle as long as* $\left(\frac{\alpha p A_{t+1}}{r}\right)^{\frac{1}{1-\alpha}} \leq \pi_{t,a}$. *If* $t_1 < t$,

$$K_{t,a} < K_{t,b}; \tag{IV.39}$$

$$\frac{K_{t,a}}{K_{t-1,a}} < \frac{K_{t,b}}{K_{t-1,b}}, \tag{IV.40}$$

where both $(K_{t,a} - K_{t,b})$ *and* $\left(\frac{K_{t,a}}{K_{t-1,a}} - \frac{K_{t,b}}{K_{t-1,b}}\right)$ *are increasing in* f.

Proof. This relation follows immediately from comparing the level and growth rate of capital in firm a (cf. Proposition 2) with the level and growth rates of capital in firm b (cf. equations IV.12 and IV.13), using the fact that $\frac{K_{t,a} - IK_{t,a}}{K_{t,a}}$ is increasing for $t < t_1$. □

Interpretation of Proposition 3. If firm a (technologically) depends on external financing, it has a comparative disadvantage in the sense of Ricardo, compared to firm b that is located in the country with a perfectly developed financial system: It allocates less to the production of the commodity. However, this level effect does not automatically translate into different capital growth rates in both firms.

For financial development to impact capital growth rates from $t-1$ to t, financial development has to impact firm a's capital allocation decision both at $t-1$ and at t, and, in addition, it has to impact the capital allocation decisions at both points in time in a different manner. With the assumed functional form of f, firm a meets this requirement if its dependence on external financing is positive and, in addition, changes over time. Along the productivity growth cycle, financial dependence is positive and increasing if $t \leq t_1$.

Notably, the assumption that supply shifts follow the defined growth cycle is not crucial to derive this result: Internal funds depend on the history of the firm. They represent the cumulative function of past profits as long as there are positive investment opportunities in the future, which the owner foresees because supply shifts are assumed to be deterministic. Hence, internal funds are non-decreasing. The growth-cycle definition simplifies the analysis because it allows to reduce the history of the firm to the last period, and the future of the firm to the next period. Due to the growth-cycle assumption, current technological dependence on external financing and future technological dependence on external financing are linked in a way that ensures that the owner does not let the manager invest excessive internal funds only because—at some time in the future—the firm again will face positive growth opportunities.

Empirical Implications. Proposition 3 suggests an econometric test that is close to, but different from that by Rajan and Zingales (1998) (cf. their specification in Subsection 1.2.3). One can interpret firm a as a representative firm of a particular industry in country a that is subject to temporary, stochastic demand shifts. Firm b is a representative firm of the same industry in country b. Applying Proposition 3, sectoral capital growth rates in the financially less-developed country a are in fact lower than in the country with the perfectly developed financial system. As found by Rajan and Zingales (1998), this model predicts a positive sign of the coefficient of an interaction between the degree of financial development and technological, financial dependence.

The comparison of the capital reallocation in both firms following persistent supply shifts suggests certain refinements:

- Rather than the industry's absolute (technological) dependence on external financing, its change has to be interacted with the degree of financial development. Positive financial dependence is a prerequisite, but not enough for financial development to impact growth rates.[20]

- In contrast, absolute (technological) dependence on external financing, as used by Rajan and Zingales (1998), is important to explain the Ricardian specialization of financially well-developed countries in industries that technologically depend on external financing. Thus, the product of the development of a financial system and the absolute financial dependence of that industry should have a positive impact on the level of capital allocated to the respective industry.

The analysis allows further suggestions for an empirical test:

- The specification only applies to certain industries. Such industries are at an early stage in the industry growth cycle (young firms).[21] The concept of technological, financial dependence (and, hence, the suggested specification) is especially important for industries with low profit margins and for industries with a long time lag between the investment outlay and the cash flowing back from operations (in my model this time lag is 1 period).

Comparison: Temporary Demand versus Persistent Supply Shifts. This section compares the results from the analysis of temporary demand and persistent

[20] As opposed to the predictions from my model, Rajan and Zingales (1998) use the measure of financial dependence in the financially perfectly developed country b. This measure is meant to reduce the endogeneity between the capital growth rates and financial dependence in country a. I have two remarks on their measures: First, optimal capital growth rates of firm b and the financial dependence of firm b are of course related. Therefore, the measure by Rajan and Zingales (1998) accounts for part of the growth opportunities that my model suggest to add. Importantly, the concepts of capital growth rates and financial dependence are not the same: Industries with positive growth opportunities are not necessarily financially dependent if they can use internally accumulated profits to finance such growth opportunities. Furthermore, the test by Rajan and Zingales (1998) fails to distinguish between the industry characteristic of financial dependence, which has an impact on the capital allocation, and the change in that industry characteristic, which has an impact on capital growth rates. Second, my model shows that $\frac{K_{t,b}-IK_{t-1,b}}{K_{t-1,b}}$ is not uniquely determined because a large range of distribution decisions is optimal for the owner in the financially perfectly developed country b (cf. the derivation of equation IV.12). Rajan and Zingales (1998) avoid this ambiguity with respect to the optimal distribution of firm b by defining technological dependence as the difference between capital expenditures and operating cash flows, relative to capital expenditures.

[21] Rajan and Zingales (1998) already test the impact of their measure particularly on young firms.

supply shifts in order to derive different empirical implications. The main distinctions are the following:

- Regarding temporary demand shifts, sectoral capital growth rates in the financially less-developed country a positively depend on the product of the degree of financial development and efficient capital growth rates. In contrast, concerning persistent supply shifts, sectoral capital growth rates in the financially less-developed country a positively depend on the product of the degree of financial development, the increase in firm a's financial dependence, and efficient capital growth rates. In summary, the product of the degree of financial development and capital growth rates in country b is expected to have a statistically significant and positive impact both regarding temporary demand and regarding persistent supply shifts. However, technological, financial dependence is only a relevant concept in the latter case. Therefore, one could empirically distinguish between the two specifications by testing whether the product of the degree of financial development, the increase in firm a's financial dependence, and efficient capital growth rates is statistically significant (which points to persistent supply shifts) or not (which points to temporary demand shifts).[22]

- The development of a financial system influences capital growth rates, and has only a weak impact on the absolute level of capital allocated towards an industry that is subject to temporary demand shifts in the respective countries. In contrast, regarding persistent supply shifts, the financially better developed country specializes in those industries that technologically depend on external financing.

- As to temporary demand shifts, the development of the financial system im-

[22] For simplicity, it is also possible to add only the absolute value of technological, financial dependence, instead of its increase. Only regarding persistent supply shift, this concept should matter at all.

pacts growth rates in industries even in their steady-state. Concerning persistent supply shifts, by contrast, only industries at early stages in their industry growth cycle are affected.

4.7 Extension 2: Financial Development in the Form of Different Financing Contracts

The analysis of the baseline model shows: The role of financial development crucially depends on the nature of growth opportunities. Following temporary, stochastic demand shifts, the development of a financial system impacts capital growth rates even in a steady-state. In contrast, following persistent, deterministic supply shifts, the development of a financial system impacts capital growth rates only along the growth path. Only regarding persistent, deterministic supply shifts, the concept of technological, financial dependence is important in order to explain this relation.

Financial dependence does not only have a technological component. A firm's internal financing capacity is, in addition, determined by the design of the external financing contracts, in particular by the specifications of the repayment modalities. Therefore, I extend the model to distinguish between two types of external financing contracts. The analysis of this extension shows a further difference between the role of a financial system for the capital reallocation following temporary, stochastic demand shifts, and following persistent, deterministic supply shifts: Both types of growth opportunities systematically differ in their financing needs and, hence, refer to different aspects of a financial system.

4.7.1 Model Extension

I distinguish between two types of external financing contracts that are available for firm a. For firm b, such a distinction is not necessary because any external financing is provided frictionless.

Contract type 1 offers external financing at the additional costs of f_D per unit of external financing of type 1 (D_t). It specifies that the firm pays back fixed amortization and interest of r for each unit of D_t at the end of the period.

Contract type 2 offers external financing at the additional costs of f_E per unit of external financing of type 2 (E_t). It leaves the pay-back schedule unspecified. At the end of the period, the providers of this type of external financing (along with the owner of the firm) choose the distribution d_t for each unit of E_t.

Let f^* denote the overall equilibrium premium for external financing. Assume, as above, that f_E and f_D are increasing in $\frac{K_{t,a}-IK_{t,a}}{K_{t,a}}$, where f_E, $f_D \rightarrow 0$ as $\frac{IK_{t,a}}{K_{t,a}} \rightarrow 1$.

4.7.2 Analysis

I analyze the optimal choice of d_t if firm a raises external financing of type 2 (i.e., $K_{t,a} = IK_{t,a} + E_{t,a}$), first, in the steady-state with temporary demand shifts, an second, along the growth path with persistent supply shifts.

Corollary 2. *Let $\varepsilon > 0$ and $A_t = A = const$. If firm a is technologically independent of external financing (phase 2), then $\frac{d_{t,a}}{IK_{t,a}+E_{t,a}} \geq r$.*

Proof. By Proposition 1, in phase 2, firm a is technologically independent of external financing. Analogously to the suggested optimal distribution policy in Subsection 4.4, $d_{t,a} = \pi_{t,a} - IK^*_{t,a}$, where $IK^*_{t,a}$ denotes the optimal level of capital hoarding:

$IK^*_{t,a} = \underset{IK_{t,a}}{argmax} \left[\frac{1}{2}p_{low}AIK^{\alpha}_{t,a} + \frac{1}{2}\left(p_{high}AK^{*\alpha}_{t,a} - (r+f^*)\left(K^*_{t,a} - IK^*_{t,a}\right)\right)\right]$. Since $0 < \alpha < 1$, $\frac{d_{t,a}}{K_{t,a}} \geq r$.

□

Therefore, in a phase where firm a adjusts less than firm b to stochastic demand shifts, there is no advantage of contract type 2 over contract type 1 because—at the end of each period—both require distribution of (at least) r per unit of external financing.

Corollary 3. *Let $\varepsilon = 0$ and $0 < \frac{A_t}{A_{t-1}} < \frac{A_{t+1}}{A_t}$ for $t \leq t_1$, $\frac{A_{t+1}}{A_t} < \frac{A_t}{A_{t-1}}$ for $t_1 < t \leq t_2$ and $\frac{A_{t+1}}{A_t} = const$ with $1 \leq \frac{A_{t+1}}{A_t} \leq r^{1-\alpha}$. If $t \leq t_1$, $\frac{d_{t,a}}{IK_{t,a}+E_{t,a}} < r$.*

Proof. By Proposition 2, firm a's relative demand for external financing increases in phase 1 ($t \leq t_1$). Analogously to the suggested optimal distribution policy in Subsection 4.5, $d_{t,a} = 0$, i.e., the owner of firm a optimally chooses the boundary solution. Hence, if outside financing is partly provided via contract of type 2, setting $d_{t,a} = 0$ improves firm a' s internal financing capacity and, hence, increases profits in this first stage in the growth cycle as long as $t+1 \leq t_1$. Therefore, $\frac{d_{t,a}}{IK_{t,a}+E_{t,a}} < r$. □

Therefore, in a phase where firm a adjusts less than firm b to deterministic persistent supply shifts, contract type 2 offers a systematic advantage over contract type 1: It allows to leave more funds inside the firm in a phase where internal funds are scarce.

Interpretation and Empirical Implications. With respect to temporary demand shifts, the development of the financial system has a steady-state impact on capital growth rates of firm a. In that phase, firm a is technologically independent of external financing and, hence, there is no additional advantage of financing contracts that can flexibly postpone repayment in order to leave funds inside the firm. In contrast, regarding persistent supply shifts, the development of the financial system only has an impact on capital growth rates if firm a is at an early stage in the industry growth cycle, where technological, financial dependence is still increasing. However, in that phase, the owner would like to leave more capital inside the firm to allow the firm to get faster independent of external financing. However, the owner cannot inject new capital. Therefore, in this phase, firm a has an additional advantage of external financing contracts that can flexibly postpone repayment to leave funds inside the firm.

Therefore, an empirical test should categorize the measures of financial development according to whether they rather suit the financing of temporary, stochastic growth opportunities (i.e., refer to the provision of short-term financing) or the financing of persistent, deterministic growth opportunities (i.e., refer to the provision of long-term financing). If the aspects of a financial system that provide short-term external financing and those that provide long-term external financing are not developed to the same extent in a particular country, the empirical specification for temporary demand shifts should be tested using different measures of financial development than the specification for persistent supply shifts.

5 Conclusion

The analysis derives from my model that a financial system can in fact impact sectoral growth rates in the respective economy. This result is based on the assumption that a firm can only raise external financing within its own national financial system. Assuming instead that a firm can raise external financing abroad, for instance, by listing at a foreign stock exchange, within the framework of this model, the national financial system would not have the same impact on national capital growth rates. However, international integration of financial systems may seem plausible with respect to stock exchanges, but less so with respect to other elements of a financial system: Bank credits, for instance, do not seem to be perfectly suited for international integration: Even within one economy, banks typically do not deal in credits outside a narrow geographic circle (Guiso, Sapienza, and Zingales, 2004).

My analysis shows that both approaches to the capital reallocation hypothesis (cf. above Subsection 1.2.3) refer to different natures of growth opportunities: the first approach to temporary, stochastic growth opportunities (cf. Subsection 4.4), the second approach to persistent, deterministic growth opportunities (cf. Subsection 4.5). Both types of growth opportunities lead to different financing needs (provision of short-term versus long-term capital) and, hence, refer to different aspects of a financial system (cf. Subsection 4.7). It is likely that international integration differently affects the components of a financial system that provide short-term capital and those that provide long-term capital. Consequently, in the course of international integration of national financial systems, the element of a financial system that is more affected by international integration than the other one should have a decreasing effect on the growth rates in the respective economy. If, concluding from Guiso, Sapienza, and Zingales (2004), bank credits were less internationally integrated than equity markets, this would result in a weaker impact of financial development according to the second approach to the capital reallocation hypothesis (regarding industries with dependence on external financing, cf. Subsection 1.2.3).

This theory is reflected in the results by Fisman and Love (2007) as explained above (in Subsection 1.2.3). They show that the impact of financial development on sectoral growth rates is weaker emphasizing industries with dependence on external financing (second approach, above Subsection 1.2.3), compared to an emphasis on industries with positive investment opportunities (first approach, cf. Subsection 1.2.3). However, their conclusion that the first approach comprises all functions of a financial system, and that the second one only refers to the narrow channel of external financing is incomplete. The analysis of my model associates both interpretations with different kinds of growth opportunities, but with the same function of a financial system, namely the provision of external financing.

The majority of studies on the capital reallocation hypothesis use data from the 1980s. It is worthwhile to test whether supposedly increased international integration of financial systems since then has weakened the impact of national financial systems or of one of their elements. A way to do so would be to use more recent data and to measure more explicitly the extent of international integration of financial systems, such as the extent of cross-listings or foreign direct investments, or the extent of regional financial integration, for instance, within the European Union.

Appendix

A Review of Studies at the Macroeconomic Level

One stream in the empirical literature tries to pin down an impact of the degree of development of a financial system on the growth in the respective economy at the macroeconomic level: They compare cross-country differences in overall economic growth rates with the development of the respective financial system. These macroeconomic studies address the main issues in this literature, namely the problems of reverse causality and of omitted variables mainly by certain econometric techniques. They exploit either the cross-sectional variation in the country-level data (over different countries c), the time-series variation (over different points in time t) or both the cross-sectional and the time-series variation:

- Cross-section variation: $Growth_i = \alpha Z_c + \beta F_c + \varepsilon_c$

  Controlling for other country-level factors that influence economic growth (Z_c), cross-sectional studies predict the influence (β) of financial indicators (F_c) on economic growth rates ($Growth_c$). As the benchmark study, King and Levine (1993a) find that contemporaneous financial development positively predicts contemporaneous as well as subsequent economic growth. Levine and Zervos (1998) provide similar evidence even after controlling for other relevant economic and political factors at the country level. Cross-sectional studies often address the concern of omitted variables with the help of instruments (Ang, 2008), but do not solve the egg-chicken problem of reserve causality. In contrast, time-series data allows to observe the relation between financial development or economic growth over time (Arestis and Demetriades, 1996).

- Time-series variation: $Growth_t = \alpha Z_t + \beta F_t + \varepsilon_t$

  Time-series studies find a causal effect of financial development on economic growth (e.g., Neusser and Kugler, 1998; Rousseau and Wachtel, 1998), but cannot fully exclude a bi-directional causality between financial development and economic growth (Luintel and Khan, 1999). Furthermore, financial systems may develop in anticipation of future economic growth and, hence, be a leading indicator rather than the underlying cause (Rajan and Zingales, 1998). Rousseau and Vuthipadadorn (2005) still conclude that finance acts as the driving force behind investment.

- Cross-section and time-series variation: $Growth_{ct} = \alpha Z_{ct} + \beta F_{ct} + \varepsilon_{ct}$

  Panel data allows to econometrically control for unobserved country- and time-specific effects and allows to more confidently conclude that a well-developed financial system promote economic growth (Beck and Levine, 2004; Rousseau and Wachtel, 2000).

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