Essays on firm performance, finance, and formality

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Abstract

This thesis examines the association between finance, formalisation, and firm performance for Vietnamese manufacturers.

The first empirical analysis develops empirical studies of the finance-productivity relation, investigating the impact of financial constraints on productivity at the different points of productivity distribution. I apply quantile regressions for the rich panel data of firms in Vietnam over the period 2005-2013 and I control for endogeneity problem arising from the implied relation by conducting the instrumental variables approach. The findings are as follows: (i) financial constraints have nonmonotonic distributional effects on productivity; particularly, financially constrained firms at the upper quantiles have the higher productivity than their unconstrained counterparts, while performers at bottom quantiles absorb negative effects of financial constraints; (ii) there is strong evidence of generating high internal funds in increasing productivity when firms are financially constrained; such positive effect appears stronger for firms at higher quantiles. I add further validity to the estimation by applying quantile treatment effects to compare financially constrained and unconstrained firms with similar control variables.

The second analysis explores the relationship between leverage and technical efficiency across firm size and formality status. Using a rich firm-level dataset from the manufacturing sector in Vietnam during the period 2005-2013, I find that smaller firms—regardless of formality status—experienced higher efficiency gains from increased leverage than larger firms. However, the nature of leverage matters with formal and short-term financing playing a crucial role in improving technical efficiency amongst small firms. Further extension of the analysis shows that the way in which firms possess property rights helps shape the leverage-efficiency link across different types of firms. These findings uphold the access to formal finance for smallest firms, including informal firms, as a likely mainstay of efficient

resource allocation in the developing economy.

The third analysis studies the effect of the reform that streamlined formalisation process on increased formal and/or informal financing of Vietnamese micro-firms. The difference-in-differences estimations identify the heterogeneity of the associated impact by firm age. The reform increased the propensity to use informal debt for young registered firms by 18.2 percentage points relative to those remaining informal, likely in the form of using informal finance only. The reform, under strong local governance, offered advantages for young firms in using formal finance only. Older counterparts continued to benefit from more access to formal finance with a resultant reduction in informal finance after the reform. The findings question whether access to formal financing is an ostensible benefit of formalisation for many young informal firms and whether the formalisation change in the real sector could provide an additional impetus for more flexibility in formal financial markets.

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Chapter 1

Introduction

1.1 Motivation and background

Much of the attention has been given to potential that properly functioning financial systems hold for long-term economic growth of the whole economy (Levine 1997, King & Levine 1993). Recent research has directed such attention to microeconomics perspectives with emerging focus on the intersection between corporate finance and firm performance. These two thematic areas, which were studied separately in prior research, are theoretically and practically interdependent. Based on Jensen & Meckling (1976)'s agency cost theory, external finance performs a disciplinary function in limiting agency costs that arise from conflicts of interests between the firm's owners and its managers. By putting more pressures for managers in using free cashflow against their own discretion, increased loans sustain firm performance. The link between access to external finance and firm performance draws attention of researchers during recent years in both advanced and developing economies. It also requires policy makers to better understand whether firms react uniformly to increased leverage, or whether certain firms need supporting external finance most to yield their potential. Identifying firm-specific heterogeneity to maximise benefits gained from financial sector to real sector is key to this thesis.

Understanding corporate finance and firm performance in developing economies, however, requires special focus largely due to distinct features in both real and financial sectors. First, the overwhelming dominance of small and informal firms, which become the source of income growth and employment for up to half of GDP and labour force of entire economies, fuels speculation over varying degrees of impacts throughout performance distribution over mangerial differences between formal and informal firms. Some small and informal firms become strong competitors with formal firms in formal financial markets (Distinguin et al. 2016); hence, their intrinsic financial managerial discretion is worth researching. Second, there exist less developed financial markets in developing countries due to coexistence of informal lenders alongside formal financial institutions. Such dual financial systems are mainly because informal firms inherently induce the demand for informal finance and they by no means can have access to formal loans (Degryse et al. 2016, Beck et al. 2015, Allen et al. 2005). Based on these features, central questions for policy makers

are whether the effects of access to external finance on firm performance differ depending on firm size, formality status, and firm performance relative to counterparts and whether there are real-side implications for the use of formal and informal finance from any change in policy that has come into effect.

In further understanding, I use two measures of firm performance: productivity and efficiency. As Nishimizu & Page (1982) credibly note the distinction between technical efficiency and total factor productivity (TFP): technical efficiency and technological progress, which refers to technological changes of best practice production frontier, constitute a whole part of TFP. Thus, technical efficiency refers to stochastic and indirect changes in production process, such as managerial decisions and short-run adjustments of production factors to external shocks and is worth a separate analysis from productivity changes.

In the first empirical chapter, Chapter 2, I first focus on the productivity implication of finance which is central from a policy perspective in the sense that favourable financial conditions have the potential to deliver benefits to economies by enabling firms to finance productivity-enhancing activities. With the exception of Chen & Guariglia (2013), who study the implications of financial constraints for productivity amongst large Chinese firms, the existing literature in this field has been confined to study firms from developed countries (Ferrando & Ruggieri 2018, Levine & Warusawitharana 2021). While previous studies evaluate average effects of financial constrains at the conditional mean of the productivity distribution, I argue that the effects may vary across different points of productivity distribution.

For the association between finance and efficiency in Chapter 3, less is known about the relative efficiency gains for increased leverage. Pointing to firm size further conjectures the practical importance of upholding access to external finance for informal firms—by which smallest firms are largely formed—versus formal firms for emerging economies. Also, the nature of leverage such as the financial sources (formal informal loans), maturity structure (short- and long-term financing), along with some other economic activities such as possession of property rights, also reveals how policy makers should further support small, constrained firms through financial markets.

Given the dominance of informal firms and the existence of dual financial systerms, the thesis continues to examine the relative use of formal versus informal finance from a policy perspective in Chapter 4. This final analysis highlights real-side implications from the formalisation reform that streamlined the registration process. The formalisation reform has shown to signal a first welcome for informal firms to formal sector, a question is whether it doubly welcomes these firms to formal financial markets. I highlight financial behaviour of firms not only through whether the firms use formal and informal finance, but also the form of external financing in which firms prefer: co-funding of both sources; sole-funding of either source.

1.2 The reasons for studying a developing country

As the thesis motivation discussed above pursues research avenues of understanding financial patterns in developing countries as opposed to existing finance-firm performance studies on advanced economies, the thesis is primarily confined to firms in Vietnam.

On the one hand, the country has many distinct features which bear a strong resemblance to most developing countries: the dominance of small firms, and the presence of formality dimension within both real and financial sectors. First, Vietnamese informal firms, by which a fair share of smallest firms is formed, are highly integrated with formally operating firms in several industries or product markets with extensively mutual links and transactions. According to Cling et al. (2011), they are the source of income and employment for a fifth of GDP and most labour force of the whole economy. They are also deemed competitive with smallest formal firms in access to external finance (Distinguin et al. 2016). Thus, their strong presence raises the question over their managerial decisions, financial behaviour in using scare resources: labour and capital expenditures, in particular, relative to formal firms. There are also some other factors (landleasing arrangements). Tenev et al. (2003) emphasise that landleasing arrangements are, too often, made with state or non-state enterprises or with other informal firms. Second, a prominent feature of informal sector is linked to the dual financial systems of formal and informal financial markets within the country. Informal finance performs an essential function, either as a complement to or a substitute for formal finance, especially in this developing country in which financial markets are underdeveloped. Chapters 3 and 4 focus on these features of the country.

On the other hand, the country also manifests itself an interesting case that offers unique features to enrich a more contextualised understanding especially when it comes to policy evaluation. First, Vietnam experienced rather low productivity gains relative to her neighbouring countries in recent years, which opens research avenues to identify driving factors to impel aggregate productivity for the whole economy. Having been stagnating at the middle-income trap and low productivity levels for several years to date, Vietnam posits a striking example of a low-productivity economy. Finding factors that keep firms remaining/stagnating in bottom tail of productivity distribution is crucial to reducing its weight on aggregate productivity and to converging to growth and development of other countries within the region.

Second, Vietnam's financial markets have some peculiar features of rapid credit growth over short periods of time, yet imperfections (that is, unequal access to external financing across firms) that can supress firm performance. Since a remarkable market-oriented reform "Doi Moi" in 1986, has progressively undergone radical changes in financial sector through formal banking system, ostensibly to facilitate more favourable extension of lending to real sector, particularly smallest firms that are generally subject to restricted access to finance from such formal banking system. Yet, the presence of information asymmetries in underdeveloped financial sector has diluted the passage to the market-oriented economy (Anos-Casero & Udomsaph 2009) and suppressed aggregate productivity gains (Schmittmann et al. 2017). As an important strand of the thesis is on the financial sector,

these features become one of key advantages of studying Vietnam and hence are explored throughout three empirical chapters of the thesis.

Third, Vietnam implemented a momentous reform in an endeavor to reduce barriers to business registration in 2010. The reform streamlines and improves the previously introduced registration procedure; this reform is proven to make it easier for firms to start a legally registered business. Although many other countries also introduce seemingly similar reforms of streamlined procedures, they are not necessarily uniformly applied across countries or across municipals in practice. Also, the extent to which the Vietnamese registration procedures are improved is built on results of extensive research that is relevant to certain development and improvement of the economy at a particular time period. Indeed, this reform is part of largest national administrative simplification program since "Doi moi" with markedly extensive coverage on several regulatory reform tools (e.g., regulatory impact assessment, stakeholder consultation); the program is collectively known as Project 30, aiming to enhance national and regional economic integration and competitiveness. Thus, the formalisation reform implemented in Vietnam and its impact evaluations are worth exploring. I has paid due attention to the reform and its impact on a firm's use of external finance in Chapter 4.

Pointing to Vietnam in context, the thesis uses Vietnamese dataset which covers micro, small and medium-sized firms. The dataset helps enriche a contextualised understanding through lenses of formality settings and access to external finance of different resources with further details in section 2.5 of chapter 2.

1.3 Contributions and research questions of each essay

Starting from the motivation discussed above, this thesis aims to provide answers to a set of following research questions that feed directly into a wider contextualisation of the institutional setting but have been paid little attention to: first, whether a firm's restrictions on access to external financing vary across different points of productivity distribution; second, whether the impact of access to finance to technical efficiency gains differs by formality status, firm size, financial resources and maturities; third, the relative use of formal and informal finance for registered firms in response to the formalisation reform. Studying these questions in sequence, the thesis is therefore able to start with providing a full picture of whether access to finance affects firm performance uniformly across firms in chapters 2 and 3, equivalently to first and second research questions. As for the last question, the focus however shifts toward small-and informal-firm research only to understand the real-side implications of the relative use of formal and informal financing induced by the momentous registration reform.

With respect to theories, there are two main theories that these chapters introduced draw on. Chapters 2 and 3 build on agency cost theory which, as first pointed out by Jensen & Meckling (1976), refers to a disciplinary function of external finance in advancing the firm performance through mitigating managerial discretions in using free cash flow; the agency costs arise from the conflicts of interests between the firm's owners and its

managers. In this way, further pointing to small and informal firms as in chapter 3, such agency cost theory might not be applicable due to the lack of separation between ownership and some degree of control within these firms. I therefore draw on rationales from empirical research in formality to explore peculiar managerial decisions on the use of external finance for these firms, and to decompose external finance into financial resources and maturities. For instance, the disciplinary function of formal finance on efficiency gains is dependent upon hard information (e.g. interest rate payment and collateral requirement), while that of informal finance is upon soft information (e.g. personal relationships with strong social ties and coercion controls). Chapter 4 that empirically studies the relative use of formal and informal finance draws on the newness approach in exploring the heterogeneous effects by firm age.

Methodology-wise, different methods are used for each research question. The first question understands the finance-productivity effects at different points of productivity distributions; therefore I employ quantile regression and control for endogeneity problem arising from the implied relation by conducting instrumental variables approach. For the second question about leverage on technical efficiency, I apply true fixed effects stochastic frontier approach by Greene (2005). The technique is a widely used econometric technique in the contemporary line of research on production frontiers to estimate the technical inefficiency effects of the production process. For the last question, I perform probit difference-in-differences estimations which are known as a useful policy evaluation technique to study the effects of formalisation reform by making comparative analyses between firms that registered legally and those who did not do as such.

Each empirical chapter contributes to the relevant literature of firm performance, finance, and formality in several ways.

Chapter 2 aims to investigate the impact of financial constraints on productivity at the different points of productivity distribution since it is far from clear whether financial constraints would uniformly impede firm productivity. Rather than evaluating the effects of financial constrains at the conditional mean of the productivity distribution (i.e. at the average firm level) only, in this chapter, I argue that if there is significant heterogeneity in firms' productivity, these average effects may not accurately describe the financial constraints-productivity link. I therefore allow for the possibility that the effects of financial constraints may have varying effects throughout the productivity distribution. For the measurement of financial constraints, I take a more recent approach by Ferrando & Ruggieri (2018) because their work is regarded as the most convincing composite measure upon investment needs relative to debt capacities, interest rate payments and internal finance as opposed to a single indicator in earlier papers. I make two main contributions in the existing literature. First, my work is complementary to Ferrando & Ruggieri (2018)'s analysis: rather than highlighting the mean effect, I use quantile regressions to account for estimates across the entire productivity distribution. Second, I provide an empirical application of the most recent quantile regressions for panel data proposed by Powell (2016) and respective quantile treatment effects to this body of research. At the core of this method to the analysis is its benefit in addressing endogeneity issues in the finance-productivity estimation by introducing non-additive fixed effects.

Chapter 3 aims to investigate heterogeneous effects of leverage across firm size and formality status on technical efficiency. To better understand the role of firm size within formal and informal firms, this chapter also explores aspects of other economic activities including the possession of property rights, financial position, and location, and also decomposes the effects of leverage from the financial resources in which the firm uses and maturity structure that the loans have. This chapter makes three main contributions to the literature: (i) extend the finance-efficiency literature by investigating the role of firm size, formality dimension in the sense that formal and informal firms differ in terms of technology used, resource scarcity, favourable financial terms, and degree of financial control; (ii) how legal, financial and geographic factors can be attributed to efficiency differences from external finance across firm size; (iii) understand the financial patterns in which the heterogeneous effects of leverage are largely engineered through.

Chapter 4 investigates the effect of the business registration reform that streamlined the business registration process on the relative use of formal and informal finance and whether the effect differs between young and old firms. This chapter builds on the exclusive view theory in formality research: initial and ongoing costs of formalisation is too expensive to some informal firms, especially small firms and it is not worth investing in formalisation, thus formalisation reform helps to reduce such costs and encourage more firms to register. It also draws on empirical research of the link between formality and increased access to formal credit markets. That said, less is known about the relation with the use of informal finance and as is the relative use of formal and/or informal financing. This chapter makes several contributions to the existing literature. First, I demonstrate whether the introduction of registration reform impacts the way in which the dual financial systems of formal and informal finance are functioning for unregistered firms, or whether cofounding or sole funding by either source of finance is well positioned when firms start formalised. Second, I explore whether the number of years in which firms operate as unregistered and the local governance quality condition the relative use of formal and informal finance around the passage of reform. Thus, from policy perspectives, I highlight whether the reform doubly welcomes unregistered firms to both formal real sectors and formal financial systems.

1.4 Main findings and policy implications

Chapter 2 on the financial constraints-productivity link highlights two main findings: (i) financial constraints have nonmonotonic distributional effects on productivity; (ii) firms with higher internal finance have higher productivity when under financial constraints. Particularly, financially constrained firms have higher productivity than their unconstrained counterparts in middle-large range of productivity distribution, while performers at the lower quantiles absorb the negative effects of financial constraints. Another firm in a similar financial constrained setting, conditional on other firm characteristics, can induce its productivity by making use of other financial sources. This study suggests two main policy implications: (a) identifying firms at lower quantiles of productivity distribution through a means of financial instruments is conducive to reduce the weight of the bottom tail of productivity distribution; (b) incentives to access credit, such as favourable financial

conditions and financial schemes to accommodate increases in credit demand from firms under financial constraints for financing their investment activities.

Chapter 3 on the leverage-firm size-efficiency link has three main findings that are worth highlighting: (i) higher leverage paves the way for efficiency gains of the smallest firms; (ii) the efficiency that these smallest firms, regardless of their formality, gain are largely engineered through formal financial channels and short-term financing; and (iii) the heterogeneous effects of leverage by firm size vary with legal factors and financial position. Thus, there necessitates a concreted push in policymaking to facilitate provision of property-rights for informal firms, which is likely to give rise to efficiency. Also, paying due attention to firm-size differences in the formal and informal sector and providing better business environment are conducive to favour formality and to facilitate efficient capital allocation from financial markets to real sector.

Chapter 4 on business registration reform has two main findings related to heterogenous effects by firm age and local governance quality: (i) the reform increased the use of informal finance for young registered firms, likely in form of using informal finance only; (ii) the reform, under strong local governance, increased the use of formal finance only for young firms. This analysis shows the need for policymakers in making formal credit supply be more accessible to accommodate higher credit demand, and also better regulations to alleviate an alternative channel of informal finance long-run.

Chapter 2

Financial constraints and productivity: A quantile regression study

Abstract

This chapter develops empirical studies of the finance-productivity relation, investigating the impact of financial constraints on productivity at the different points of productivity distribution. I apply quantile regressions for the rich panel data of firms in Vietnam over the period 2005-2013 and I control for endogeneity problem arising from the implied relation by conducting the instrumental variables approach. The findings are as follows. First, financial constraints have nonmonotonic distributional effects on productivity. Particularly, financially constrained firms at the upper quantiles have the higher productivity than their unconstrained counterparts, while performers at bottom quantiles absorb negative effects of financial constraints. Second, I find strong evidence of generating high internal funds in increasing productivity when firms are financially constrained; such positive effect appears stronger for firms at higher quantiles. I add further validity to estimations by applying quantile treatment effects to compare financially constrained and unconstrained firms with similar control variables.

2.1 Introduction

Access to finance offers firms many opportunities to improve their productivity performance by enabling them to undertake optimal decisions and allocate their resources efficiently. However, in underdeveloped financial markets, firms are more likely to face financial constraints. Such constraints limit firms' ability to engage in productivity-enhancing activities which would otherwise induce firms to yield their potential. For smaller firms, financial constrains have been found to be particularly severe. In this chapter, I exploit a

unique data source to examine the effects of financial constraints on productivity amongst small and medium-sized firms in Vietnam. I pay attention to the implications of financial constrains along the entire productivity distribution.

While the bulk of the microeconomic empirical literature on financial constraints has focused on examining the effects of financial constraints on firms' investment decisions such as, fixed capital investments, innovation, and exporting, the direct link between financial constraints and firms' total factor productivity has remained understudied in the empirical literature. In this chapter, I argue that attempting to evaluate the indirect effect of financial constrains on productivity by examining its role on firms' investment decision might be inaccurate as productivity-enhancing investment opportunities are difficult to be measured (Campello et al. 2010). In other words, it is difficult to ascertain whether the investments forgone as a result of financial constrains were in fact productivity-enhancing projects. Given this limitation, I evaluate directly the effect of financial constraints on firms' total factor productivity. I focus on total factor productivity as it captures the outcome of different firms' decisions including "hard" productivity-enhancing investment, as well as "soft" organizational and managerial practices that might affect productivity.

Focusing on productivity is also highly relevant from a policy perspective, as improving total factor productivity, rather than promoting specific investments, is one of the ultimate goals of policy makers around the globe. One of the reasons for targeting productivity as a key policy objective is the widely accepted view that differences in total factor productivity, rather than the accumulation of factor inputs, are the main factor explaining cross-country success. Focusing on the productivity implications of finance is also central from a policy perspective as favourable financial conditions have the potential to deliver benefits to economies by enabling firms to finance productivity-enhancing activities.

With the exception of Chen & Guariglia (2013), who study the implications of financial constraints for productivity amongst large Chinese firms, the narrow literature in this field has been confined to study firms from developed countries with more advanced financial systems (i.e. Ferrando & Ruggieri (2018) for eight European countries; Gatti & Love (2008) for Bulgaria). In contrast to these studies, I contribute to this emerging literature by understanding the productivity implications of financial constraints on small and medium enterprises in Vietnam, as it is widely recognised that these firms are more likely to be severely affected by financial frictions (Beck et al. 2005).

To overcome the well-known difficulty of measuring firms' (unobservable) financial constraints, I adopt a recent methodology developed by Ferrando & Ruggieri (2018) which uses information from firms' financial statements and financial conditions to construct a continuous and time varying indicator of financial constraints. As pointed by Ferrando & Ruggieri (2018), a key advantage of this index is that unlike previous works which rely on time invariant single indicators to capture financial constraints, it combines a set of different financial variables and their interrelation with some scenarios to generate a time variant index capturing different degrees of financial constraints. The construction of this index heavily depends on detailed information on investments, financial indicators, and the cost of debt, which is rare in most small and medium enterprises databases. The database is unique in the sense that it not only contains a rich array of real variables that allows me to estimate total factor productivity, but also includes a rich set of financial

indicators that allows me to construct Ferrando & Ruggieri (2018)'s index.

While previous studies evaluate the effects of financial constrains at the conditional mean of the productivity distribution (i.e. at the average firm level) only, in this chapter I argue that if there is significant heterogeneity in firms' productivity, these average effects may not accurately describe the financial constraints-productivity link. I therefore allow for the possibility that the effects of financial constraints may have varying effects throughout the productivity distribution. For example, it is plausible that the productivity of firms at the bottom of the productivity distribution are more severely affected by financial constrains than their counterparts at the top of the distribution. A potential reason for this is that more productive firms might be more capable to allocate their resources more efficiently despite facing financial constraints. To examine these potential nonmonotonic effects I use a newly developed quantile regressions for panel data (QRPD) proposed by Powell (2016). To the best of my knowledge, I are the first to examine the relationship between financial constraints and firms' productivity along the productivity distribution.

After controlling for firm-level fixed effects and the potential endogeneity of firms' financial constraints the results show that financial constraints have nonmonotonic distributional effects on productivity. Particularly, financially constrained firms have higher productivity than their unconstrained counterparts in middle-large range of productivity distribution, while performers at the lower quantiles absorb the negative effects of financial constraints. When investigating the role of internal funds in the implied relation, I find strong evidence of generating high internal funds in promoting productivity when firms are financially constrained; such effects appear stronger for firms at higher quantiles. Alternatively put, another firm in a similar financial constrained setting, conditional on other firm characteristics, can induce its productivity by making use of other financial sources.

The chapter is organised as follows. Section 2.2 reviews the literature. Section 2.3 provides the institutional setting for Vietnam. Section 2.4 describes the method and empirical estimation. Section 2.5 presents the dataset collection, descriptive statistics and variables. Section 2.6 discusses the estimation results and some robustness tests. In section 2.7, I present concluding remarks.

2.2 Literature review

2.2.1 Financial constraints and productivity

In this section, I review both theoretical and empirical literature on the relationship between financial constraints and productivity. I first briefly present the theoretical backgrounds from which financial constraints are binding to firms, and then turn to the main focus of the finance-productivity relation.

The degree to which financial constraints that are binding to a firm is traceable to Modigliani & Miller (1958)'s theorem. The theorem captures the costless substitution

between internal and external funds under the perfect or symmetric information between external creditors (e.g., banks or other financial institutions) and firms as potential borrowers. Alternatively put, there is no cost difference relating to the use of these resources to firms. Yet the credit market imperfections — for instance, information asymmetries — raise concerns over cost wedge incurred: external financing becomes a costly substitute for internal resources due to the cost of borrowing (e.g. interest payments for bank loans that a firm takes out). If more uncertainty signals of the firm's creditworthiness were given to the creditors, these creditors would (i) restrict its full access to a desired loan or (ii) incur higher borrowing costs for the loan.[1] On the side of firms as borrowers, financial choices between internal or external financing theoretically correspond to Myers & Majluf (1984)'s "pecking order" theory: if the firm needs to finance its investment, the firm preferably exhausts its internal funds first and relies on external funds if investment demand is still high. That can perhaps best be seen under circumstances in which firms are not binding to very financial constraints, although one would presumably argue that, in more realistic practices, the determination of financial choices should boil down to the purpose of investment and the availability of external financing.

Such credit market imperfections shed more light on key theories about the effect that financial constraints exert on productivity. Available theories from the macroeconomics perspectives often point to capital misallocation or failure of reallocating capital efficiently, translating into lower productivity for the whole economy (Moll 2014). Although the mechanism of capital allocation is not the main interest, I build on some work of macroeconomics effects to gain broader perspectives. Early attempts by Solow (1957) have featured labour- and capital-augmenting technical change or technological changes as key sources of promoting productivity at the aggregate level.[2] Thus, the effect of financial constraints on productivity is mediated by capital allocation and accumulation for activities relating to technological changes, along with typical production factors of physical and human capital. For better understanding, one would arguably pin such finance-productivity effect down to microfoundations: (i) which productivity-enhancing activities that firms are engaged in and (ii) which financing resources are available to them.

Existing theories about the finance-productivity relation from the microeconomics perspectives are formed as such: through the investment mechanism of individual firms towards productivity-enhancing activities. On the one hand, a substantial theoretical literature studies the negative effect of financial constraints on firm-level productivity: when being financially constrained by the shortage of internal and external funds, a firm is reluctant to make sizeable investments to promote its productivity. Early contributions that have emphasised the importance of such investments are by Fazzari et al. (1988), Hoshi et al. (1991), Whited (1992), Bond & Meghir (1994) with many other followers providing more views in the context of different investment types. Among others, Nickell

[1] Borrowing costs or interest payments, as argued by Stiglitz & Weiss (1981), respond positively to possible risks associated with the repayment probabilities of individual firms as borrowers as assessment by the creditors; external creditors are more likely to rely on such risks to allocate credit amongst firms. However, as also argued by Stiglitz & Weiss (1981), firms as borrowers should receive the identical interest rates to reduce the default rate of firms to the creditors.

[2] See Baily et al. (1992), Greenwood et al. (1997), Acemoglu (2003), Jones (2005), Aghion & Durlauf (2005) for examples concerning the effect of these aspects on the long-run development.

& Nicolitsas (1999), Benito & Hernando (2007) point to the impact of financial constraints on impeding human capital investments which, as argued by Moretti (2004), are costly but enhance productivity in the long run. Gertler & Gilchrist (1993), Bond & Meghir (1994), Almeida & Campello (2007) identify the role of bank financing for investments in physical capital and capital-embodied technological innovation and thus, lack of access to bank financing lowers such investment expenditures and firm performance accordingly. On the other hand, financial constraints binding to firms leads to higher accumulation of internal funds to finance innovation opportunities including, but not limited to, research resources and other activities that are based on technological progress rather than on capital.[3] The notion about the role of internal finance for these activities dates back to a seminal paper by Schumpeter (1942) who characterises these investments as being less suited to bank financing – due to a high degree of risk and a low level of collateral to pledge against borrowing – but more to internal funds.[4] Still, Rahaman (2011) confirms an inherent transition between internal and external financing patterns when higher levels of productivity that firms reach can translate into larger internal funds and greater debt capacity at a later stage of the business phase.

Empirical evidence on the relationship between binding financial constraints and productivity, however, does not necessarily follow these theoretical predictions and indeed seems scare concerning the firm-level in three main patterns as follows.[5] First, a few studies find a monotonically negative relationship — that is, financial constraints inhibit firms' productivity – over both well-developed and under-developing financial markets. Particularly, the most recent paper by Ferrando & Ruggieri (2018) and Levine & Warusawitharana (2021) exploiting data on a broad set of European countries find a statistically negative effect that financial constraints exert on firm productivity, although indicators for financial constraints vary between these studies. In line with this possibility, Gatti & Love (2008) confirm the negative link through the counterfactual cases in which Bulgarian firms have more access to credit. Second, a related strand of literature captures a monotonically positive estimate for the implied relation, favouring the theoretical prediction that internal finance facilitates investments under financial constraints.[6] Notably, Rahaman (2011) confining the research to firms in the UK and Ireland emphasises that the degree of binding constraints and firm performance coincides in the presence of internal resources; such positive effect however attenuates when the firm has easier access to external financing. Similarly, Chen & Guariglia (2013) report the positive effects of internal finance on productivity for firms in China. Third, to date, only a paper by Nunes et al. (2007) shows a nonmonotonic effect of access to external finance to productivity for Spanish firms: at a low levels of productivity, larger external financing negatively affect productivity; however, such effect changes in sign for firms at higher levels of productivity.

[3] Although I mention the seemingly similar innovation activities, the use of technological progress are less likely to be different between these. One is more technology or physical driven and therefore the higher availability of physical or tangible capital which are pledged as collateral against bank financing.

[4] Many other theoretical models alluding to Schumpeterian notion include Nelson (1959) and Arrow (1962) with much emphasis on the role of internal financing for investments in research and development (R&D). See Hall (2002) for a broad review.

[5] See Levine et al. (2000), Aghion et al. (2014), among others, for empirical studies at the aggregate and industry levels.

[6] A large number of recent empirical studies focus on the impact of internal resources in R&D investments which in turn translate into higher productivity levels (see, for instance, Himmelberg & Petersen (1994), Ughetto (2008), Brown et al. (2012), Gorodnichenko & Schnitzer (2013)).

One key reason why studies on the finance-productivity relation is challenging at the firm-level and not much presented is mainly due to the uncertainty and variability in gauging the degree of binding constraints. Early research with much inclination to traditional cash-flow sensitivities of investment proposed by Fazzari et al. (1988) has long been intensively debated due to a major disadvantage of bypassing investments when firms are financially constrained (Sufi 2009). Recent interest is, therefore, reoriented to alternative direct measures of availability of external financing. A few studies use self-reported survey responses to questions as to a firm's obstacles in access to external financing (see, for example, Gatti & Love (2008), Gorodnichenko & Schnitzer (2013)), while many others trace these binding constraints to balance-sheet information: access to bank credit line or bank financing (Rahaman 2011); debt and equity financing (Levine & Warusawitharana 2021); leverage or external financing resources (Nunes et al. 2007, Chen & Guariglia 2013).[7] Either measure, however, does not suffice to capture the extent of financial constraints. Rather, it complements each other to gain a broader sense: the survey-reported measure shows no financial condition but real obstacles of having such condition and quite often, the cost of obtaining financial resources; the balance-sheet measure, by contrast, reports none of these obstacles but a detailed financial and investment condition. The most recent paper by Ferrando & Ruggieri (2018) combines these two measures by constructing a synthetic indicator that is conditional on both investment opportunities and the cost of external financing, among other characteristics, thereby inspiring the research on the basis of its composite measure on financial constraints.

2.2.2 Internal financing resources, financial constraints and productivity

Although the investment-cash flow sensitivity is arguably a poor indicator for financial constraints, an important strand of literature concerning the availability of internal financing resources (often proxied by cash-flow) and its effect on the firm's investment behaviour and on the link between binding constraints and productivity should come to the force.[8] The role of these resources, has early been captured in the seminal work by Fazzari et al. (1988) when the firm is binding to financial constraints, its investment expenditures become more sensitive to its internal resources; the sensitivity varies with levels of financial constraints.[9] This view, however, has been intensively debated by a number of subsequent studies. Contrary to Fazzari et al. (1988)'s evidence, Kaplan & Zingales (1997), Cleary (1999), Gomes (2001), Alti (2003), among others, find that the sensitivity of investment to internal finance is lower when firms appear more financially constrained. The literature therefore holds two theoretical grounds for the role of internally generated funds in the context of difficulty in obtaining external financing. Based on these views, one can draw the inference about the effect on productivity: if firms are financially constrained, the

[7] Leverage refers to the ratio of debt financing and other current liabilities over total assets.

[8] Cash flow has been widely used as a proxy for internal financing resources (See, for instance, Hubbard (1998), Cleary et al. (2007), Guariglia (2008)). One might argue that the cash-flow – although not embedding the accumulated funds available to gauge the true extent of internal financing — is considered as a primary source of variation of internal funds. This view is supported by Cleary et al. (2007) who document the high correlation between cash flow and internal funds.

[9] Although this paper implicit investment expenditures, one might define expenditures on fixed capital, human capital and R&D activities which are interpreted as crucial components of firm productivity enhancement.

availability of internal finance is positively associated with productivity owing to higher investment outlays in either fixed capital, human capital or R&D activities as Fazzari et al. (1988) suggested, while the negative effect is seen according to the other theoretical strand.

Empirical evidence examining whether internal finance could alter the link between financial constraints and productivity confirms the theoretical intuitions above to some extent. Guariglia et al. (2011) and Chen & Guariglia (2013) stress the importance of internal funds in firm performance, irrespective of severe financial constraints, in the Chinese context. More specifically, Guariglia et al. (2011) emphasise on the main mechanism through which investment in fixed capital or working capital that enhance firms' asset growth, suggesting the analogue between this approach and investment in productivity-enhancing activities in higher productivity growth; Chen & Guariglia (2013) also document the positive effects of internal funds on productivity with the financial constraints, also if there is a decline in working capital or liquidity as an indicator for more externally financial constraints, the availability of internal funds is more important in enhancing productivity. Nucci et al. (2005) emphasise the stronger negative effects for firms with leverage and productivity for firms with lower share of liquidity or working capital for Italian evidence (although this is different from negative cash flow, one might think of working capital as one main cause of operating cash flow changes in the cash flow statement). Another extent to which this view is gauged is rather ambiguous without confirming any theoretical grounds. Guariglia et al. (2011), although providing the comparison picture between firms with and without external financing and linking it with higher reinvestment rates and thereby reaping higher productivity growth, find the ambiguous link between internal funds and productivity growth.

Based on empirical evidence, I formulate two hypotheses on the distributional effects of financial constraints on productivity for firms in Vietnam as follows:

$Hyp1$: Financial constraints do not have systemic impact on productivity across different points of productivity distribution. Put differently, productivity difference between financially constrained and unconstrained firms is nonmonotonic.

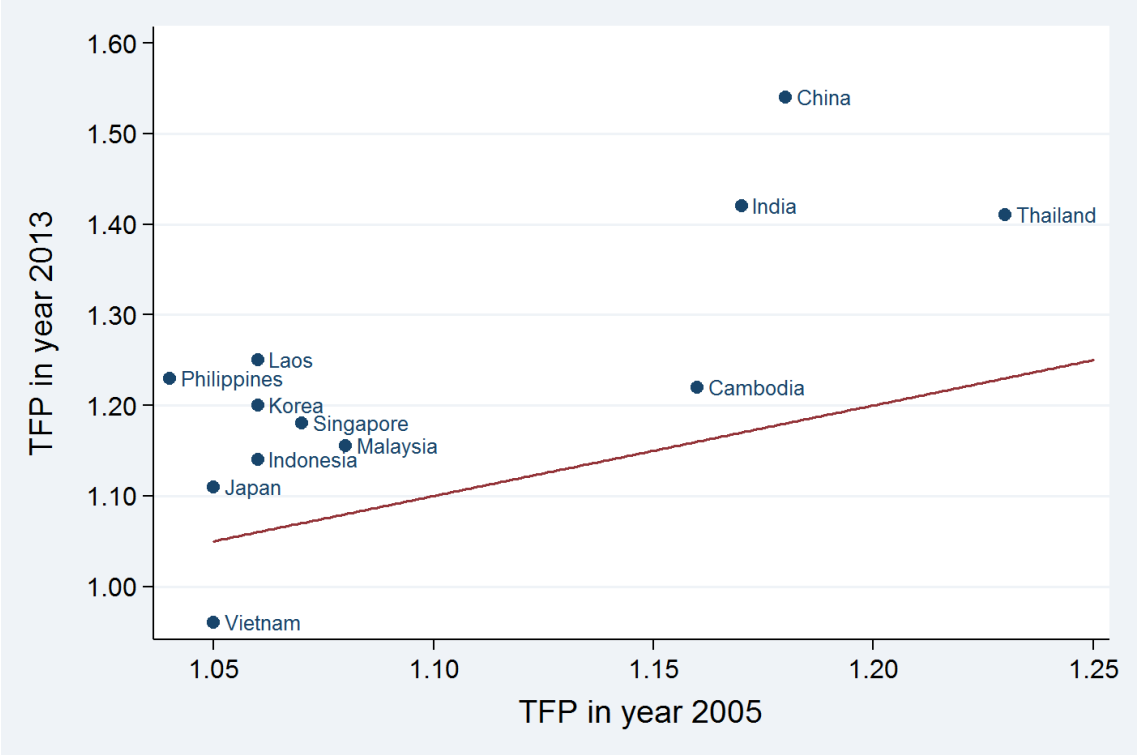
$Hyp2$: The effect of internal finance on productivity is positive for financially constrained firms across the entire productivity distribution. Also, such effect is stronger for firms at higher productivity levels.

2.3 Institutional setting

Evidence by the International Monetary Fund documents that Vietnam's financial markets have some peculiar features that are worth exploring: rapid credit growth over short periods of time, yet imperfections (that is, unequal access to external financing across firms) that suppress aggregate productivity gains (Schmittmann et al. 2017). In this section, I provide a comprehensive picture by comparing productivity gains across Asian countries, pointing to Vietnam in context.

Before making valid cross-country comparisons of productivity for particular Asian

Figure 2.1: Cross-country comparisons of total factor productivity (TFP), 2005-2013



Notes: This figure reports the relation of TFP indices over the period 2005-2013 for some Asian countries (Index in 2000 = 1). Source: Authors' calculations based on Asian Productivity Organisation database.

countries, it is important to briefly outline two financial crises with somewhat enduring effect on these countries both prior to and during the period 2005-2013. The first one to mention is the 1997 Asian financial crisis that followed many years of financial liberalisation (with fewer or without restrictions on capital flows across the border). The notion of financial liberalisation, although might be good for well-developed financial markets, lost its edge with severe economic repercussions for many Asian emerging economies.[10] Among these economies, Vietnam was less affected. Indeed, the ongoing domestic economic reform – which is often known as "Doi moi" – did not accompany the financial liberalisation until the post-crisis period, or to be more exact, until the WTO access in 2007. Unlike the first crisis consequences, Asian economies were capable of withstanding global financial crisis in late 2008 without much severe impact on financial markets (Keat 2009).[11] To further understand these economies, I draw on the Asian Productivity Organisation data, demonstrating the cross-country comparisons of total factor productivity – See Figure 2.1 for visual presentation. In comparison with other Asian economies, only Vietnam shows lower productivity gains over the examined period, which somehow contradicts with the prospect of the less affected economy from financial crises. The case of Vietnam, therefore, posits a striking example of an otherwise productive economy.

[10]The financial crisis led to widespread repercussions in the financial markets over several countries: a sharp decrease in capital flows; severe exchange rate pressures in affected countries (O'Toole & Newman 2017).

[11]Research from Keat (2009) reports that global financial crisis made export volume and the amount of trade credit of affected countries become subdued. Nevertheless, financial markets remained stable with little effect on interest rates and exchange rates; so was real economy with firms confronting the financial crisis in generally good financial position.

2.4 Empirical estimation

This section provides an empirical estimation of the relationship between financial constraints and productivity over the entire distribution. I start by providing the practical measurement of total factor productivity (TFP), which is also known as multifactor productivity, amongst productivity measures in the literature.[12] To build the intuition, I start with a modification of the Cobb-Douglas production function to more general technologies (i.e., inclusion of intermediate materials as another production input). The production function still holds with the assumption of constant returns to scale:

$$Output_{i,s,t} = TFP_{i,s,t} K_{i,s,t}^{\alpha_K} L_{i,s,t}^{\alpha_L} M_{i,s,t}^{\alpha_M} \tag{2.1}$$

where $Output_{i,s,t}$ denotes total production output for firm i in industry s in year t, K is capital inputs, L is labour inputs, and M is intermediate materials used in the production process, α_K, α_L and α_M denote firm-specific elasticities of output with respect to respective production inputs K,L and M. In the next step, I adopt the Levinsohn & Petrin (2003)'s approach by approximating the Cobb-Douglas production function or taking the logarithm of Eq. 2.1,[13] TFP is obtained as residuals of the production function:[14]

$$TFP_{i,s,t} = Output_{i,s,t} - \alpha_K K_{i,s,t} - \alpha_L L_{i,s,t} - \alpha_M M_{i,s,t} \tag{2.2}$$

I next move to the main interest of quantile regressions to gauge the effect that financial constraints or frictions exert on productivity levels for the panel data sample.[15] I use $lnTFP_{i,s,t}$ obtained in the Eq. 2.2 as the dependent variable in the firm-level production function which augments the binding financial constraints that firms face. The approach is closest to the work of Ferrando & Ruggieri (2018); the difference from this chapter is that I modify the static linear model of the production function by adding the dynamic

[12] I note here some features of the productivity measures: First, TFP is preferable to labour productivity which is a more common productivity index in empirical studies. Syverson (2011) and many other scholars argue that TFP captures the variation in output through neither of observable production inputs, while labour productivity do such in unequal input settings or more specifically, it tends to attribute the output variation to capital and other production inputs except for labour. Second, I use the productivity measure conceptually based on physical quantities (e.g. production output) rather than that on revenues or sales of products although both are commonly used in the literature. The revenue-based measures are preferred if one considers the price variation or quality of products delivered, which is not the main purpose. The output production values are deflated by industry-specific price indexes particular to each year.

[13] The Levinsohn-Petrin approach is developed from Olley-Pakes estimation which also applies the general Cobb-Douglas technologies, but rules out the possibility of simultaneity (see Olley & Pakes (1996), Anos-Casero & Udomsaph (2009)). I also report the robustness check of the production function with Olley-Pakes measurement in this chapter. It should also be noted that the Levinsohn-Petrin approach provides a major advantage over the traditional Cobb-Douglas production function in the sense that it captures a simultaneous change of a firm's decision on its production inputs in response to a productivity shock. More specifically, the presence of intermediate materials ($M_{i,s,t}$) holds with the monotonicity condition: firms with higher investment in $M_{i,s,t}$ are more likely to have higher productivity and therefore, when a firm faces a productivity shocks, a shift in $M_{i,s,t}$ and a change in investment in production coincides. Alternatively put, $M_{i,s,t}$ is considered as a proxy for investment to explain unobservable firm-specific productivity.

[14] Note here that the Eq. 2.2 provides a reduced functional form of the Levinsohn-Petrin approach. I use this approximation and the "prodest" command in STATA with translog form to obtain TFP. To further understand functional forms behind econometric procedures of such approach, see Levinsohn & Petrin (2003).

[15] Note that I do not consider the effect that these constraints exert on heterogeneous investments in specific production inputs, but one could make indirect inference for production inputs as a whole.

lagged value of productivity. The main reason is that I attempt to facilitate the innate dynamic responses between history patterns of productivity and independent variables, for instance financial constraints. The production function, although moderately persistent, still allows me to use the dynamic panel data estimation in the sense that the sample available at two-year intervals does not rule out the fundamental assumption of no correlation between transient errors (Wintoki et al. 2012). I now proceed with estimation of the production function for the short panels ($T = 5$) using traditional quantile regression:

$$lnTFP_{i,s,t} = \alpha lnTFP_{i,s,t-1} + \beta FC_{i,s,t} + \gamma X_{i,s,t} + u_{i,s,t} \tag{2.3}$$

where $lnTFP_{i,s,t-1}$ denotes lagged productivity; $FC_{i,s,t}$ is a dummy variable for firm i in industry s in year t; $FC_{i,s,t}$ equals 1 if the firm is financially constraints and zero otherwise. X presents a vector of firm-level control variables including $Size$, Age and their respective quadratic terms, $NewProd, NewTech, Export, Association, Competition$, and $GovSupport$. $u_{i,s,t}$ is idiosyncratic error term. See section 2.A and Table A2.1 in Appendix to Chapter 2 for detailed definition, measurement of all variables, and justifications for selection of these controls and sign expectation.

A key aspect of Eq. 2.3 with the application of traditional quantile regression is the assumption in which the key variable of interest — financial constraints ($FC_{i,s,t}$)— is an exogenous variable.[16] Such intuition has an orthogonal form as $E(u_{i,s,t}|FC_{i,s,t}) = 0$. Indeed, firms are subject to heterogeneous financial conditions as argued by (Fazzari et al. 1988) and then make different choices in productivity-enhancing projects and investment expenditures on production inputs. In this sense, the financial constraints cannot be taken as strictly exogenous but endogenous (Mundlak et al. 2012). I recognise that the violation of exogeneity assumption in the finance-productivity studies can lead to two distinct consequences, namely, biases and inconsistency for the parameter estimates (Roberts & Whited 2013). More seriously, it would cause invalidity for the inference. A rationale behind that line is found in prior studies: the upward biases of the least – squares estimates are reported in that productive firms are more likely to have high demand of external financing resources and therefore tend to face a higher level of financial constraints. One therefore can draw the inference about the positive relationship between financial constraints and productivity, yet the expectation is a negative effect (Gorodnichenko & Schnitzer 2013). In response to such concerns over endogeneity, I investigate potential sources of the endogeneity problem in finance-productivity studies in section 2.4.1 and then discuss the quantile regression for panel data with endogenous variable in section 2.4.2.

[16]The basic premise of such intuition should be traced back to a commonly made assumption in the estimation of the production function which is homogenous across firms. This —- in words of Griliches & Mairesse (1999) —- necessitates a better measure of firm-specific heterogeneity and behaviour theory. Simply put, decisions made on the levels of inputs and the operation of production process, on the grounds of behaviour theory, vary differently across firms. The same inference can be made for the examined link between financial constraints and productivity.

2.4.1 Sources of endogeneity in the finance-productivity relation and potential solutions

Measurement error

Measurement error is described as the most common source from financial constraint measures. Much of earlier studies use balance-sheet information to derive the actual external finance that a firm can have access to. Such information, however, computes an inappropriate proxy for the financial constraints: it fails to take into account of investments that are forgone when firms actually face financial constraints. Alternatively put, discernible differences between empirical practice and economic measure lead to measurement error. A recent approach of using the self-reported survey data inherently captures direct and better measurement of credit constraints, but ends up facing the same problem of measurement error due to subjective and cultural biases (Gorodnichenko & Schnitzer 2013).

Thus, in order to address the problem of measurement error, I construct the financial constraint index by adopting the measurement by Ferrando & Ruggieri (2018) who accommodate the balance-sheet approach with added consideration of firm-level investment behaviour. Their measurement suggests me to elicit responses to particular survey questions: (1) Whether the firm has made investments since last surveyed year, (2) The amount of investment in fixed assets including land, buildings, equipment and machineries, and (3) The amount of internal fund available (i.e. cash flow or retentions measured by profits and additional income). Accordingly, firms are defined as financially unconstrained if the firm have made investments with (i) a negative financing gap (i.e. fixed asset investments less internal finance) and positive debt capacity; or (ii) a positive financing gap, positive debt capacity and paid interest rates lower than market rates. That is, an unconstrained firm is able to finance its investment by either its sufficient internal fund, or external fund with rather low financing costs relative to market rates. By contrast, a financially constrained firm with investment needs has less favourable financing conditions than an unconstrained. Note here that I capture financial constraints by borrowing the index measured by Ferrando and Ruggieri. The guine interest is the presence of financial constraints on productivity; I also investigate firms in a similar setting of certain features but their financing conditions to resolve whether such difference is due to the presence of financial constraints.

Simultaneity

Financial constraints and productivity are also subject to simultaneity problem. This is mainly because the level of output produced can partially explain the level to which financial constraints are binding. With specific respect to Eq. 2.3, the simultaneity problem occurs when $E(u_{i,s,t}|FC_{i,s,t}) \neq 0$. The economic appeal of financial constraints in accounting for productivity performance could be that higher financial constraints are associated with lower productivity (Ferrando & Ruggieri 2018). The reverse can be equally convincing: the higher level that productivity could reach, the more retentions that the firm has and the probably lower likelihood of rejections in terms of bank loan application.

To address endogeneity bias arising through simultaneity, I (i) derive a system of equations: one equation estimates $FC_{i,s,t}$ from $lnTFP_{i,s,t}$ and a set of control variables and the other estimates $lnTFP_{i,s,t}$ and the same set of control variables, and (ii) introduce strictly exogenous instruments (IVs) of endogenous $FC_{i,s,t}$. The IVs — which, as the financing literature suggests, has a direct effect on financial constraint, but no direct effect on productivity — is therefore expected to have low correlation with productivity. I introduce three IVs as follows. The first instrumental variable is whether the firm has failed to service its debt payments on time ($Debtfail$).[17] Indeed, either low productivity performance or failure to make timely debt payments in the past entail higher risk of default that the firm might pose to external creditors and thus, reduce chances of having successful bank loans that the firm would obtain otherwise. The second one is whether the firm has sold any land, buildings or other fixed assets in the surveyed year ($Sellasset$).[18] As argued by Rampini & Viswanathan (2013), fixed assets are often pledged as collateral against debt financing; a sequence of low cash flows might induce the firm to sell its assets; with lower levels of fixed assets, the firm might end up with lower borrowing, or worse yet, no borrowing whatsoever due to lack of promises to service its borrowing. As such, the third variable is rather a strong indicator for binding constraints but, as one can infer, has no impact on productivity. The third one is trade credit or accounts payable to suppliers ($Tradecredit$).[19] The interest in such variable departs from its ability to capture a common financing pattern of SMEs and domestic financial settings. SME firms are found more reliant on trade credit as an alternative to bank finance (Casey & O'Toole 2014). In the Vietnamese institutional setting, a large amount of credit is granted through this channel of financing due to strong inter-firm networks and its flexibility in either formal or informal contract binding (McMillan & Woodruff 1999). More importantly, the trade credit variable has been introduced as a convincing instrument for the access to external financing (Biais & Gollier 1997, Gorodnichenko & Schnitzer 2013). An essential rationale for this line is simple: a firm with the sizable amount of available trade credit can be a leading signal to its external creditors of its credit worthiness and therefore is likely to be a positive indicator of obtaining more bank finance (Biais & Gollier 1997, Burkart & Ellingsen 2004, Petersen & Rajan 1997). Indeed, available trade credit means that the firm is less tempted to diversion of initial use as pronounced with suppliers – in other words, less likely to commit potential moral hazard problems and hence, eases binding financial constraints relating to banks or other financial institutions. Note that I use $Debtfail$ and $Sellasset$ as IVs in the baseline estimations while $Tradecredit$ is left for robustness check. The reason for that is because trade credit is considered as another financing resource along with bank financing.

Unobserved heterogeneity

Another severe source of endogeneity regarding the relation between financial constraints and productivity is the unobserved heterogeneity. With specific respect to Eq. 2.3, the

[17] $Debtfail$ is available across all waves of data corresponding to the question "Did the enterprise ever fail to service its debt on time?"

[18] $Sellasset$ corresponds to the question "Did your firm sell any land, buildings or (used) equipment?"

[19] $Tradecredit$ corresponds to the question "Current outstanding balance owed to all suppliers? (million VND)"

problem occurs when $E(u_{i,s,t}|FC_{i,s,t}) \neq 0$. Notice, though, that financial constraints are not random; that a firm is financially constrained also depends on spurious shocks to the whole economy in which the firm operates or the industry to which the firm belongs. These shocks are generally unobservable and therefore, it is markedly important to account for the time-invariant component of unobserved heterogeneity to capture heterogeneous financial patterns across industries and firms.

To address the potential bias arising from unobserved heterogeneity, I introduce fixed effects to capture unobserved heterogeneity as follows. First, owing to the availability of the data relating to the industries that firms belong to, I add industry fixed effects to account for unobserved time-invariant characteristics specific to each industry in which firms operate. If, for instance, one considers industry fixed effects in terms of physical capital between a manufacturing firm and the other in services industry. The manufacturing firm that is often documented with higher physical capital relative to that of services firm, paribus ceteris, is more likely to end up with easier access to bank financing. Also, I capture time-invariant firm-specific characteristics of heterogeneous financing patterns, Rajan & Zingales (1998) stress that financial constraints vary differently across firms. This could be due to several reasons: the scale at which the firm operates, the duration in which cash flow is generated, the gestation period of projects, among others.

2.4.2 Quantile regression for panel data

In order to obtain unbiased estimates over the severity of endogeneity problem that might arise in gauging the distributional effects of financial constraints on productivity, I apply quantile regression for panel data (QRPD) with nonadditive fixed effects proposed by Powell (2016). To an econometric extent, this estimator addresses the main concern of unobserved heterogeneity inhererent in the finance-productivity relation as argued. The essence of this method is the nonadditive fixed effects — that is, in this case, fixed effects are maintained in the estimated equation of the financial constraints, but not specified in the main underlying equation of productivity. The reason is that the fixed effects or heterogeneous financial patterns that determine the binding financial constraints of the firms are not specified in the productivity estimation to reduce potential correlation between productivity and error term.[20] Following Powell (2016)'s intuition, I rewrite Eq. 2.3, deriving a system of following equations to test $Hyp1$: (i) the financial constraint equation with the inclusion of fixed effects, and (ii) the main underlying equation to estimate productivity with an error term which is often known as "proneness" of productivity distribution.

$$FC_{i,s,t} = \mu Z_{i,s,t} + \tau X_{i,s,t} + \theta_i + \theta_s + \theta_t + u_{i,s,t} \tag{2.4}$$

$$lnTFP_{i,s,t} = \alpha lnTFP_{i,s,t-1} + \beta FC_{i,s,t} + \gamma X_{i,s,t} + u^*_{i,s,t} \tag{2.5}$$

[20] To eliminate those fixed effects which might lead to potential correlation between productivity and error term, the QRPD method with additive fixed effects use first-differences (Wintoki et al. 2012). However, the QRPD method with nonadditive fixed effects suggests otherwise I do not need to use first-differences which has many disadvantages.

where Z presents additional instrumental variables Debtfail and Sellasset θ_i,θ_s and θ_t denote firm, industry and year fixed effects, respectively: while the firm and industry fixed effects capture unobserved and time-invariant characteristics of firms and industries, the year fixed effects control for aggregate time-varying and economy-wide shocks such as transitional period of WTO access or global financial crisis. $u^*_{i,s,t}$ is idiosyncratic error term which is formed by a function of the error term and a full set of fixed effects listed in Eq. 2.4: $u^*_{i,s,t} = f(\theta_i + \theta_s + \theta_t + u_{i,s,t})$ — a spirit of the quantile regression estimation.[21] This feature of nonadditive fixed effects is the major advantage of the Powell (2016)'s approach in comparison to traditional quantile regression by Koenker & Bassett (1978) which does not control for fixed effects, and the QRPD approach with additive fixed effects (see Lamarche (2010), Canay (2011), Kato et al. (2012), Rosen (2012)). Let me further explain how the approach with additive fixed effect would alter the inference for otherwise productivity distribution. The nonadditive fixed effects allow me to obtain values of the estimation on the distribution of $lnTFP_{i,s,t}|FC_{i,s,t}$, whereas the hypothetically additive fixed effects approach provides estimation on an unexpected distribution of $lnTFP_{i,s,t} - \theta_{i,s,t}|FC_{i,s,t}$ where $\theta_{i,s,t}$ refers to θ_i,θ_s and θ_t. A less desirable case could be when the firm that is at the top of the $lnTFP_{i,s,t}$ distribution might end up being at the bottom of the $lnTFP_{i,s,t} - \theta_{i,s,t}$ distribution.[22]

To ease the interpretation for the key variable of interest – financial constraints ($FC_{i,s,t}$), I note that the coefficient β associated with such variable measures the differences between the productivity of financially constrained firms ($lnTFP|FC = 1$) and that of financially unconstrained firms ($lnTFP|FC = 0$). As I argue, if a firm is financially constrained due to lack of access to bank financing, the firm is still able to rely on other resources to finance its productivity-enhancing activities, driving increased productivity accordingly. I therefore do not expect a systemic effect of financial constraints on productivity throughout the entire productivity distribution. Instead, there should be nonmonotonic effect and the coefficient β is still expected to be statistically significantly different from zero. Particularly, to test the $Hyp1$, I expect negative coefficients β for firms at lower levels of productivity distribution, and positive coefficients associated with $FC_{i,s,t}$ for top performers.

I make a further step in the baseline estimation (Eq. 2.5) by investigating whether

[21] To facilitate the understanding of $u^*_{i,s,t}$, it is important to emphasise that θ_i,θ_s and θ_t are nonadditive fixed effects that are neither measured nor specified in the productivity estimation (Eq. 2.5). Instead, these effects are maintained in the financial constraint equation (Eq. 2.4) to absorb heterogeneous financing patterns, aiding identification for the degree of binding constraints. Although one might argue that the productivity distribution can be attributable to unobserved heterogeneity, the inclusion of these fixed effects in the production equation potentially generates biased estimates when I have relatively short panels of $T = 5$, but the financial constraint equation (Eq. 2.4) suggests otherwise since the instrumental variables (IV) approach helps to absorb such biases.

[22] The reason is that for additive fixed effects approach, a set of fixed effects $\theta_{i,s,t}$ is not eliminated. Hence, being conditional on individual fixed effects can distort the inference about $lnTFP_{i,s,t}$ distribution: Quantiles conditional on, for instance, firm industry fixed effects refer to firms with the highest productivity within certain industries, other than those with highest productivity regardless of the industry that they belong to —- as suggested by the nonadditive fixed effects approach. Thus, adjustment is essentially an extra step to obtain unbiased estimates of the additive fixed effects: From the initial estimates of $lnTFP_{i,s,t}$ distribution, one instead obtain $lnTFP_{i,s,t} - \theta_{i,s,t}$. This exercise might change the firm rankings in that firms from the top of the initial estimates might end up elsewhere over the $lnTFP_{i,s,t} - \theta_{i,s,t}$ distribution or being at the bottom at worst.

financially constrained firms could gain productivity if they have higher internal funds or cash flows. I follow Guariglia (2008), Chen & Guariglia (2013), Bernini et al. (2015), constructing a $MCF_{i,s,t}$ dummy: $MCF_{i,s,t} = 1$ when the cash flow ratio (measured by cash flows over tangible assets) over the sample median and zero otherwise. The estimated equation to test the validity of $Hyp2$ is as follows:

$$lnTFP_{i,s,t} = \alpha lnTFP_{i,s,t-1} + \beta FC_{i,s,t} + \sigma FC_{i,s,t} \times MCF_{i,s,t} + \gamma X_{i,s,t} + u^*_{i,s,t} \quad (2.6)$$

The estimated coefficient σ of the interaction term $FC_{i,s,t} \times MCF_{i,s,t}$ in Eq. 2.6 measures the productivity differences between high liquid constrained firms ($lnTFP|MCF = 1, FC = 1$) and low liquid constrained firms ($lnTFP|MCF = 0, FC = 1$). When testing $Hyp2$, I expect to obtain larger positive estimates for σ at the upper tail of productivity distribution relative to those at the lower tail. The main reason is that sufficient internal funds can still drive productivity for firms that are binding to financial constraints ($FC = 1$), especially when there are some investment better suited to the use of these funds than other external funds (see more Ughetto (2008)) — those at higher productivity levels possibly generate higher amount of internal funds and end up with higher productivity than those at the lower distribution. Also, Eq. 2.6 adds further validity to $Hyp1$ that there should be no systematic relation between financial constraints and productivity distribution, although one should expect the lower effects of coefficient β in Eq. 2.6 relative to Eq. 2.5.

Regarding the empirical procedures, I also use the use ordinary least squares (OLS) with robust standard errors to emphasize the extent to which regressions on conditional quantiles throughout the entire distribution provide less biased estimators than OLS regressions on conditional means. Although one might expect that the OLS regressions would perform poorly on the panel data, the estimation is needed to check the consistency with the existing literature.

2.5 Data collection, variables and descriptive statistics

2.5.1 Data collection

I use Vietnam small and medium enterprise (SME) surveys conducted by Central Institute for Economic Management (CIEM) and Institute of Labour Science and Social Affairs (ILSSA) of the Ministry of Labour in Vietnam, and collaboratively led and strictly reviewed by University of Copenhagen (UCPH) and UNU-WIDER.[23] Obtaining technical support from such external partners, the SME surveys provide a rich source of reliable data. The surveys were taken at two-year intervals (2005, 2007, 2009, 2011, and 2013).[24] The selection of the surveyed firms is based on the stratified random sampling approach which requires data coverage of two characteristics—geographical location and ownership

[23] Source: https://www.wider.unu.edu/

[24] Although the most recent survey was conducted in 2015, its released timing to have access to has been long delayed. By that time, this thesis has been progressing through data cleaning process and preliminary analyses. However, I believe that the time frame 2005-2013 is sufficient to capture changes over a long period of time and a key economic change—business registration reform—that the country implemented in 2010 and that I will analyse further in Chapter 4.

Table 2.1: Unbalanced panel structure of the dataset

Panel A: Frequencies of firms over years

No. of years per firms	No. firms	No. firm-year obs
1	947	947
2	765	1,530
3	446	1,338
4	1,162	4,648
Total	3,320	8,463

Panel B: Firm-year observations per year

Year	No.obs	Percentage
2007	2,291	27.07
2009	2,112	24.96
2011	2,054	24.27
2013	2,006	23.70
Total	8,463	100.00

Source: Authors' calculations based on the CIEM-DANIDA dataset.
Note that because the models use lag variables, observations in the first wave of 2005 (and some in other waves) are undoubtedly dropped in estimations and the final sample.

form. Accordingly, the samples attract widespread coverage of firms in the country insofar as the firms locating in 10 cities of northern, central and southern key economic zones (Hanoi, Phu Tho, Ha Tay, Hai Phong, Nghe An, Quang Nam, Khanh Hoa, Lam Dong, Ho Chi Minh city and Long An) and belonging to 5 types of non-state ownership (household, private, collective, limited liability and joint stock firms) are well-represented in all waves.

Panel A in Table 2.1 shows the unbalanced panel structure of the dataset with a sample of over 3,300 firms corresponding to 8,463 firm-year observations. Among these, roughly 1,000 firms appear over all waves. Panel B shows the number of firm-year observations per surveyed year with more than over 2,000 observations per year.[25]

2.5.2 Data description

The survey gives detailed information on various general characteristics of firms including establishment year, product types, etc. with its heart goes to a set of questionnaires related to investments, liabilities, balance sheet and production structure. It therefore provides me sufficient information to construct the variables of interest and their proxies where necessary.

Table 2.2 provides the descriptive statistics of various financing sources that a firm can rely on in response to its investment demand and their proportion in the total funds. Based on responses to the survey question about financing sources "How much percentage

[25]Sample selection steps are as follows. The original dataset after data cleaning process has a totalling number of over 13,000 firm-year observations. Around 4,500 observations are dropped for missing variables of interest including lagged variables. The final sample that I use has 8,463 firm-year observations.

Table 2.2: Share of firms reporting financing sources for investments in the year preceding survey year

Percentage of financing	Internal funds	Banks	Nonbanks	Friends/ Relatives	New shares issued
<10%	68.99	53.81	86.27	84.11	99.91
10%-25%	3.73	2.44	2.69	3.14	0.02
25%-50%	3.51	5.15	2.73	3.19	0.02
50%-75%	4.54	10.00	2.71	2.58	0.02
75%-90%	1.21	4.46	0.65	0.89	0.01
>90%	18.02	24.14	4.95	6.09	0.01
Total	100.00	100.00	100.00	100.00	100.00
No.responses	8,463	4,308	4,282	4,267	8,463

Source: Authors' calculations based on the CIEM-DANIDA dataset.

of new investment undertaken in the year preceding the survey was financed with (1) Internal funds (2) Banks or credit institutions (3) Nonbanks (4) Friends or relatives (5) New stock issues",[26] I observe that a large share of firms in the sample are dependent on their internally generated funds or bank loans rather than informal sources. Nearly a fifth of firms respond with over 90 per cent of investment attributed to internally generated funds, making the number of firms with more than half of internally financed investment climbs to a quarter of firm responses. Those who least prefer to use this financing source (less than 10 per cent of their investment) make up as many as 70 percent. Firms also use external funds from following sources. Roughly 40 per cent of firms use bank credit to finance over 50 per cent of their investment. Informal sources does not appear to be a favourable financing source for most firms to rely on. Over 85 per cent of firms report less than 10 per cent of contribution to total funds from nonbanks or friends or relatives. Stock finance is the least favourable financing source with a rather meagre share (nearly 0.1 per cent) of firms in the sample issuing new stocks to finance from 10 to 75 per cent of their investment. Although the focus in this chapter is lack of access to bank financing, the data shows the completeness of different financing choices from either internal funds or external funds of firms in the Vietnam sample.

Panel A of Table 2.3 reports the mean, standard deviation and different percentiles of variables in the baseline estimation Eq. 2.5. The productivity ($lnTFP$) has a zero mean and a negative median (-0.01), indicating that $lnTFP$ is slightly right skewed or a longer right tail of the productivity distribution. I also measure TFP values with lower positive values in comparison with European counterparts – see Ferrando & Ruggieri (2018).[27] The distribution of financial constraints, however, yields a rather different pattern to $lnTFP$. FC is left skewed with a mean (median) of 0.69 (1.00), showing that there is a longer left tail of FC distribution. Indeed, only a first quartile of firms in the full sample are reported financially unconstrained ($FC = 0$), leaving as many as 75 per cent of firms in

[26] I note that these responses opt to firms who response "Yes" for the question "Has the firm made any investment in the preceding year", opting out those whose answer is "No".

[27] This might stem from better-functioning institutional settings in European countries than a developing country Vietnam. Additionally, a noticeable difference could be due to the TFP measurement. Ferrando-Ruggieri measurement follows the standard Levinsohn-Petrin production function without translogs as mine.

Table 2.3: Descriptive statistics

Panel A: Descriptive statistics of some variables

	Mean	Median	Std. Dev	5th perc.	25th perc.	75th perc.	95th perc.
TFP	1.04	0.99	0.39	0.69	0.88	1.12	1.50
$lnTFP$	0.00	-0.01	0.27	-0.38	-0.13	0.11	0.41
FC	0.69	1.00	0.46	0.00	0.00	1.00	1.00
$Sellasset$	0.04	0.00	0.19	0.00	0.00	0.00	0.00
$Tradecredit$	313,056	2,000	6,366,542	0.00	0.00	35,000	760,000
$Debtfail$	0.66	1.00	0.47	0.00	0.00	1.00	1.00
$Size^{\psi}$	1.98	1.79	1.15	0.69	1.10	2.71	4.22
Age^{ψ}	2.81	2.83	0.60	1.79	2.40	3.18	3.97
$NewProd$	0.04	0.00	0.18	0.00	0.00	0.00	0.00
$NewTech$	0.12	0.00	0.32	0.00	0.00	0.00	1.00
$Association$	0.91	1.00	0.29	0.00	1.00	1.00	1.00
$Competition$	0.87	1.00	0.33	0.00	1.00	1.00	1.00
$GovSupport$	0.13	0.00	0.33	0.00	0.00	0.00	1.00
$Export$	0.06	0.00	0.24	0.00	0.00	0.00	1.00
No. obs	8,463						

Panel B: Mean comparison between financially constrained and unconstrained firms

	Unconstrained firms ($FC = 0$)	Constrained firms ($FC = 1$)	Difference	t-value
TFP	1.04	1.04	-0.00	0.94
$lnTFP$	0.01	-0.01	0.02	0.02
$Sellasset$	0.05	0.03	0.02	0.00
$Tradecredit$	449,258	251,940	197,319	0.19
$Debtfail$	0.92	0.55	0.37	0.00
$Size^{\psi}$	2.35	1.82	0.53	0.00
Age^{ψ}	2.75	2.83	-0.09	0.00
$NewProd$	0.04	0.03	0.01	0.15
$NewTech$	0.15	0.10	0.05	0.00
$Association$	0.88	0.92	-0.04	0.00
$Competition$	0.91	0.86	0.05	0.00
$GovSupport$	0.16	0.11	0.05	0.00
$Export$	0.09	0.05	0.04	0.00
No. obs	2,621	5,842		

Notes: Panel A reports descriptive statistics of all variables. Panel B compares variables between two groups with the financial constraint measurement following Ferrando and Ruggieri (2018). ($^{\psi}$) indicates the variables measured in logarithm. (***) indicates significance level of 1%.
Source: Authors' calculations based on the CIEM-DANIDA dataset.

the distribution found constrained ($FC = 1$). Nearly three-fourths of firms have failed to pay debt; not many firms use trade credit, and very small number of firms in the sample has sold their assets. Turning to firm size ($Size$) and age (Age), $Size$ is right skewed while Age is left skewed with the mean (median) of these variables observed 1.98 (1.79) and 2.81 (2.83), respectively. Regarding other control variables, new product ($NewProd$) or new technology ($NewTech$) generation, exporting ($Export$) and receiving government subsidies ($GovSupport$) are truly unfavourable to Vietnamese firms in the sample with as much as 75 per cent having little experience in any of such activities. By contrast, being part of a business association ($Association$) and facing market competition ($Competition$) become more likely and appealing to the sample firms with merely 5 per cent responding "No" to these features.

Panel B of Table 2.3 reports mean comparisons between two groups of financially constrained and unconstrained firms for most variables in Eq. 2.5. I observe that all estimated variables are statistically significant and different across these two groups. Financially constrained firms exhibit lower productivity, which is as expected since firms as such are less likely to have sufficient funds to invest in productivity-enhancing activities. These financially constrained firms are also smaller and older than unconstrained counterparts, indicating that large firms (but not mature firms) have more favours in external financing. See Figure 2.2 for visual presentation of productivity, firm size and age distribution across groups.

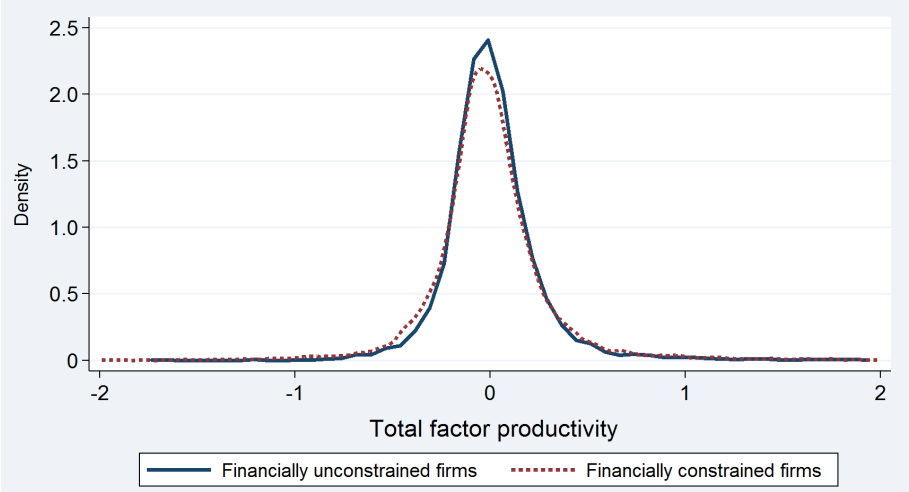
Table 2.4 shows the Pearson and Spearman correlation coefficients between variables estimated in Eq. 2.5. I are inclined to focus on the linear correlation between productivity and other variables. First, instrumental variables, namely $Sellasset$, $Tradecredit$, $Debtfail$, as expected, have insignificantly low correlation with $lnTFP$. Nonetheless, correlation coefficients between these IVs and endogenous FC are all reported significantly negative following Spearman estimates. Second, there is insignificantly negative and weak correlation between FC and $lnTFP$, suggesting no serious bias in the estimated coefficient associated with FC in linear regressions. Other variables show weak correlation with $lnTFP$ except for firm age. More specifically, significantly negative correlation coefficients between firm age and productivity imply that more matured firms are more likely to have lower productivity.

2.6 Empirical results

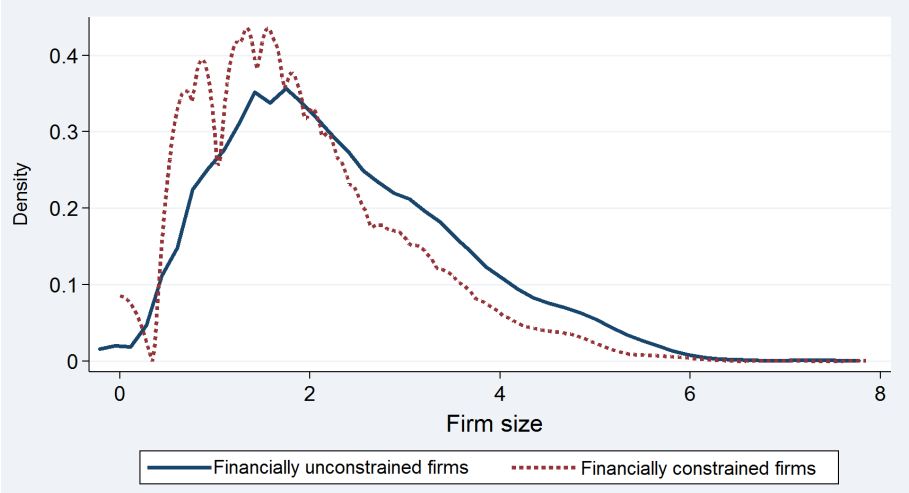
2.6.1 Baseline estimation

Table 2.5 reports the results of the finance-productivity estimations for the full sample. The first two columns report the static OLS specification with and without the inclusion of a set of time, firm and industry fixed effects in each column, whereas remaining columns present the dynamic quantile regression (QRPD) estimates specified in Eq. 2.5 (columns 3 through 7) and Eq. 2.6 (columns 8 through 12) over a range of different quantiles. I can easily observe both significantly negative and positive effects of the financial variable

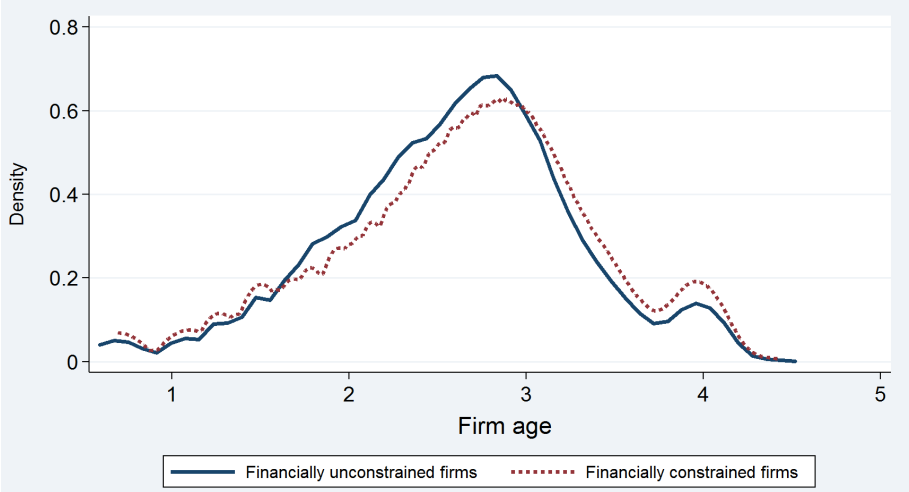
Figure 2.2: Distribution of firm-level productivity, firm size and age, 2005-2013



(a) Panel A



(b) Panel B



(c) Panel C

Notes: Figures reports Kernel density distribution with Epanechnikov kernels of productivity, firm size and age in logarithm-scales for financially (un)constrained firms.
Source: Authors' calculations based on the CIEM-DANIDA dataset.

Table 2.4: Pearson and Spearman correlation matrix

	$lnTFP$	FC	$lnTFP_{t-1}$	$Sellasset$	$Tradecredit$	$Debtfail$	$Size$	Age	$NewProd$	$NewTech$	$Association$	$Competition$	$GovSupport$	$Export$
$lnTFP$		-0.027	0.301*	0.013	0.062*	0.022	-0.003	-0.141*	-0.039*	0.016	0.027	0.043*	-0.070*	0.031*
FC	-0.023		0.000	-0.064*	-0.270*	-0.360*	-0.167*	0.044*	-0.027	-0.061*	0.060*	-0.068*	-0.102*	-0.061*
$lnTFP_{t-1}$	0.319*	-0.006		0.003	0.077^{ψ}	0.036^{ψ}	0.057*	-0.158*	-0.011	0.017	0.043*	0.037^{ψ}	-0.008	0.012
$Sellasset$	0.018	-0.064*	0.003		0.058*	0.030^{ζ}	0.053*	0.006	0.018	0.075*	-0.031^{ζ}	0.019	0.009	0.033^{ζ}
$Tradecredit$	-0.001	-0.018	-0.005	0.012		0.433*	0.428*	-0.157*	0.065*	0.163*	-0.119*	0.167*	0.024	0.145*
$Debtfail$	0.008	-0.360*	0.020	0.030^{ζ}	0.021		0.201*	-0.063*	0.006	0.059*	-0.067*	0.092*	0.072*	0.075*
$Size$	0.000	-0.173*	0.054*	0.061*	0.083*	0.195*		-0.212*	0.136*	0.268*	-0.308*	0.188*	0.026	0.320*
Age	-0.154*	0.033^{ζ}	-0.176^{ψ}	0.009	-0.001	-0.060*	-0.183*		-0.112*	-0.114*	-0.011	-0.083*	-0.026	-0.067*
$NewProd$	-0.033^{ζ}	-0.027	-0.010	0.018	0.006	0.006	0.139*	-0.114*		0.304*	-0.084*	0.062*	0.091*	0.073*
$NewTech$	0.011	-0.061*	0.016	0.075*	0.043*	0.059*	0.282*	-0.108*	0.304*		-0.131*	0.082*	0.063*	0.129*
$Association$	0.034*	0.060*	0.039^{ζ}	-0.031^{ζ}	-0.038*	-0.067*	-0.336*	-0.018	-0.084*	-0.131*		-0.045*	-0.058*	-0.213*
$Competition$	0.049*	-0.068*	0.034	0.019	0.000	0.092*	0.166*	-0.081*	0.062*	0.082*	-0.045*		0.024	0.029^{ψ}
$GovSupport$	-0.047*	-0.102*	0.006	0.009	0.023	0.072*	0.045*	-0.023	0.091*	0.063*	-0.058*	0.024		0.019
$Export$	0.016	-0.061*	0.016	0.033^{ζ}	0.050*	0.075*	0.393*	-0.063*	0.073*	0.129*	-0.213*	0.029^{ψ}	0.019	

Notes: (*), ($^{\zeta}$) and ($^{\psi}$) denotes statistical significance at Bonferroni-adjusted levels of 0.01, 0.05 and 0.1, respectively. Off-diagonal values show Pearson and Spearman correlation coefficients with Pearson's below the diagonal and Spearman's above such.

Source: Authors' calculations based on the CIEM-DANIDA dataset.

of the interest and many control variables over the dispersion of firms' productivity levels with noticeably different results from the OLS estimates focused on the mean effects. I also find that estimates are generally similar across the first two columns relating to OLS specification with the exception of the export behaviour variable which I will give further interpretation in the next part.

I first consider the financial constraints that firms are binding to ($FC_{i,s,t}$). A statistically significant and negative coefficient obtained from the OLS estimation confirms that financially constrained firms, on average, are less productive than unconstrained firms. This finding, however, does not hold across a wide range of productivity distribution – see columns 3 through 7 for estimation in Eq. 2.5. At the upper tail of such distribution, financially constrained firms have the higher productivity than their unconstrained counterparts. Indeed, financially constrained firms at the 0.90 quantile have higher productivity of 3.5 percentage points more than unconstrained firms. The magnitude of the effect is lower to only 0.6 percentage points for firms at the 0.75 quantile. By contrast, the effects share a different pattern for firms below the 0.5 quantile of productivity distribution from which financially constrained firms become less productive than unconstrained firms. This is confirmed by significantly negative coefficients at 0.10, 0.25 and 0.5 quantiles. To visually show the effect of $FC_{i,s,t}$ on productivity for the full distribution of firms in the sample, Figure 2.3 is provided for completeness with discernible difference over the upper and lower quantiles as proved. The results confirm a nonmonotonic effect of financial constraints on productivity, thereby supporting $Hyp1$.

An explanation for such nonmonotonic effect should boil down to a firm's availability of financing resources relative to its investments in productivity-enhancing activities. There are certain cases in which a firm's internal and external financing resources are disproportional to its investment needs; the firm therefore is less likely to invest in these activities according to the theoretical intuition by Fazzari et al. (1988), Bond & Meghir (1994), Nickell & Nicolitsas (1999), among others. One might link these cases with low productivity firms upon which I find negative $FC_{i,s,t}$ coefficients. Another scenario is the firm's ability to finance these investments by relying on its sufficient internal funds or alternative financing sources such as informal sources, trade credit, and governmental subsidies. For Vietnamese firms, internal funds and informal sources, among others, are rather important due to underdeveloping financial markets in which these firms operate. This intuition is suited to the sample firms at the upper tails of the productivity distribution with positive $FC_{i,s,t}$ coefficients. The obtained coefficients of financial constraints are consistent with two separate yet related strands of theories and empirical studies on the relationship with productivity. To date, only an empirical paper by Nunes et al. (2007) who find the nonmonotonic effect in the finance-productivity relation — although the interpretation is rather different since the authors introduce leverage to measure availability of credit, not the binding constraints.

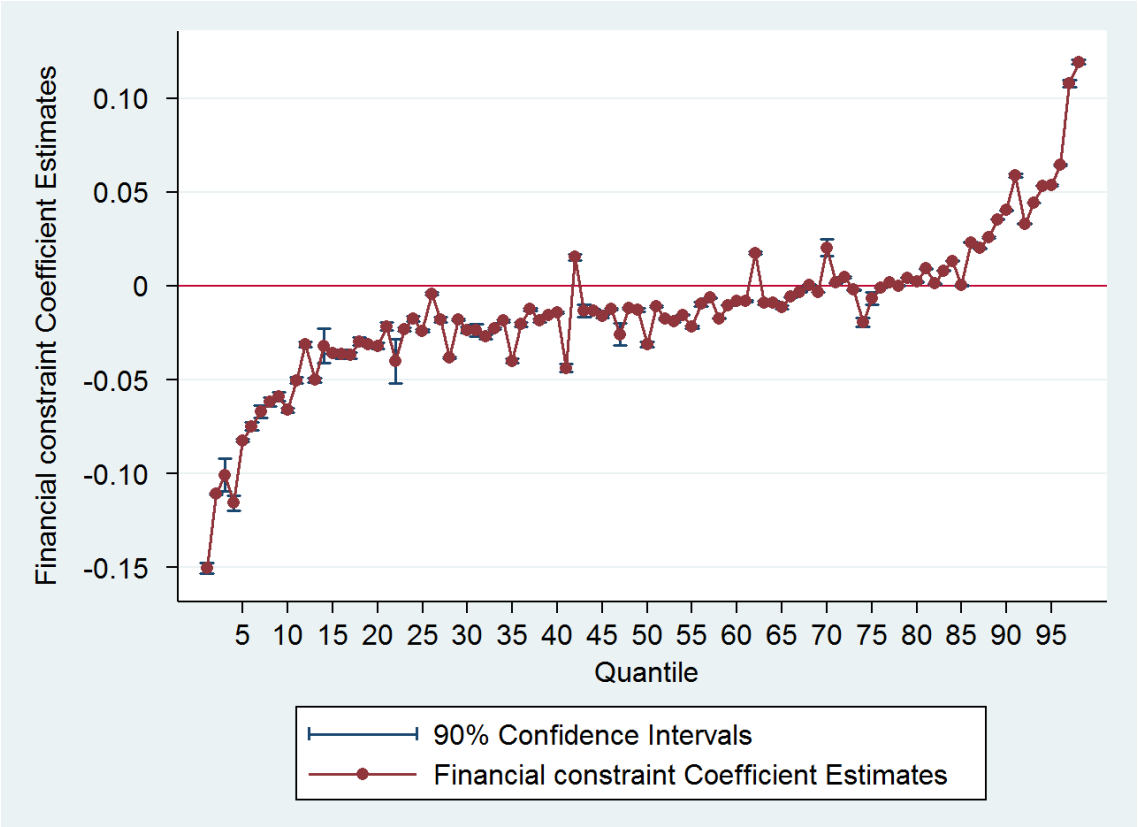
In a different estimation Eq.2.6, I find clear evidence of keeping retentions for firm-level productivity: (i) positive coefficients of the interaction term $FC_{i,s,t} \times MCF_{i,s,t}$ indicate that financially constrained firms generating sufficient internal funds are more productive than those in a similar financial setting with insufficient resources, and (ii) such positive effect is stronger for firms at higher quantiles of productivity distribution. This

Table 2.5: OLS and QRPD: Financial constraints on firm productivity

	OLS		QRPD					QRPD: conditional on cash flow				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	OLS	OLS	Q0.10	Q0.25	Q0.50	Q0.75	Q0.90	Q0.10	Q0.25	Q0.50	Q0.75	Q0.90
	b/se	b/se	b/se	b/se	b/se	b/se	b/se	b/se	b/se	b/se	b/se	b/se
$FC_{i,s,t} \times MCF_{i,s,t}$								0.075***	0.086***	0.110***	0.129***	0.350***
								(0.013)	(0.003)	(0.001)	(0.003)	(0.007)
$lnTFP_{i,s,t-1}$			0.221***	0.231***	0.253***	0.319***	0.355***	0.190***	0.214***	0.242***	0.281***	0.301***
			(0.004)	(0.006)	(0.003)	(0.015)	(0.007)	(0.007)	(0.002)	(0.001)	(0.001)	(0.001)
$FC_{i,s,t}$	-0.016***	-0.018***	-0.050***	-0.036***	-0.001***	0.006*	0.035***	-0.098***	-0.026***	-0.014***	-0.012***	0.016***
	(0.005)	(0.005)	(0.007)	(0.001)	(0.000)	(0.003)	(0.004)	(0.020)	(0.001)	(0.001)	(0.000)	(0.002)
$Size_{i,s,t}$	-0.022***	-0.026***	-0.006	-0.010**	-0.045***	-0.053***	-0.033***	-0.069***	-0.019***	-0.024***	-0.038***	-0.035***
	(0.008)	(0.008)	(0.016)	(0.004)	(0.007)	(0.005)	(0.006)	(0.026)	(0.002)	(0.000)	(0.001)	(0.002)
$Size^2_{i,s,t}$	0.005	0.003	-0.015***	-0.003	0.013***	0.015***	0.017***	0.000	0.002***	0.005***	0.006***	0.019***
	(0.004)	(0.003)	(0.004)	(0.002)	(0.003)	(0.001)	(0.002)	(0.002)	(0.001)	(0.000)	(0.001)	(0.001)
$Age_{i,s,t}$	0.032	0.010	0.066**	-0.014	-0.114***	-0.075**	-0.223***	0.133***	-0.000	-0.022***	-0.096***	-0.222***
	(0.020)	(0.020)	(0.028)	(0.010)	(0.016)	(0.030)	(0.009)	(0.050)	(0.005)	(0.001)	(0.004)	(0.005)
$Age^2_{i,s,t}$	-0.020***	-0.013***	-0.030***	-0.005***	0.013***	0.007	0.029***	-0.039***	-0.008***	-0.002***	0.009***	0.029***
	(0.004)	(0.004)	(0.003)	(0.001)	(0.003)	(0.006)	(0.002)	(0.008)	(0.001)	(0.000)	(0.001)	(0.001)
$NewProd_{i,s,t}$	-0.046***	-0.021**	0.006	-0.039***	-0.042***	0.009	-0.014*	0.043*	-0.053***	-0.017***	-0.004***	-0.009***
	(0.009)	(0.010)	(0.023)	(0.009)	(0.004)	(0.009)	(0.008)	(0.022)	(0.004)	(0.002)	(0.001)	(0.003)
$NewTech_{i,s,t}$	0.014*	0.019***	0.003	0.006**	-0.009	0.014**	0.031***	0.036***	0.020***	0.027***	0.017***	0.030***
	(0.008)	(0.007)	(0.017)	(0.003)	(0.006)	(0.006)	(0.004)	(0.005)	(0.002)	(0.001)	(0.001)	(0.001)
$Association_{i,s,t}$	0.024**	0.021*	-0.073***	-0.003*	-0.025***	-0.018***	-0.021***	0.034***	0.026***	0.004***	-0.035***	-0.018***
	(0.012)	(0.012)	(0.024)	(0.002)	(0.006)	(0.004)	(0.003)	(0.009)	(0.001)	(0.001)	(0.002)	(0.002)
$Competition_{i,s,t}$	0.041***	0.035***	0.080***	0.048***	0.004*	-0.011**	-0.032***	0.068***	0.052***	0.010***	0.002***	-0.026***
	(0.009)	(0.009)	(0.007)	(0.003)	(0.002)	(0.005)	(0.002)	(0.014)	(0.001)	(0.002)	(0.000)	(0.006)
$GovSupport_{i,s,t}$	-0.041***	-0.022***	-0.018**	-0.016***	-0.011***	-0.034***	-0.009*	0.007	-0.025***	-0.035***	-0.013***	-0.042***
	(0.007)	(0.007)	(0.008)	(0.002)	(0.003)	(0.003)	(0.005)	(0.011)	(0.001)	(0.001)	(0.001)	(0.003)
$Export_{i,s,t}$	0.028	0.050***	0.035***	0.047***	0.041***	0.008	0.049***	0.015	0.050***	0.043***	0.099***	0.036***
	(0.017)	(0.017)	(0.008)	(0.004)	(0.004)	(0.012)	(0.006)	(0.027)	(0.004)	(0.002)	(0.004)	(0.005)
$i, s, t - FE^{\psi}$	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. obs	8,463	8,463	8,463	8,463	8,463	8,463	8,463	8,463	8,463	8,463	8,463	8,463

Notes: OLS estimates are reported with robust standard errors. Estimates in columns 3-12 uses quantile regressions for panel data; those in columns 8-12 are obtained by interacting financial constraint with cash flow dummies ($MCF_{i,s,t}$) which take value of 1 if cash flow ratios (=cash flows over tangible assets) are higher than the sample median and 0 otherwise. ($^{\psi}$) indicates the inclusion of a set of fixed effects. *p <0.10, ** p <0.05, *** p <0.01. Standard errors are in parentheses. Source: Authors' calculations.

Figure 2.3: Financial constraint coefficient estimates



Notes: This figure reports financial constraint coefficient estimates of Eq. 2.5 over the full quantiles. Confidence intervals are truncated at -0.15 and 0.10.
Source: Authors' calculations.

finding is indeed in line with existing literature on the role of internal funds in covering operating costs and raising higher investments in physical and human capital when external financing is impeded (see Chen & Guariglia (2013), Ferrando & Ruggieri (2018)). Rahaman (2011) also find that the degree of binding constraints and firm performance coincides in the presence of internal resources. Overall, I can conclude that financially constrained firms with high internally generated funds help gain higher productivity and financial constraints induce higher productivity for firms with high productivity, but not for those having lower productivity. The results therefore support $Hyp2$.

I next move to consider control variables representing for firms characteristics and the business environment within which they operate. I start with firm size and age and their respective quadratic terms.[28] For firm size variable ($Size_{i,s,t}$), I record the negative relationship between firm size and firm productivity with strong evidence of statistically significant and negative coefficients for the average and all quantiles examined. Upper quantiles have seen stronger negative effects, which further confirms that the negative relationship is more robust for top firms with high productivity. However, to some degree, when firms start getting larger, the effects are different across quantiles. More specifically, firms at upper quantiles are reported with a change to positive coefficients for the quadratic term of firm size ($Size^2_{i,s,t}$)—that is, small firms are less productive than incumbents—while the negative relationship still holds for firms at lower quantiles. The results are in line with the literature that smaller firms may inflict productivity persistence over time and larger firms benefit from "learning" process of growth dynamics and improve productivity (Jovanovic 1982, Coad et al. 2016).

For the firm age variable ($Age_{i,s,t}$), I find that the importance of the maturity characteristics is different across quantiles; such effect changes when firms become more mature. Indeed, the results only show significantly negative coefficients for firms at the 0.50 quantile and below, which means that for such firm group, mature firms are less productive than younger counterparts. By contrast, for firms at the bottom tail of productivity distribution, mature firms are rather more productive. However, a different pattern is seen in a quadratic fashion: mature firms or incumbents gain more (less) productivity at top (bottom) quantiles than younger counterparts. This finding is consistent with both strands of relevant literature: mature firms may draw on established capabilities and long history of technology to gain higher productivity over younger firms; they could also pose certain forms of organisational inertia and therefore are more likely to hinder their productivity gains (Coad & Reid 2012, Coad et al. 2016, Daunfeldt et al. 2016).

I continue to further study the effects of other control variables as indicators for firms' innovation capabilities, exporting behaviour and business environment on firm-level productivity. For innovation-related variables, I record a negative effect of the introduction of new product to the market on productivity and positive effect for new technology introduction through the OLS estimates. Although the OLS estimates can only capture the mean effect rather than different productivity distribution as measured by QRPD estimates, rather similar patterns are found across most quantiles. The results therefore

[28] Note that firm size and age variables and their quadratic terms are all transformed in logarithm. The interpretation for the effects on firm productivity—which is also in logarithm form — is therefore the elasticity (that is, the percent change), rather than percentage point change as the interpretation for financial constraint variable.

suggest the importance of the introduction of new technology rather than new products particularly on firms' production process and productivity as an eventual consequence, which have long been stressed in the innovation literature (Hall et al. 2010, Coad et al. 2014). The presence of market competition and being part of business association are, on average, positively associated with firm productivity, which is in line with a study by Ayyagari et al. (2011). Such positive effect is particularly strong for firms at lower tails of productivity distribution and strikingly, I find the opposed effect over the top quantiles. The results indicate that for firms with highest productivity in the sample, those that are part of a business group or face market competition have lower productivity that those without. The impact of having received subsidies from the government are consistent across both OLS and QRPD estimates: firms receiving governmental support are less likely to be as productive as those without. This finding is somehow different from a study by Mateut (2018). For export behaviour variable, I find a significantly positive relationship between export behaviour that a firm has and its productivity over all range of quantiles, which is consistent with a large body of exporting literature on self-selction and learning-by-doing through engaging in exporting behavior (See Biesebroeck (2005), Bernard & Jensen (1999)). The relationship, however, is different across OLS estimates. The coefficient—although positive in both estimates—turns statistically significant only when I include the industry and time dummies, which suggests the heterogeneity of export behaviour across industries.

2.6.2 Robustness checks

The quantile regression estimates, although having yielded rather interesting nonlinearity results over the range of quantiles, still raise concerns over several dimensions: the validity of variables of interest; the sensitivity of the implied finance-productivity relationship. To further check the validity of the main results, I introduce multiple robustness tests including QRPD with additional instruments for financial constraints and an alternative measure of productivity and financial constraints, panel data estimations, and unconditional quantile treatment estimations.

Quantile estimation with alternative measures of financial constraints and productivity

First, I re-estimate the QRPD with the addition of trade credit in the regressions with results reported in columns 1 through 5 in Panel A of Table 2.6. I find positive coefficients on the financial constraint variable ($FC_{i,s,t}$) in upper tails of distribution, which is consistent with the baseline estimations results and amplifies the higher magnitude notwithstanding. When including $Tradecredit$ as additional instrument in the regression of Eq. 2.5, I record that the impact of financial constraints on productivity is attenuated by the presence of trade credit availability in bottom and top quantiles. Indeed, the productivity difference between financially constrained and unconstrained firms, at 0.1, 0.25 and 0.9 quantiles are -5.0, -3.6 and 3.5 percentage points respectively (in columns 3, 4 and 7 of Table 2.5) without the inclusion of trade credit are lessened to -4.6, -1.4 and 2.6 percentage points (in columns 1, 2 and 5 of Table 2.6). Although I cannot find such impact for firms at 0.5

and 0.75 quantiles, I can conclude that the impact of financial constraints on productivity in the main estimation is robust with differential effects across the range of productivity distribution.

Second, I also provide an alternative measure of total factor productivity following Olley & Pakes (1996). The results obtained in columns 6 through 10 in Panel B of Table 2.6 further confirm the effect that financial constraints exert on productivity across quantiles with the magnitude of the effect is different with the LP measurement. For instance, financially constrained firms at the middle quantile are reported having 2.6 percentage points lower than those unconstrained in the OP measurement, which is much higher than to meagre 0.1 percentage points reported in the LP measurement (column 5 of Table 2.5). Although finding different magnitudes of effects across estimated quantiles, I can conclude that, in general, the baseline results are robust to an alternative measure of TFP and an extra instrument for endogenous financial constraint variable.

Third, instead of estimating a static OLS model, I use the first-difference Generalised Method of Moments (GMM) approach by Arellano & Bond (1991). This approach accounts for both unobserved heterogeneity and endogeneity of the regressors by estimating the first-differences equation. In the GMM model, I assume all regressors employed in the QRPD model as endogenous and instrument these regressors using their two lags in the differenced equation. I also include year and industry fixed effects in the model and instrument sets. The results are reported in column 1 of Table 2.7. Although the estimate for financial constraint is not significant, which indicates that the OLS estimation discussed above can be biased. This finding also suggests that there may be differential estimates throughout the productivity distribution which may offset each other. The Hansen statistics with the $p - value$ greater than any significant levels shows that the instruments selected in the model are valid. The model has appropriate specifications with no second-order serial correlation in the first-differenced residuals using $m2$ test with the null hypothesis of no second-order serial correlation of the differenced residuals.

Fourth, to check whether outliers can bias the results, I re-estimate the QRPD after winsorising top and bottom 1% of all continuous variables used in the QRPD model. The results are reported in columns 2 through 6 in Table 2.7. After dealing with outliers, the estimates for financial constraints are rather robust with the baseline estimations, albeit slightly stronger magnitude of impacts for firms at the lowest quantiles. Estimates of financial constraints on other quantiles in the productivity distribution remain rather consistent with the baseline model, suggesting that the outliers do not seriously bias the estimations.

Lastly, I construct an alternative index of measuring financial constraints that has been proposed by Hadlock & Pierce (2010). The Hadlock-Pierce index is measured as follows: $(-0.737 * Size) + (0.043 * Size^2) - (0.040 * Age)$ where Size is log of total assets after inflation, and Age is number of years in establishment. I take a further step in constructing a dummy from the Hadlock-Pierce index to create a SAIndex that takes the value of 1 for any index falls above the sample median sample of the distribution at a particular year and industry. The result is reported in remaining columns of Table 2.7. Overall, the estimates for financial constraints remain robust with the baseline estimations, albeit smaller magnitudes across productivity levels.

Table 2.6: Robustness check: QRPD with an additional instrument and alternative TFP measurement

	Panel A: QRPD with more IV					Panel B: QRPD with Olley-Pakes TFP measurement				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Q0.10	Q0.25	Q0.50	Q0.75	Q0.90	Q0.10	Q0.25	Q0.50	Q0.75	Q0.90
	b/se	b/se	b/se	b/se	b/se	b/se	b/se	b/se	b/se	b/se
$lnTFP_{i,s,t-1}$	0.206***	0.218***	0.238***	0.268***	0.315***	0.196***	0.209***	0.194***	0.301***	0.318***
	(0.004)	(0.002)	(0.002)	(0.005)	(0.003)	(0.008)	(0.001)	(0.005)	(0.002)	(0.009)
$FC_{i,s,t}$	-0.046***	-0.014***	-0.009***	0.015*	0.026***	-0.036***	-0.026***	-0.026***	0.011***	0.025***
	(0.002)	(0.001)	(0.000)	(0.008)	(0.003)	(0.001)	(0.001)	(0.002)	(0.001)	(0.003)
$Size_{i,s,t}$	-0.020***	-0.007***	-0.030***	-0.042***	-0.034***	-0.017***	-0.014***	-0.101***	-0.094***	-0.033***
	(0.002)	(0.001)	(0.001)	(0.006)	(0.002)	(0.005)	(0.001)	(0.008)	(0.003)	(0.003)
$Size^2_{i,s,t}$	-0.005***	-0.002***	0.006***	0.015***	0.016***	-0.012***	0.000	0.025***	0.032***	0.017***
	(0.001)	(0.000)	(0.000)	(0.003)	(0.000)	(0.002)	(0.000)	(0.002)	(0.001)	(0.001)
$Age_{i,s,t}$	0.119***	0.064***	-0.016**	-0.165***	-0.232***	0.196***	-0.031***	0.002	-0.124***	-0.245***
	(0.005)	(0.007)	(0.007)	(0.027)	(0.005)	(0.006)	(0.011)	(0.007)	(0.017)	(0.011)
$Age^2_{i,s,t}$	-0.034***	-0.018***	-0.005***	0.022***	0.028***	-0.059***	-0.002	-0.016***	0.014***	0.032***
	(0.001)	(0.001)	(0.001)	(0.005)	(0.001)	(0.004)	(0.002)	(0.002)	(0.003)	(0.002)
$NewProd_{i,s,t}$	-0.029***	-0.055***	-0.026***	-0.020***	-0.012***	-0.043***	-0.013***	-0.029***	0.018***	-0.017***
	(0.002)	(0.005)	(0.003)	(0.005)	(0.002)	(0.013)	(0.002)	(0.004)	(0.003)	(0.002)
$NewTech_{i,s,t}$	0.038***	0.018***	0.034***	0.013***	0.028***	-0.022	0.024***	0.049***	0.022***	0.025***
	(0.004)	(0.001)	(0.001)	(0.005)	(0.002)	(0.025)	(0.001)	(0.002)	(0.002)	(0.003)
$Association_{i,s,t}$	0.021***	0.002	0.014***	-0.035***	-0.024***	-0.041*	0.006***	-0.037***	-0.022***	-0.019***
	(0.002)	(0.003)	(0.004)	(0.010)	(0.002)	(0.024)	(0.001)	(0.005)	(0.003)	(0.006)
$Competition_{i,s,t}$	0.131***	0.039***	0.006**	-0.013**	-0.036***	0.121***	0.051***	-0.011***	-0.016***	-0.041***
	(0.002)	(0.002)	(0.002)	(0.005)	(0.002)	(0.004)	(0.001)	(0.002)	(0.001)	(0.002)
$GovSupport_{i,s,t}$	-0.017***	-0.016***	-0.021***	-0.033***	-0.033***	-0.028***	-0.023***	0.004	-0.020***	-0.034***
	(0.002)	(0.001)	(0.006)	(0.001)	(0.001)	(0.003)	(0.001)	(0.004)	(0.001)	(0.002)
$Export_{i,s,t}$	0.071***	0.045***	0.048***	0.014	0.063***	0.138***	0.041***	0.086***	-0.014***	0.060***
	(0.005)	(0.002)	(0.002)	(0.018)	(0.002)	(0.023)	(0.001)	(0.004)	(0.006)	(0.005)
$i,s,t-FE^{\psi}$	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. obs	8,463	8,463	8,463	8,463	8,463	8,463	8,463	8,463	8,463	8,463

Notes: Both panels report robustness test of QRPD estimation in Eq. 2.5 with an additional IV of *Tradecredit* in Panel A and Olley-Pakes TFP measurement in Panel B. ($^{\psi}$) indicates the inclusion of a set of fixed effects. *p <0.10, ** p <0.05, *** p <0.01. Standard errors are in parentheses. Source: Authors' calculations.

Table 2.7: GMM and QRPD: Other robustness tests

	GMM	Winsorise top and bottom 1%					QRPD: Hadlock-Pierce SAIndex				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
		Q0.10	Q0.25	Q0.50	Q0.75	Q0.90	Q0.10	Q0.25	Q0.50	Q0.75	Q0.90
	b/se	b/se	b/se	b/se	b/se	b/se	b/se	b/se	b/se	b/se	b/se
$FC_{i,s,t}$	-0.004	-0.089***	-0.027***	-0.011***	-0.006***	0.025***					
	(0.092)	(0.026)	(0.001)	(0.002)	(0.002)	(0.001)					
$SAIndex_{i,s,t}$							-0.019***	-0.016***	-0.015***	0.019***	0.051***
							(0.001)	(0.001)	(0.002)	(0.002)	(0.003)
$lnTFP_{i,s,t-1}$	0.045	0.273***	0.194***	0.247***	0.280***	0.344***	0.197***	0.235***	0.265***	0.270***	0.315***
	(0.043)	(0.042)	(0.005)	(0.001)	(0.004)	(0.005)	(0.002)	(0.002)	(0.002)	(0.004)	(0.006)
$Size_{i,s,t}$	0.011	-0.010	-0.035***	-0.034***	-0.063***	-0.047***	-0.012***	-0.030***	-0.074***	-0.058***	-0.028***
	(0.193)	(0.009)	(0.002)	(0.002)	(0.004)	(0.004)	(0.002)	(0.003)	(0.004)	(0.013)	(0.002)
$Size^2_{i,s,t}$	-0.024	-0.009	0.009***	0.008***	0.023***	0.025***	-0.007***	0.002***	0.013***	0.020***	0.017***
	(0.071)	(0.008)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.004)	(0.001)
$Age_{i,s,t}$	1.271*	0.222***	0.008	-0.086***	-0.157***	-0.279***	0.090***	0.072***	-0.066***	-0.115***	-0.201***
	(0.737)	(0.009)	(0.007)	(0.012)	(0.017)	(0.016)	(0.006)	(0.004)	(0.021)	(0.013)	(0.008)
$Age^2_{i,s,t}$	-0.343*	-0.052***	-0.009***	0.008***	0.020***	0.038***	-0.030***	-0.021***	0.006	0.013***	0.026***
	(0.196)	(0.002)	(0.001)	(0.002)	(0.003)	(0.003)	(0.001)	(0.001)	(0.004)	(0.003)	(0.002)
$NewProd_{i,s,t}$	-0.118	-0.017***	-0.051***	-0.028***	-0.020***	-0.017**	-0.035***	-0.035***	-0.047***	-0.021***	-0.003
	(0.270)	(0.003)	(0.004)	(0.004)	(0.005)	(0.007)	(0.004)	(0.001)	(0.004)	(0.003)	(0.007)
$NewTech_{i,s,t}$	0.202	0.037***	0.014***	0.038***	0.003	0.015***	0.039***	0.016***	0.017***	0.022***	0.043***
	(0.191)	(0.003)	(0.001)	(0.001)	(0.004)	(0.003)	(0.001)	(0.001)	(0.003)	(0.001)	(0.005)
$Association_{i,s,t}$	0.009	0.017	0.022***	-0.003	-0.029***	-0.034***	0.030***	0.010***	-0.041***	-0.011***	-0.015*
	(0.227)	(0.011)	(0.002)	(0.003)	(0.006)	(0.007)	(0.002)	(0.002)	(0.004)	(0.003)	(0.009)
$Competition_{i,s,t}$	0.087	0.112***	0.047***	-0.001	-0.000	-0.048***	0.103***	0.019***	0.005	0.011**	-0.034***
	(0.166)	(0.002)	(0.005)	(0.002)	(0.003)	(0.002)	(0.002)	(0.004)	(0.005)	(0.005)	(0.002)
$GovSupport_{i,s,t}$	-0.016	-0.017***	-0.011***	-0.018***	-0.015***	-0.027***	-0.010***	-0.021***	0.003	-0.043***	-0.035***
	(0.137)	(0.004)	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)	(0.000)	(0.002)	(0.008)	(0.006)
$Export_{i,s,t}$	-0.181	0.062***	0.032***	0.058***	0.056***	0.048***	0.057***	0.088***	0.105***	0.050***	0.045***
	(0.300)	(0.016)	(0.003)	(0.004)	(0.004)	(0.003)	(0.001)	(0.008)	(0.007)	(0.005)	(0.004)
$i, s, t - FE^{\psi}$	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. obs	5,128	8,463	8,463	8,463	8,463	8,463	8,463	8,463	8,463	8,463	8,463
Hansen (p-value)	0.854										
m2 (p-value)	0.964										

Notes: The GMM estimator is reported in column 1. Estimates in columns 3-12 uses quantile regressions for panel data after winsorising the top and bottom 1% of all continuous variables; those in columns 8-12 are obtained adopting a financial constraint measurement by Hadlock & Pierce (2010). (ψ) indicates the inclusion of a set of fixed effects. *p <0.10, ** p <0.05, *** p <0.01. Standard errors are in parentheses. Source: Authors' calculations.

Table 2.8: Unconditional QTEs: Financial constraints and firm productivity

	(1) Q0.10 b/se	(2) Q0.25 b/se	(3) Q0.50 b/se	(4) Q0.75 b/se	(5) Q0.90 b/se
$FC_{i,s,t}$	-0.050**	-0.013*	0.010	0.190**	0.331*
	(0.034)	(0.050)	(0.098)	(0.102)	(0.003)
No. obs	8,463	8,463	8,463	8,463	8,463

Notes: *p <0.10, ** p <0.05, *** p <0.01. Standard errors are in parentheses.
Source: Authors' calculations.

Unconditional quantile treatment effects

Given the interest in the effect of financial constraints on different levels of the productivity distribution, economic analysis may challenge the heterogeneous impacts that control variables exert on the distributional effects. In response to such concern, I apply the unconditional quantile treatment effects (QTEs) that characterise firm heterogeneous features between financially constrained and unconstrained firms in the context of quantile estimates.[29]

I start by matching firms with rather similar control variables. Recall that I base on a given set of control variables representing different features of firms in the sample: firm age; firm size; introduction of new product or new technology; export behaviour; whether firms are subsided, market-concentrated or part of business association. These control variables may be confounded if financially constrained and unconstrained firms share no or quite few features in common (Abadie et al. 2004, Campello et al. 2010). In order to reconcile the comparisons between such firms, the matching technique is applied. The basic idea behind the matching technique application is simple: I match firms with arbitrarily similar control variables other than the financially constrained setting. Accordingly, there are two comparison groups of the interest: a treated group represents financially constrained firms, and the other is called a control group with otherwise unconstrained firms. The potential outcomes (i.e. productivity) of the former and the counterfactual outcomes of the latter are then based on estimated probabilities of whether firms are financially constrained.

As the financial constraint ($FC_{i,s,t}$) is an endogenous variable, the probability estimation involves two steps in practice: (i) estimating a local logit for the IV that accounts for $FC_{i,s,t}$ to obtain instrumental propensity scores using "locreg" command in Stata, and (ii) estimating other local logit regressions based on these propensity scores and corresponding weights for with each regression for either financially constrained and unconstrained firms. Note that in the second step, the weights are measured by: $W_i^F M = \frac{Z_i - Pr(Z=1|X_i)}{(Pr(Z=1|X_i)1-Pr(Z=1|X_i)}(2FC_i - 1)$ with $Pr(Z=1|X_i)$ presenting instrumental propensity scores.[30]

[29] I rather pay attention to quantile estimates other than the linearity terms and means effects of productivity levels which often implement average treatment effects method.

[30] A restriction in Frolich & Melly (2013) is that they do not allow the presence of several IVs or nonbinary IVs in QTEs but a binary variable. I therefore combine and transform the IVs ($Debtfail, Sellasset, Tradecredit$), one of which is a nonbinary IV ($Tradecredit$), to a binary one (Z_{FC}) – See Frolich & Melly (2008) for details of the transformation.

I continue with using the unconditional quantile treatment effects (QTEs) proposed by Frolich & Melly (2013).[31] Also, the unconditional effects, as opposed to the conditional effects, on any of the given control variables, along with the endogenous financial constraints ($FC_{i,s,t}$) as the treatment variable, give rather a different expression in terms of quantiles.[32] More specifically, the unconditional 0.90 quantile in the analysis refers to firms with the highest productivity levels regardless of, say, age or size groups that they belong to. The 0.90 quantile conditional on these factors (i.e. firm age and size), however, refers to firms with the highest productivity within certain groups of these factors, and therefore might not include those with the highest productivity overall or in different dimensions. I report the estimation of unconditional QTEs in Table 2.8. The results are supportive of quantile regression estimates throughout the analysis: Financial constraints promote productivity of firms at higher quantiles, but impede productivity of those at lower quantiles. Particularly, the effects of financial constraints on productivity is positive above the 0.75 quantile and negative below it. Also, I found no statistically significant effect of financial constraint on productivity of firms at the 0.5 quantile. Additionally, the magnitude of the effect is stronger for firms with productivity levels closer to either tail of the productivity distribution. This robustness test of QTEs confirms that the effect of financial constraints on productivity do not remain similar in magnitude but in sign to the main estimation results. A possible explanation is mostly due to the transformed IV other than several original IVs of the interest.

2.7 Conclusion

In this study, I advance the perceived understanding of the extent to which a firm's financial constraints impact its productivity. The perceived understanding is often shaped by two strands of literature over the mean effects: financial constraints impede the firm's productivity due to the lower investments in productivity-enhancing activities; such constraints also impel productivity by accumulating higher internally generated funds. These two strands, although contradict with each other, occur conditionally on firm heterogeneity. Based on such understanding, I investigate the implied relation at the different points of productivity distribution for firms in Vietnam. I do that by extending the work by Ferrando & Ruggieri (2018) who introduce a composite measure of financial constraints, by controlling endogeneity problem arising in the implied relation and by applying quantile regressions to account for unobserved heterogeneity across the full productivity distribution for a rich firm-level dataset of firms in Vietnam over the period 2005-2013.

The estimation results show robust evidence of significant differences in productivity between financially constrained and unconstrained firms in two following respects. First, financial constraints that are binding to firms are negatively associated with productivity of firms at lower quantiles, but not for those at upper quantiles. A plausible reason is a considerable reliance on external resources to finance productivity-promoting investments

[31] An early version of this paper is Frolich & Melly (2008).

[32] Due to the focus on the binary and endogenous treatment variable, estimates of unconditional QTEs are preferable to other QTEs methods: conditional QTEs for exogenous treatment variables by Koenker & Bassett (1978) or for endogenous variable by Abadie et al. (2002); unconditional QTEs for exogenous treatment variables by Melly (2006), (n.d.), Frolich (2007).

of low productivity firms. Consistently with this reason, I also find the stronger negative effects at lower quantiles, suggesting that performers at these quantiles are attributable to financial constraints to the degree that increases with low productivity performance. Second, I make a further step in analysing the role of internal resources in mediating the implied finance-productivity relation. I find strong evidence of keeping retentions in increasing productivity when the firm is financially constrained. Such positive effect appears stronger for firms at higher quantiles where internal funds are more generated probably owing to higher productivity performance. I add further validity to the estimation by applying quantile treatment effects to compare financially constrained and unconstrained firms with similar control variables. The analysis might also have some extensions in several directions. For instance, it is worth investigating the distributional effects on productivity in each industry in order to obtain homogenous subsamples in terms of financial patterns and productivity.

This study is as markedly important as a starting point for the design of policy initiatives towards factors that impede access to external financing. First, identifying firms at lower quantiles of productivity distribution through a means of financial instruments is conducive to reduce the weight of the bottom tail of productivity distribution, thereby serving the ultimate goal of impelling the productivity of Vietnam to converge to that of neighbouring countries. Second, incentives to access credit suggest the financial market be efficient and well-functioning to accommodate increases in credit demand from firms under financial constraints for financing their investment activities. One incentive could be to provide favourable financial conditions; another incentive could be government financial schemes that aim to support certain productivity-enhancing activities that firms engage in. These incentives to external finance have the potential to deliver benefits to the economic development aroused from the productivity-enhancing projects being financed.

Appendix

2.A Definition and expectation of variables

In this part, I explore how a variety of firm observable characteristics affect productivity with three main sets of following aspects. First, theoretical models and empirical evidence of firm productivity growth dynamics have intensively focused on size and age effects, which have been postulated by many scholars. As to the size effects, Jovanovic (1982) points to the nuanced understanding of "learning" process among firms, shedding light on different aspects of growth dynamics – including productivity – in response to this process.[33] Such process is briefly explained as follows: when entering the market, a firm yields a certain level of productivity (and thereby has information about its productivity in levels); its relative productivity with all other firms is yet to be known until the firm acknowledges its profits; more productive firms "learn" that if growth, they have more chance of higher dynamics, while smaller counterparts who inflict productivity persistence over time might eventually choose to exit from the market. One therefore can conclude the positive relationship between firm productivity dynamics and size effects.

As to the age effects, Jovanovic (1982), Hopenhayn (1992), Sutton (1997) document that a key driver of productivity dynamics is large-scale technology which young firms are less likely, than their incumbents, to employ. Rather, they use common technology which soon becomes obsolete; in order to catch up with higher productivity firms and be more competitive, the transition to the new technology is required, which might take time to accommodate changes in operations. Therefore, these young firms generally have lower productivity than mature firms which might increase their internal capabilities from historical experience. Others, however, show a different view on firm age effects: young firms are not necessarily hindered by liabilities of inertia organisation and obsolescence, thereby having more flexibility in their production ideas. Empirically, positive effect is seen in Huergo & Jaumandreu (2004), Taymaz (2005), Coad et al. (2016).

Second, I turn to other heterogeneity that characterises firms – export and innovation. Exporters are more likely to be more productive than non-exporters, which follows two theoretical premises: self-selection – that is, only productive firms are able to enter export market due to the costs; and learning-by-doing theory – that is, through exporting activities that they engage in, exporters accumulate new knowledge and expertise

[33] The concept of productivity plays an important role in understanding growth dynamics (Coad et al. 2016).

Table A2.1: Variable definition

Variable	Variable definition
$lnTFP$	Total factor productivity in logs
$Output$	Total production output in logs
K	Total physical capital in logs
L	Number of labour in logs
M	Costs of intermediate materials in logs
FC	Financial constraint index following Ferrando & Ruggieri (2018)
$Size$	Number of labour in logs
Age	Firm age (Years since establishment) in logs
$NewProd$	=1 if the firm developes a new product
$NewTech$	=1 if the firm applies new technology
$Association$	=1 if the firm participates in business association
$Competition$	=1 if the firm is self-reported to face competition
$GovSupport$	=1 if the firm receives government support
$Export$	=1 if the firm exports
$Sellasset$	=1 if the firm sells any land, buildings or (used) equipment
$Tradecredit$	Current outstanding balance owed to all suppliers (Million VND)
$Debtfail$	=1 if the firm fails to service its debt on time

Notes: Values that are expressed in real terms exclude inflation effects for corresponding years; inflation rates were collected from www.gso.gov.vn.

from their international counterparts, thereby enhancing the productivity (Biesebroeck 2005, Bernard & Jensen 1999). Innovators are also likely to be more productive than non-innovators. Hall et al. (2010), Coad et al. (2014) stress the importance of not only innovation efforts but also successful innovation outputs which are in the form of product and process innovation – that is, invention or implementation of new or significantly improved products or services.

Third, I include in the model variables on business environment within which firms operate – subsidies, business association, and competition. The relation between these factors and the firm's productivity stems from the idea that the firm might underinvest the productivity-enhancing activities and therefore these factors help stimulate its productivity (see more Ayyagari et al. (2011) for empirical evidence regarding market competition, Mateut (2018) for governmental subsidies).

Chapter 3

Leverage and technical efficiency: The role of firm size and formality

Abstract

This chapter explores the relationship between leverage and technical efficiency across firm size and formality status. Using a rich firm-level dataset from the manufacturing sector in Vietnam during the period 2005-2013, I find that smaller firms—regardless of formality status—experienced higher efficiency gains from increased leverage than larger firms. However, the nature of leverage matters with formal and short-term financing playing a crucial role in improving technical efficiency amongst small firms. Further extension of the analysis shows that the way in which firms possess property rights helps shape the leverage-efficiency link across different types of firms. These findings uphold the access to formal finance for smallest firms, including informal firms, as a likely mainstay of efficient resource allocation in the developing economy.

3.1 Introduction

In recent decades small firms have been regarded as important contributors of technical efficiency due to their ability to quicky adjust to changing economic environments (Audretsch 1999). With this view, a central policy objective of governments around the globe has been the improvement of access to external finance to support these firms, which very often suffer from financial constraints. This chapter contributes to the literature by evaluating whether greater access to external finance (i.e. an increase in leverage) leads to efficiency gains in small firms in the same way that it helps larger firms to improve their performance. Previous literature has documented efficiency improvements from higher leverage,[1] but the role of firm's size in the leverage-efficiency link has been largely neglected in the literature.

[1]See Hanousek et al. (2015), Margaritis & Psillaki (2007, 2010), Berger & di Patti (2006).

A common explanation for the positive effects of leverage on firm's efficiency is provided by the agency cost theory that leverage performs a disciplinary function in advancing the firm' efficiency through mitigating agency cost within the firm (Hanousek et al. 2015, Margaritis & Psillaki 2007, 2010, Berger & di Patti 2006). While this explanation is more likely to describe the managerial behavior of large firms, where there is a clear separation between ownership and control, little is known about how firms of different sizes (specially small firms) respond to an increase in leverage. Understanding the role of firm's size in the leverage-efficiency nexus is important as there is evidence that small and large firms have different managerial strategies to adjust their resources in response to higher levels of leverage (Spaliara 2009, 2011, Walker & Petty 1978).

Most existing finance-efficiency studies notably focusing on firms in advanced economies often lack detailed data on small firms.[2] In contrast, I analyse a rich firm-level dataset from Vietnam, of which the provision of micro and SMEs allows me to gain deep insights into the impact of leverage on technical efficiency conditional on firm size.

More importantly, this dataset manifests an ideal opportunity to contextualise the relation between small-firm research and access to finance along the formality dimension: formal and informal firms. This dimension has been largely ignored in the existing leverage-efficiency literature. Yet, a body of work has argued that informal firms have some peculiar managerial advantages that are likely to affect their efficiencies through the way of using financial resources. First, most family or household businesses are owners-managed; hence, the paucity of separation between ownership and some degree of control mitigates agency costs associated with leverage and leads to higher efficiency gains accordingly (Tokman 1978, Belenzon et al. 2016). Second, informal firms are resources-scare relative to formal firms and higher leverage challenges such informal firms to make wiser use of resources (Bennett 2010). Third, larger informal firms may benefit more from leverage than micro or small formal firms since the latter may struggle with more costs: associated costs of formalisation on top of borrowing costs from external finance. Pointing to small-firm research, this addition of formality dimension shows whether a small formal firm and another informal firm of the same size react differently in their managerial adjustments. Understanding how informal firms adjust their production process from increased external finance is of utmost importance for developing countries, with a similar institutional setting with Vietnam, in which a large proportion of firms operate in the informal sector.

The analysis also adds several extensions to gain deeper understanding of different factors affecting the moderating role of firm size on the leverage-efficiency nexus. First, I investigate whether the nature of leverage—financial sources (formal versus informal) and maturity structure (short- versus long-term)—affects this relationship. Relative to informal borrowings from moneylenders, family or friends, formal finance (e.g., bank loans) fulfills a better disciplinary function through enforcement of legal contracts and agreements, which would be more beneficial for efficiencies of small and informal firms. Smaller firms are largely deemed much reliant on short-term financing to overlap and overshadow high

[2] See Hanousek et al. (2015), Margaritis & Psillaki (2010), Sena (2006), Weill (2008) for European firms, Margaritis & Psillaki (2007) for New Zealand firms, Mok et al. (2007) for Chinese firms.

costs of financing (Tokman 1978).[3] Increased short-term financing for these firms helps monitor managers' financial decisions and improve firm efficiency accordingly (Agostino & Trivieri 2019). Second, I investigate the implied relation through several economic activities: possessing property rights, holding cash, and operational location. A small formal firm or an informal one that purchases or inherits property rights or preserves a high amount of cash can signal its likely wise use of external finance in improving efficiency. A location is a proxy for the degree of market competition: operating in urban areas with stronger market competition poses a risk to efficiency gains of micro, small firms.

This chapter makes three main contributions to the finance-efficiency literature. First, I consider the moderating role of firm size in the leverage-efficiency link, which has been widely neglected in existing studies. A related strand of literature has examined the role of firm size in determining the effects of leverage on sales growth (See citeDergyseetal2016 for Chinese firms). The focus of this chapter is on technical efficiency which refers to stochastic and indirect changes in production process, such as managerial decisions and short-run adjustments of production factors to external shocks—to name just a few.[4] Pointing to managerial decisions relates theoretical and empirical explanations to why firm size affects the role of leverage on firm performance. Second, I investigate the role of firm size along with the formality dimension of firms. The availability of information on small firms and formality status from the Vietnamese dataset provides an ideal opportunity to contextualise the relationship between small-firm research, access to finance, and technical efficiency. Third, the analysis adds the role of the nature of leverage—including financial sources and maturity structure—and some economic factors to explicitly paint a more complete and nuanced picture of how these factors shape the leverage-size-efficiency link.

Methodologically, I use the stochastic frontier approach (SFA) with the application of Greene (2005)'s true fixed effects estimations for the panel. This approach have two main advantages: first, it addresses the potential problems of time-invariant inefficiency that fixed or random effects models fail to control, and the unobserved heterogeneity of traditional time-varying inefficiency models (e.g., Battese & Coelli (1995)) by disentangling firm-specific heterogeneity from inefficiency effects; second, it gains common advantage of SFA in incorporating leverage and its conditional effects with size in the inefficiency term, rather than the direct yet dubious measures in the main production function.

There are two key advantages of studying Vietnam. First, the country, since a remarkable market-oriented reform (Doi Moi) in 1986, has progressively undergone radical changes in financial sector through formal banking system. These changes ostensibly facilitated more favourable extension of lending to real sector, particularly smallest firms that are generally subject to restricted access to finance from such formal banking system. Yet,

[3] Short-term financing requires continued returns to creditors to ask for rollover needs and thereby puts higher pressures for managers against their own discretion in financing risky investments (Jeanne 2009, Calomiris & Kahn 1991, Harris & Raviv 1991).

[4] Nishimizu & Page (1982) credibly note the distinction between technical efficiency and total factor productivity (TFP): technical efficiency and technological progress, which refers to technological changes of best practice production frontier, constitute a whole part of TFP. Too often, changes in technical efficiency advance TFP in a higher degree than technological progress, thereby being used interchangeably with TFP in the productivity literature. However, in any circumstances where technological progress is strongly present, changes in technical efficiency cannot be necessarily equated with productivity changes.

the presence of information asymmetries in underdeveloped financial sector has diluted the passage to the market-oriented economy (Anos-Casero & Udomsaph 2009). Second, there is coexistence of formal and informal agents in both real and financial sectors. Vietnamese informal firms, by which a fair share of smallest firms is formed, are highly integrated with formally operating firms in several industries or product markets with extensively mutual links and transactions and deemed competitive with smallest formal firms in access to external finance (Distinguin et al. 2016). Thus, the Vietnamese sample is of practical importance to separately examine each type of firms.

Three caveats are worth highlighting. First, the effects of leverage on technical efficiency decrease with firm size. Higher leverage paves the way for efficiency gains of the smallest firms. Second, the efficiency that these smallest firms, regardless of their formality, gain are largely engineered through formal financial channels and short-term financing. Third, I find that the heterogeneous effects of leverage by firm size vary with legal factors and financial position. It is not property-rights inheritance or informal arrangements but property-rights purchases that are associated with higher efficiency gains for larger informal firms than counterparts in a similar setting of formality and size. Thus, the main policy implication that follow these findings: a concreted push to facilitate provision of formal loans and property-rights for informal firms is likely to give rise to efficiency. Supporting informal firms through financing gives them more chances to legally register as formal businesses. Paying due attention to firm-size differences in the formal and informal sector is a way to facilitate efficient capital allocation from financial markets to real sector.

This chapter is organised as follows. Section 3.2 provies selective literature review, while section 3.3 describes the empirical estimation. Section 3.4 presents dataset collection, descriptive statistics and variables. Section 3.5 discusses estimation results and some robustness tests. In section 3.6, I present concluding remarks.

3.2 Literature review

The role of firm size in the leverage-efficiency link relates this chapter to the extant literature on the agency cost theory and its connection with performance of a firm, regardless of its size. As first pointed out by Jensen & Meckling (1976), leverage can increase or limit associated agency costs, as the case may be, thus affecting the firm's performance (See more Myers (1977), Grossman & Hart (1982), Stulz (1990), Harris & Raviv (1991)). The literature consistently finds that small firms are more vulnerable to imperfect capital markets and subject to a higher degree of information asymmetries than larger counterparts due to their lack of a long-standing record of credit and young age. This provides a compelling explanation for their limited access to external finance or having access with otherwise higher costs of debt (i.e., high interest rates charged) than larger firms which are presumably less constrained.

3.2.1 The role of firm size on finance-efficiency relation

The leverage-efficiency literature suggests that better managerial decisions on the use of external finance are key to comparatively higher efficiency gains. Given differential availability of external finance for small versus large firms, I highlight differences in managerial adjustments of several production factors, which inherently influence efficiency, within these sets of firms. Among the production factors, the focus is on two fundamental inputs—capital expenditures and labour.

In response to a permanent increase in demand, higher leverage perhaps well induces larger (and less constrained) firms to expand their expenditures in capital and/or labour inputs (Spaliara 2009, 2011). This expansion, while offering no guarantee of increased firm performance, incurs some labour-related adjustments costs—for instance, associated costs of hiring and training new employees—at managerial discretions. One therefore could reasonably view such generous managerial adjustments as inefficient behaviour that gives rise to management-related agency costs (Jensen 1986, Sharpe 1994).

In similar circumstances of demand shocks, smaller (and more constrained) firms are likely to dampen their expansion of capital and/or labour factors at all costs. This response is mostly because these firms are tied to the high cost of external financing.[5] However, I posit that smaller firms, although likely financially constrained, have defining characteristics in management to derive higher efficiency from increased leverage in following dimensions.

On the one hand, the small firms are less likely to make further capital expenditures and technological improvements that should be financed up front. That said, these small firms appear to have efficient utilisation of such expenditures through greater tendency to lease fixed assets (e.g., equipment, machinery) rather than a hefty purchase for larger firms (Walker & Petty 1978). Such leveraged leasing, while structurally similar with other types of external financing, is deemed costly due to the presence of agency costs;[6] it is nonetheless valuable to smaller and more financially constrained firms. Indeed, smaller firms reap the benefit of leveraged leasing regarding higher debt capacity—which outweighs the associated agency costs from leasing—than asset purchases from borrowings of an equivalent amount, as well as other financial advantages (e.g., facilitation of financial stability or flexibility) (Eisfeldt & Rampini 2008). This in turn allows the smaller firms to "preserve capital" for additional leeway to finance other valuable investments that serve for efficiency gains (Brealey & Myers 2005).

On the other hand, smaller (and more highly leveraged) firms exhibit less sensitivity to adjust their labour force due perhaps in part to a high level of above-mentioned labour adjustment costs that these firms cannot afford (Sharpe 1994, Benito & Hernando

[5] As these small firms are often deemed financially vulnerable, being highly leveraged gives creditors a warning signal of the risk-shifting potential in case firms are in default and thus, they are charged with high interest payments (i.e., the high cost of external finance)

[6] Leveraged leasing refers to the exchange of fixed assets with regular lease payments; by definition, leased assets, although still owned by external creditors, are for use and under the control of firms. Hence, the separation of ownership and control of leasing gives rise to agency costs (Eisfeldt & Rampini 2008).

2008). Thus, the firms ought to end up using labour more intensively to satisfy their output demand, sustaining efficiency accordingly. An interpretation for a paucity or a lack of labour adjustment costs on the small firms' efficiency is in particularly close ties to Jensen (1986)'s free cash flow theory. Under Jensen's interpretation, the adjustment costs are viewed as a disciplinary tool to discourage managers' risk taking to favour their interests in using working capital for labour, as argued by Sharpe (1994). Interestingly, this view also justifies the relative adjustments of both labour and capital factors and its effects on efficiency through a lack of sensitivity to labour adjustments. In Spaliara (2009, 2011)'s arguments, that higher leverage assures lower capital-to-labour ratios for smaller and more financially constrained firms is explicitly due to the increased volatility of capital expenditures, which in turn leaves almost no labour adjustment costs. Although this might not be a good financial position for this set of firms to attain, it turns out to be a blessing in disguise. These firms ought to weight the benefits of leverage against high costs of external finance due to agency costs; hence, they strengthen necessary motivation to physically discourage their managers to take risk. Such course of action sufficiently eliminates the agency conflicts that otherwise arise from the presence of labour adjustments and promotes efficiency within this set of firms accordingly.

3.2.2 Unbundling the leverage effects and firm size by formality status

To better understand the estimated pattern of leverage by firm size in a broader contextualisation of an institutional setting like Vietnam, I explore a distinct feature which bears a strong resemblance to most developing and emerging economies: the dominance of informal household businesses.

The recent literature on informal firms often cynically views them as an unwelcome imposition for formal institution environment due to their avoidance of registration costs, tax payments and other governmental regulations (La Porta & Shleifer 2014), which fuels speculation over efficiency differences between formal and informal firms. I continue to assess the premises on which the arguments over differential managerial decisions between smaller and larger firms are earlier posited—agency cost theory, capital and labour adjustments—with an additional dimension to illustrate the informality status among firms.

First, agency costs are less likely to incur in informal household firms, where there is a paucity of separation between ownership and some degree of control. Alternatively put, ownership is deemed highly concentrated. One therefore should rule out the possibility of interest conflicts between managers and owners—a primary source of agency costs—within these owners-managed firms. Indeed, they give their owners-cum-managers a full bearing on decisions of using external finance (working capital or free-cash-flows). I can align the agency-cost argument for informal household firms as part of household firms as suggested by Belenzon et al. (2016). Also, the "basic nature of entrepreneurship" within these firms well induces their owners-cum-managers to devote their efforts to efficient managerial behaviour, work hard, and have less insatiable appetite for risky investments (Tokman 1978).

Second, informal firms are resources-scarce relative to formal ones; higher leverage challenges such informal firms to make wiser use of their limited resources—labour and capital expenditures, especially for smaller firms (Tokman 1978). Quantifying such comparison, Bennett (2010) points out that an otherwise formal firms, all else equal, would use twice as much capital and labour to produce same estimated output as were they operated informally, which is quite a striking magnitude. Quality and skilfulness of labour apart, an implication behind is the efficient use of resources among smaller and informal firms from increased leverage.

Third, smaller and larger firms within informal and formal sectors differ in terms of the social ties with which a firm can strengthen to substantially dilute associated costs of formalisation. To emphasize this, McKenzie & Sakho (2010) argue that a very small firm that operates formally may suffer from tax payments and other overly burdensome regulations and thus hardly gains profits and efficiencies. By contrast, larger informal firms can still do so by resorting to their larger customer base that they expand when doing businesses and hence potentially outperform those which, while devoting their resources to being formal, are not able to overcome initial and ongoing costs of formalisation.

Among informal firms, the heterogeneous effects of leverage by firm size is much less pronounced. Amin & Islam (2015) point out that larger informal firms have better access to finance and in turn gain higher productivity, which however casts doubts over their efficiencies in using resources. While unleashing more readily identifiable links to external creditors, such firms may still be associated with high costs of external financing that outweigh its returns. de Mel et al. (2008) share responses of informal Ski Lankan firms to higher leverage that the marginal returns to capital is rather high for smaller and—to a lesser extent—larger informal firms because more wage workers reduce the relevance of financing other investments that are valuable for firm efficiencies. Additionally, one may link smaller informal firms with stronger concentrated ownership that lessens the possibility of conflicts of interests and gives rise to efficiency gains, according to aforementioned counterarguments to the agency cost theory.

Among formal firms, a plausible interpretation for heterogeneity of leverage across firm size follows the arguments discussed above on the agency-costs view, capital and labour adjustments, suggesting that higher leverage is associated with higher efficiency for smaller firms than larger counterparts.

3.2.3 Decomposing leverage into financial resources and maturities

A limited, yet growing, body of research has been devoted to examining the role of external financial sources (both formal and informal) in alleviating firms' financial constraints and affecting efficiencies.[7] For example, Ayyagari et al. (2010) recognise the relative importance of formal external finance, while Degryse et al. (2016), Beck et al. (2015), Allen

[7]Formal finance refers to borrowings from banks or other financial institutions with much reliance on enforcement of legal contracts and agreements. Informal finance, by contrast, refers to otherwise borrowings from moneylenders, family or friends, which, as is often the case, hold no legal obligations but relationship-based financial transactions.

et al. (2005) highlight the importance of informal finance—alongside formal finance—to foster firms' performance.[8] Informal finance performs an essential function, either as a complement to or a substitute for formal finance, especially in developing countries in which financial markets are underdeveloped and informal sector becomes a prominent feature.

In understanding the role of different financing sources, a body of research has focused on examining how the maturity structure of the loan performs a disciplinary function in facilitating access to external finance (Harris & Raviv 1991) and improving firm productivity and growth. A channel through which the maturity structure of the loan can enhance a firm's performance is through monitoring and disciplining mechanisms. First, the use of short-term borrowing fulfils a disciplinary function to a larger extent than longer borrowing maturity. Indeed, short-term borrowing requires continued return to creditors to ask for rollover needs and renegotiations where necessary, thereby putting higher pressures for managers or owners against their own discretion in financing risky investments at the expense of lenders (Jeanne 2009, Calomiris & Kahn 1991, Harris & Raviv 1991). Second, short borrowing maturity—although associated with higher liquidity risks especially when firms are financially distressed—reduces underinvestment problems by refinancing.

In terms of the role of firm size on determining the effects of leverage on efficiencies, smaller firms tend to be much reliant on short-term financing to overlap and overshadow high costs of financing (Tokman 1978).

3.2.4 Exploring the role of legal factors, financial position and operating location

I first investigate the literature on the legal environment. The possession of property rights has long been associated with economic activities and efficient allocation (Grossman & Hart 1986, Coase 1960, Hart 1995). I study two main economic activities associated with property rights: owning and leasing property. First, according to the principal-agent and transaction-costs theories by Grossman & Hart (1986), Coase (1960), Hart (1995), the ways in which owning property rights is linked to efficient resources allocation are manifold. Most commonly, owners of the rights are viewed with residual control rights over the properties, such as decisions to change production lines or process, to modify machinery requirements or assemblies, to extend shifts when needed—to name just a few, and thus possessing property rights benefits a firm's productivity and efficiency. In more recent productivity literature, Besley & Ghatak (2010) view property rights as a means to facilitate financial market transactions for the real sector. Indeed, property rights can enhance borrowing availability for firms by working as pledgeable collaterals for loans, thus enabling

[8]The use of external finance, either from informal or formal financing sources, can enhance a firm's performance through monitoring and disciplining mechanisms (i.e. external finance bears borrowing costs, thereby putting firms under the pressure to increase managerial efforts to service the external borrowings (Grossman & Hart 1983, Jensen & Meckling 1976, Harris & Raviv 1991). Yet disciplinary mechanisms rely on 'hard' information (e.g. interest rate payment and collateral requirement) and 'soft' information (e.g. personal relationships with strong social ties and coercion controls) for formal and informal finance, respectively (Jain 1999, Berger & Udell 1995, Aleem 1990, Udry 1990).

them to sustain productivity and efficiency investments.[9] This is seen in many firms and informal firms are not exceptional. Although legally unregistered, informal firms can have access to formal financial markets by using property rights as collateral for their borrowings (Rand & Torm 2012). Because of high cost of land-rights purchases and associated annual fee payments, Tenev et al. (2003) argue that smallest informal firms are less likely to reap full benefits from the purchases: they may not receive bank loans regardless. Less is however known about the way in which informal firms own property rights, formally and informally, can alter the efficiency gains from increased leverage between small and large informal firms. Although loans with property rights—either way—are likely secured, the possibility of higher efficiencies from leverage for informal firms depends on the way in which the firms own property rights. Second, property leasing, as discussed earlier in Section 2.2, is deemed costly due to the presence of associated agency costs which returns from leased property can hardly outweight (Eisfeldt & Rampini 2008, Brealey & Myers 2005). Among firms, smaller firms are less likely to reap benefits from property leasing due to high costs of capital, while leasing may be to larger firms' benefit. The differences between formal and informal firms are yet to be known.

I next review the relevant literature on financial position and location. A high degree of cash holdings, too often, manifestly signals profitability and credibility of borrowers (i.e., firms); hence, firms in stronger financial position may have easier access to external finance or at lower costs of capital (Guariglia 2008). Smaller firms, which are often known as more financially constrained than larger counterparts, are thus more beneficial from such high cash-holdings. The literature pointing to location in which firms operate has long noted that location is highly associated with market competition or cost-related competitive advantages. The general consensus is that higher competition and a lower share of micro firms are often seen in an urban areas than rural ones (Hansen et al. 2009, Nguyen et al. 2012). Informal firms, all of which form a fair share of micro firms as a whole, may get hurt because of market price disadvantages, especially the smallest informal firms. Small formal firms, however, can still survive and grow owing to government and local authorities' support as benefits from legal business registration.

Drawing on the empirical intuition, I formulate following hypotheses on the leverage-firm size-efficiency:

$Hyp1$: Smaller firms exhibit higher efficiency gains from leverage relative to larger counterparts.

$Hyp2a$: An increase in firm size exhibits higher negative effects on efficiency from leverage for formal firms than for informal firms

$Hyp2b$: Smaller informal (formal) firms gain higher efficiencies from leverage than larger informal (formal) firms.

$Hyp3a$: Smaller firms, irrespective of formality status, gain higher efficiencies from formal—as opposed to informal—finance than larger firms.

[9] That is pledgeability or tangibility of assets, which gives rise to the expected costs of bankruptcy firms may incur and reduces the potential of shifting risk to creditors accordingly.

Hyp3b: Smaller firms, irrespective of formality status, gain higher efficiencies from short-term—as opposed to long-term—finance than larger firms.

Hyp4a: Property-rights formal arragements are associated with higher efficiency from leverage for informal firms, regardless of size, than informal arragements.

Hyp4b: Property leasing enables larger firms, regardless of formality, to gain higher efficiency than those without property leasing.

Hyp4c: Regardless of formality, smaller firms with high cash holdings, are likely to gain higher efficiency from leverage.

Hyp4d: Operating in urban areas poses a risk to smallest informal firms.

3.3 Empirical estimations

The stochastic frontier approach (hereafter SFA), which was pioneered by Aigner et al. (1977) and Meeusen & van den Broeck (1977) and further developed for panel data by Schmidt & Sickles (1984), Battese & Coelli (1995) and Greene (2005), is a widely used econometric technique in the contemporary line of research on production frontiers to estimate the technical inefficiency effects of the production process (See details of the technique in section 3.A of Appendix to Chapter 3)

The estimation approach to investigate the effects of leverage across firm size on efficiency is based on Greene (2005)'s one-stage stochastic frontier model,[10] whereby the production inputs and inefficiency effects can be determined simultaneously in the production function. The production function (Eq.(i) as in section 3.A of Appendix to Chapter 3), therefore, has the simultaneous extension of inefficiency term which is regressed on leverage, firm size and other firm-level controls (Eq.(ii) in Appendix Chapter 3) as part of unobserved heterogeneity of the production function.

To test for $Hyp1$, I start with the baseline estimation in which I facilitate the estimation of the leverage—firmsize—inefficiency effect for the full sample. I first consider the stochastic production frontier model in the translog form for panels of N firms and T time periods:

$$Output_{i,s,t} = \alpha_0 + \sum_j \alpha_j X_{ij,s,t} + \frac{1}{2}\sum_j \alpha_j X^2_{ij,s,t} + \sum_{j,k,k\neq j} \alpha_j X_{ij,s,t} X_{ik,s,t} + v_{i,s,t} - u_{i,s,t} \quad (3.1)$$

[10]The use of true fixed effects estimation method is motivated by two reasons. First, this approach allows me to make assumption that the unobserved heterogeneity (e.g., based on different risk preference of managers or owners, effects in resource allocation of inputs in the production vary differently across firms) is correlated with the explanatory variables and error terms in the model. However, the bias arising from unobserved heterogeneity can be controlled by using the true fixed effects model. In this way, this model outperforms traditional time-varying firm-level inefficiency models (e.g., Battese & Coelli (1995)) that fail to control unobserved heterogeneity. Second, this approach mitigates the major limitation of fixed effects and random effects panel data models which treat inefficiency as time-invariant. Third, empirically, this method facilitates the one-stage estimation, rather than the traditional two-stage procedures proposed by Battese & Coelli (1995) (See Hossain & Karunaratne (2004))

where $Output_{i,s,t}$ denotes the natural log of total production output for firm i in industry s in survey year t ($t \in \{2005, 2007, 2009, 2011, \text{and } 2013\}$), X denotes natural log of a set of production inputs such as capital inputs, labour inputs, and intermediate materials sourced in the production process.[11] $v_{i,s,t}$ is the idiosyncratic error term assumed to follow normal distribution (zero mean, σ_v^2 variance) $v_{i,s,t} \sim i.i.d.N(0, \sigma_v^2)$. $u_{i,s,t}$ is one-sided inefficiency term assumed to follow the half-normal distribution (zero mean, σ_u^2 variance) $u_{i,s,t} \sim i.i.d.N^+(0, \sigma_u^2)$.

Simultaneously, the estimation for technical inefficiency effects ($u_{i,s,t}$) incorporating main variables of interest including leverage, firm size, and the interaction term between these variables, is expressed as follows:

$$u_{i,s,t} = \beta_0 + \beta_1 SIZE_{i,s,t} + \beta_2 LEV_{i,s,t} + \beta_3 LEV_{i,s,t} \times SIZE_{i,s,t} + \beta_4 Z_{i,s,t} + d_{s,t} \quad (3.2)$$

where $u_{i,s,t}$ is the one-sided inefficiency term of firm i in industry s in survey year t.[12] $d_{s,t}$ denotes 3-digit industry- and time-specific fixed effects. Industry fixed effects capture unobserved and time-invariant characteristics of 3-digit industries; the year fixed effects control for aggregate time-varying and economy-wide shocks such as transitional period of WTO access or global financial crisis. SIZE is measured as logs of full-time employees. LEV is the ratio of total debts to total assets (%). Z denotes a vector of controls including years since establishment in logs (AGE); square of firm age (AGE2); percentage share of nonproduction workers (NONPROWKR), skilled workers (SKLL), and professional workers (PROFL) among full-time employees; a dummy of high industry competition (Herfindahl-Hirschman Index (HHI)<0.15) (COMP); dummies of receiving government support in technology (GOV.TECH), loans (LOANS), human resources (GOV.TRAINING); dummies of innovation in existing products (INNO1) or new products (INNO2), a dummy of whether owners/managers finish at least upper secondary school (OWNER.EDU). See section 3.B and Table A3.1 in Appendix to Chapter 3 for detailed definition, measurement of all variables, and justifications for selection of these controls and sign expectation.

To ease the interpretation, the rationale for estimated results of the inefficiency regression (Eq. 3.2) here follows Hanousek et al. (2015)'s inference. Accordingly, a negative (positive) coefficient gauges the movement of the firm closer (farther) to its efficiency frontier and thereby indicates an increase (a decrease) in its efficiency gains. Given a predetermined frontier, a firm becomes more (less) efficient when its distance to the frontier is closer to (further away from) zero. The key coefficient β_3 for the interaction term LEVxSIZE is interpretable as the extent of efficiency changes following a 1 percent rise in leverage when the firm increase its firm size by 1 percent. As I argue, an increase in leverage induces small, and, quite often, financially constrained firms to dampen their ad-

[11] I justify the use of intermediate inputs in addition to two traditional inputs of translog production function in that ignorance of these factors in production function leads to biased estimate of production (Levinsohn & Petrin 2003), especially for the manufacturing sector.

[12] This is, however, not readily comparable to other estimations without the stochastic part. In order to avoid potential misunderstandings between outcome variables from these equations (Eq. 3.1 and 3.2), I refer hereafter the *outcome variable* to inefficiency that is obtained from the inefficiency equation (Eq. 3.2), and use the *dependent variable* for OUTPUT from the production frontier model (Eq. 3.1). I will do further specifications with alternative measures of the *dependent variable* which is OUTPUT, not inefficiency (Results are reported in Table 3.3).

justments of capital and/or labour sourced in the production process, making these firms sustain more efficient resource allocation relative to output demand. Alternatively put, the costs of being large may outweigh the potential benefits of external finance (Benito & Hernando 2008, Spaliara 2009). When testing for $Hyp1$, I therefore expect a positive coefficient for LEVxSIZE in the inefficiency estimation in which the expectation for the LEV coefficient is negative, as many argue that leverage is conducive to efficiency (Hanousek et al. 2015, Margaritis & Psillaki 2010, 2007).

Next, to test for hypotheses $Hyp2a$ and $Hyp2b$, I move to another set of estimations in which I further investigate the efficiency differentials following an increase in leverage between survey subsamples along the formality status. Accordingly, I have two subsamples of formal and informal firms. I proceed two following steps.

In the first step, I pool both sets of firms together in a single regression, testing whether the slope coefficient on the interaction LEVxSIZE is significantly different between these firms. To this end, I introduce an informal firm dummy into SFA estimation and employ the triple interaction of leverage, firm size and these dummies. The SFA estimations start with production frontier model Eq. 3.1 and the inefficiency equation for the entire sample:

$$\begin{aligned} u_{i,s,t} =& \beta_0 + \beta_1 SIZE_{i,s,t} + \beta_2 LEV_{i,s,t} + \beta_3 LEV_{i,s,t} \times SIZE_{i,s,t} + \beta_4 INF.FIRM_{i,s,t} \\ &+ \beta_5 LEV_{i,s,t} \times INF.FIRM_{i,s,t} + \beta_6 SIZE_{i,s,t} \times INF.FIRM_{i,s,t} \\ &+ \beta_7 LEV_{i,s,t} \times SIZE_{i,s,t} \times INF.FIRM_{i,s,t} + \beta_8 Z_{i,s,t} + d_{s,t} \end{aligned} \tag{3.3}$$

where INF.FIRM is a dummy if firms operate informally and zero otherwise. The triple interaction of leverage, firm size and informal firm dummy, LEVxSIZExINF.FIRM, allows me to compare the relative efficiency gains by financial leverage across firm size and then resolve the difference of such gains between two subsamples. The definition of informality closely corresponds to its broad literature by La Porta & Shleifer (2014), Schneider & Enste (2000), Pretes (2002), Khavul et al. (2009). Accordingly, I refer to these firms as a whole set of legally unregistered household businesses that largely do not pay tax. Further pointing to Vietnam in context, I define informal firms as household businesses that hire no more than 10 employees and do not have a tax registration certificate (TRC), which is pursuant to Vietnam's Law of Enterprises.[13]

[13] I classify formal and informal firms as such for following reasons. First, the threshold of 10 employees is pursuant to Vietnam's 2005 Enterprise Law No. 60/2005/QH11 dated November 29, 2005, and thus, hiring above that threshold, a firm should register as an enterprise to legally operate. That said, such threshold varies substantially across countries—e.g., five employees for African countries (Khavul et al. 2009). Second, although business registration or license is often seen as a cement of informality (See OECD et al. (2002) and Demenet et al. (2016), Amin & Islam (2015) for empirical work), it is less convincing for the Vietnamese sample firms. The firms surveyed over the period 2005-2013 undergo a momentous change of tax administration and business registration system around the passage of the Decree 43/2010/ND-CP dated 15 April 2010. Following a previous system, firms acquire a business registration certificate (BRC) as a prerequisite for a TRC. Through the ethnographic fieldwork, Rand & Torm (2012) point out that firms having a BRC does not necessarily have a TRC mostly because of separate procedures which somehow lessen the rigidity of obtaining both certificates. Firms that do so, on the one hand, reap the benefits of operating formally, and on the other hand, head off from tax payments. However, a new system offers a different BRC in which a tax code is embedded and firms do not need to register for a separate TRC. The new tax system mostly affects firms that are surveyed in the last two waves insofar as they are

In this estimation for the hypothesis $Hyp2a$, the key coefficient of interest is β_7 that is associated with the triple interaction term LEVxSIZExINF.FIRM.[14] The triple interaction term LEVxSIZExINF.FIRM is expected to be negative under the rationale: (i) small informal firms, which do not suffer from registration costs, can yield higher efficiencies from leverage and increased firm size; (ii) small formal firms have to compete with large informal firms and struggle to afford ongoing registration costs and therefore may not be able to devote their efforts to efficient managerial behaviour (Belenzon et al. 2016, Tokman 1978). In order to yield proper estimates for triple interaction terms, I also need to consider interaction terms LEVxSIZE and LEVxINF.FIRM. As argued, smaller firms exhibit higher efficiencies gained from leverage than larger firms, so I expect a positive coefficient associated with LEVxSIZE. The coefficient for LEVxINF.FIRM is also expected to be negative, following arguments by Belenzon et al. (2016) and Tokman (1978) that the "basic nature of entrepreneurship" within informal firms well induces their managed-owners to work hard and that an otherwise formal firms, all else equal, would use twice as much capital and labour to produce same estimated output as were they operated informally.

In the second step, to test for the hypothesis $Hyp2b$, I split the whole sample into the categories (i.e., formal versus informal firms) so as to check whether the results of the triple interaction term hold across individual subsamples. In this step, I simply estimate Eq. 3.1 and 3.2 for corresponding subsamples. Key coefficients of interest are those associated with LEVxSIZE in each estimation of subsamples. These coefficients are expected to be positive and statistically significant, indicating that smaller firms, irrespective of formality status, have better efficient management behavior for increased leverage.

Lastly, to test for hypotheses $Hyp3a$ and $Hyp3b$, I add an extra layer of understanding different patterns of external finance by decomposing external finance into different financial resources (formal versus informal) and by maturity structure (short- versus long-term). I therefore estimate Eq. 3.1 for the production frontier model with some changes in inefficiency equations as follows:

$$\begin{aligned} u_{i,s,t} =& \beta_0 + \beta_1 SIZE_{i,s,t} + \beta_2 DECOMPOSE^h_{i,s,t} \\ &+ \beta_3 DECOMPOSE^h_{i,s,t} \times SIZE_{i,s,t} + \beta_4 Z_{i,s,t} + d_{s,t} \end{aligned} \tag{3.4}$$

where DECOMPOSE^h $\in$ {LEV.INF, LEV.F, LEV.ST, LEV.LT}. LEV.F (LEV.INF) is the ratio of total formal (informal) debts to total assets (%); LEV.ST (LEV.LT) is the ratio of total short (long)-term debts to total assets (%). I perform estimations of Eq. 3.1 and 3.4 for the full sample and subsamples based on formality status and industrial variation. In each estimation, the key coefficient is β_3 for the interaction terms between different types of external finance and firm size. Particularly, when testing for $Hyp3a$, the key coefficients

either newly established or subject to change in their previous registration documents. Thus, to classify household businesses that operate in the untaxed sector, I use the TRC or tax code to capture the full extent of changes in the tax system in Vietnam, which is consistent with Rand & Torm (2012) for a Vietnamese sample, and McKenzie & Sakho (2010), Fajnzylber et al. (2009) for other country samples. I use the alternative classification by the BRC for the robustness checks.

[14]The estimation with the triple interaction term helps keep sample size and degrees of freedom as many as possible instead of running separate regressions for formal and informal firms, and technically tests whether the efficiencies gained through increased leverage and firm size differ between formal and informal firms.

for LEV.FxSIZE are expected to be positive and statistically significant for estimations for formal and informal firms, while coefficients associated with LEV.INFxSIZE are expected to be insignificant. For *Hyp3b*, coefficients for LEV.STxSIZE are expected to be positive and statistically significant, while the ones for LEV.LTxSIZE are not significant. These expectations are motivated from a large body of literature on the nature of leverage that increased formal finance and short-term financing shapes more efficient financial markets through monitoring and disciplinary tools over projects being financed (Agostino & Trivieri 2019).

3.4 Data and descriptive statistics

3.4.1 Data collection

I use Vietnam SME surveys as introduced in the last chapter (See section 2.3 in Chapter 2 for data collection). Attracting widespread coverage of firms belonging to 5 types of non-state ownership (household, private, collective, limited liability and joint stock firms) across waves, the surveys give available information on household businesses, or more broadly, informal sector to which this chapter pays particular attention.[15] This information is regarded as a distinct advantage of these surveys and not many country-level datasets on developing economies offer broad coverage to such extent. See Appendix Table A3.3 for the structure of unbalanced dataset.

The surveys also give data on a range of general characteristics including but not limited to establishment year, employment, industrial classification, owners' or managers' characteristics and business environment—with their heart going to a set of questionnaires on access to external finance and production structure. Another particular advantage of these surveys is the presence of financial patterns at the firm-level in a broader sense. Not only I have information about whether firms have access to finance and the total amount of financing, but the surveys also allow me to boil down to the financial resources (formal versus informal) and their maturities (long- versus short-term), which, as argued in Section 3.2, perform disciplinary function to efficiency in a varying degree. Measures and definition of variables of interests are detailed in Table A3.1 in Appendix. For reasons of implementations, only firm-year observations present in at least 2 waves without any missing values of variables of interests after imputation are included. I winsorise 1% top and bottom of financial leverage and real turnovers (but not production output) since these observations are often regarded as the least and most financially constrained firms, respectively, and thereby might reduce the efficacy of financial access of relevance to majority of firms within the sample. I, however, still drop outliers of the production output

[15] That said, the samples fairly represent the Vietnamese informal sector as the whole. The main reason is that, as noted by the data providers, the surveyed samples are not proportional to the whole sample of Vietnamese firms but representative samples drawn from GSO business census information which is reportedly as part of the whole (GSO 2008). Additionally, according to Rand & Torm (2012), potential on-site selection bias might arise if the enumerator selects the number of informal or formal firms disproportionate to their scale in the de facto sample, leading to underestimated sample of informal segment as argued by the authors.

in a robustness check.[16]

3.4.2 Descriptive statistics

Table 3.1 summarises basic descriptive statistics for the analysis sample. Throughout the surveyed period 2005-2013, the average Vietnamese manufacturer generates 11.65 million VND (in 2004-prices) worth of output (8.30 in logs) and hires 12 employees (2.08 in logs), although the sample is largely dominated by firms with as few as 6 employees (See the median of Size(level)). The key explanatory variable LEV is measured as the ratio of total debts over total assets (in market value). The Vietnamese sample firms have average leverage of 8.44%. The ratio is unsurprisingly less than that of advanced countries with presumably developed financial markets and better access to external finance for firms; nonetheless, it shares similar patterns with private firms in transition economies.[17]

I further decompose this leverage ratio into financing from different financial resources and by maturities to capture the full extent of the leverage's impact. Vietnamese firms in the sample has higher degree of average leverage from formal resources than from informal resources (4.98 versus 3.45), indicating that that the firms use more formal—than informal—debt to finance their assets. Similarly, there is clear evidence of more preferable use of short-term—than long-term—debts for the average Vietnamese sample manufacturer, albeit a bit less than those of advanced economies.[18] The median firm has zero leverage ratios along debt from different financial resources and by different maturities, yet it has nonzero leverage from total debt (LEV). These values reflect that a majority of Vietnamese sample manufacturers lack access to either formal or informal financial resources. Intriguingly, these resources are used alternatively by some sample firms,[19] as are short- and long-term debts. These statistics are supportive of weak and not significant correlations between formal and informal financial resources, and also short- and long-term financing as shown in Panel B of Table 3.1. Panel B also reports the correlations across these dimensions: long-term loans could come from formal and, to a lesser extent, informal financial resources; short-term financing is highly likely from either financing system.

In all regressions, I also add a full set of controls as listed above. The average Vietnamese sample firm ages 18 years old; the non-production worker share is a third of its

[16] Follows are details of sample selection. The original dataset after data cleaning process has a totalling number of over 13,000 firm-year observations. As I aim to investigate only manufacturing sector, around 4,200 observations are dropped. Outliers of financial factors including financial leverage and turnover account for another 300 observations dropped. Another large observation drop (1,800 observations) is for missing controls of interest. The method stochastic frontier analysis does not consider 2,000 observations for some reason, leaving the final sample of 4,868 firm-year observations studied.

[17] See Campello & Larrain (2015), Hanousek et al. (2015), Coricelli et al. (2012) for European countries (10% to 20% for mean values of leverage); Margaritis & Psillaki (2007) for New Zealand (22%).

[18] See, for instance, Agostino & Trivieri (2019) for Italian manufacturers, although they refer to bank debt only.

[19] Indeed, half of sample firms are reported with access to either financial resource, of which over two thirds rely only on informal debt (not reported). As pointed out by Rand (2007), informal debt is not necessarily more costly than formal resources, thus being widely used by Vietnamese manufacturers. I, however, shall not further consider usage of financial resources as alternatives or complements to each other and will defer doing so in another analysis.

Table 3.1: Descriptive Statistics: All firms

Panel A: Descriptive Statistics

Variable	Mean	Std. Dev.	Min	Median	Max
Output (Level)	11,650.54	25,365.97	149.00	3,651.72	315,298.66
OUTPUT	8.30	1.39	5.00	8.20	12.66
Size (Level)	12.04	23.19	1.00	6.00	500.00
SIZE	2.08	0.85	0.69	1.95	6.22
LEV	8.44	14.70	0.00	1.32	99.24
LEV.F	4.98	11.62	0.00	0.00	97.30
LEV.INF	3.45	8.91	0.00	0.00	95.24
LEV.ST	5.22	11.32	0.00	0.00	96.27
LEV.LT	3.20	9.87	0.00	0.00	97.30
Controls					
Age (Level)	18.74	12.96	2.00	16.00	83.00
AGE	2.71	0.69	0.69	2.77	4.42
NONPROWKR	33.42	22.52	0.00	30.00	100.00
SKLL	78.65	24.20	0.00	85.71	100.00
PROFL	2.43	6.01	0.00	0.00	80.00
COMP	0.56	0.50	0.00	1.00	1.00
GOV.TECH	0.01	0.09	0.00	0.00	1.00
GOV.LOANS	0.13	0.34	0.00	0.00	1.00
GOV.TRAINING	0.02	0.13	0.00	0.00	1.00
OWNER.EDU	0.58	0.49	0.00	1.00	1.00
OWNER.EXP1	0.03	0.18	0.00	0.00	1.00
OWNER.EXP2	0.12	0.32	0.00	0.00	1.00
INNO1	0.48	0.50	0.00	0.00	1.00
INNO2	0.12	0.33	0.00	0.00	1.00
N	*4,868*				

Panel B: Correlation matrix between leverage and associated dimensions

	LEV	LEV.F	LEV.INF	LEV.ST	LEV.LT
LEV	1				
LEV.F	0.7947***	1			
LEV.INF	0.6116***	0.0074	1		
LEV.ST	0.7406***	0.5555***	0.4979***	1	
LEV.LT	0.6381***	0.5466***	0.3402***	-0.0434	1

Notes: (***), (**) and (*) denotes statistical significance at Bonferroni-adjusted levels of 0.01, 0.05 and 0.1, respectively. Correlation matrix of firm output, leverage and firm-level controls is reported in Table A3.2 Appendix A. Source: Authors' calculations

Table 3.2: Descriptive statistics: By formality (Only means reported)

Variable	Formal firms			Informal firms	Diff. Formal-Informal
	All	of which labour>10	of which labour≤10		
Output (Level)	16,793.054	32548.10	6,077.91	2,275.393	14,517.661***
OUTPUT	8.861	9.77	8.24	7.224	1.637***
Size (level)	16.527	32.57	5.61	3.749	12.778***
SIZE	2.389	3.24	1.81	1.468	0.921***
LEV	9.068	12.91	6.46	6.795	2.273***
LEV.F	7.567	10.22	5.50	6.583	0.984*
LEV.INF	5.227	6.62	4.14	4.631	0.597
LEV.ST	5.658	7.84	4.17	4.167	1.491***
LEV.LT	4.797	6.60	3.39	4.333	0.464
No. obs	3,083	1,248	1,835	1,473	

Source: Authors' calculations.

full-time employees; most employees are skilled workers with a meagre proportion (2 percent) be professional workers.[20] Regarding business environment, these firms face weak competition with the HHI having an average of 0.56 and a median of 1. On average, 13 percent of sample firms receive government loans, while other types of government support in human training and technology are underrepresented. A majority of firms have their owners or managers finish upper secondary school and higher, although the percentages of owners or managers who previously owned other businesses or worked in manufacturing industries are rather low. Nearly half of sample firms improve their existing product, while they are less likely to develop a new product.

Table 3.2 adds more details on different groups of firms along their formality dimension. The share of informal firms in the sample is a third of the sample manufacturers and in roughly equal proportion to that of formal firms with same firm size ($\leq$10 employees).[21] Between these two firm groups, an average informal firm produces half as much as and hires slightly fewer employees than a 10-employee-and-fewer firm in formal segment, nonetheless, having higher leverage ratios across all dimensions—even in the formal financing patterns which appear to favor formal firms. Surprising as it might seem, the reasons are manifold: informal firms may have more demand for external finance; they can also secure formal loans by, for instance, pledging their certificates of land use rights as collateral, pointing to Vietnam in context (Rand & Torm 2012); there is evidence of positive correlation between the financially constrained settings that formal firms are put into and their high performance as conjectured by Rand (2007), Rand & Torm (2012). For formal firm groups, an average firm that hires more than 10 employees has higher values of leverage and associated dimensions than the remaining firm with up to 10 employees, which may suggest that access to finance seems to increase proportionately to the increase of firm size.

3.5 Empirical results

3.5.1 Baseline estimation

Table 3.3 presents the heterogeneous effects of financial leverage across firm size on technical efficiency from parametric (Columns 1 to 7) and nonparametric (Columns 8 and 9) estimations. I start first with the parametric estimates which show estimation results of Eq. 3.2 by a different set of controls, using the stochastic frontier estimation method. The main variables of interests are financial leverage (LEV) and its interaction term (LEVx-

[20]The Vietnamese sample shows the strong presence of incumbents relative to other datasets (e.g., Chen & Guariglia (2013), Pham et al. (2010)). Noticeably, a small number of firms in the sample establish prior to Doi moi reform in 1986 when manufacturing is less favourable than agriculture; thus, they must have started on presumably stagnant production environment. This evidence provides strong inclinations to control for firm age and its square in the (in)efficiency equation.

[21]The quantification a third is not quite as different as expected from the national 2007 Labour Force Survey's official estimate of 42 percent of labour working informally in manufacturing sector (see Cling et al. (2011), Rand & Torm (2012) for more details). Also note here that I refer the Vietnamese informal firms to those that hires 10 employees and fewer; the decomposition of formal firms into groups of different firm size (i.e., number of employees) can only be considered in the comparative statistics framework and neither further explained nor obtained in the estimation results.

SIZE) which captures the heterogeneous effects of financial leverage across firm size.

Regardless of the inclusion of a full set of controls in place, the results show that the positive impact of financial leverage on efficiency is attenuated by the increase in firm size (see Columns 1 and 2). To ease the interpretation, the rationale here follows Hanousek et al. (2015)'s inference that a negative (positive) coefficient gauges the movement of the firm closer (farther) to its efficiency frontier and thereby indicates an increase (a decrease) in its efficiency gains. In this way, a strongly negative coefficient for LEV of -0.019 (as in the baseline estimation—Column 2, Table 3.3) indicates that, ceteris paribus, an additional 1 percent increase in leverage is associated with a 0.019 percent efficiency gain for all firms. Yet, such impact of leverage for larger firms appears marginally lower. The estimated coefficient for interaction term LEVxSIZE is 0.006, indicating that an additional 1 percent increase in employment attenuates the 0.019 percent efficiency gain from leverage by 0.006 percent. Alternatively put, a 1 percent increase in leverage for firms that hire, for instance, 2 employees is associated with a 0.6 percent lower efficiency gain (in initial values, not in logs) than for those with a single employee. The effects of LEV and LEVxSIZE are both statistically significant at 1 percent level.

Table 3.3's following columns redisplay the baseline estimate in alternative specification settings. In Column 3, I winsorise top and bottom 1 percent of the production output values to mitigate concerns over the impacts of outliers. The effect does not substantially deviate from the baseline estimate, confirming that the results are not driven by outliers. In Column 4, I adjust the production output with the weighted averages across 3-digit industries, in which I use average industrial output shares of the country output average as weights. Apparently, access to external finance may not necessarily be subject to firm performance but industries that have heterogeneous aggregate economic shocks. This measure of shocks to industries has been inspired by Bai et al. (2018). Going forward, Column 5 excludes self-employed firms from the sample. As described in Table 3.1, a large majority of the Vietnamese sample firms have 6 employees and fewer, raising the importance of very small firms and entrepreneurs. Should these firms be strongly positively related to the heterogeneous effects of leverage by firm size, excluding them can potentially lead to otherwise unbiased for the leverage effects. The results show the effects of -0.021 and 0.07 are slightly larger than Column 2's baseline estimate yet remain statistically significant at 1 percent.

To better understand the role of firm size heterogeneity on the leverage-efficiency relation, I adopt an alternative classification of firm size and leverage, other than the continuous variables (SIZE and LEV) (Columns 6 and 7). For leverage, I construct a dummy variable LEV_LA which takes the value of 1 if a firm's leverage falls above the sample median and zero otherwise. The results in Column 6 show that higher leverage is much conducive to efficiency gains of small firms, although the its heterogenous effects by firm size is significant at 10 percent. As for firm size, this classification is based on quartiles of the firm size distribution, where I construct three dummy variables: SIZESM2550=1 if the firm size falls within 25th percentile and the median of the distribution at a particular year; SIZESM5075=1 if the firm size is over the median and below the 75th percentile; SIZELA75=1 if the firm size belongs to the highest quartile—above the 75th percentile—

in its yearly sample distribution. When I interact the financial leverage variable with these dummies, the results (Column 7) are not unexpected, showing that the efficiency gain of leverage is highest for the smallest firm size group, which is often known as the most financially constrained firms (Beck et al. 2005, Spaliara 2009, Guariglia 2008). In particular, a 1 percent increase in leverage is associated with a 0.017 percent higher efficiency gain for the firms whose firm size belongs to the lowest quartile—which is the reference category—than remaining firm size distribution. The effect of leverage evidently declines as the firm size moves toward higher quartiles, particularly in the upper-median range of the firm size distribution relative to smaller counterparts.

Table 3.3: Main results: Heterogeneous effects of leverage on technical efficiency by firm size

	Outcome Var: Technical inefficiency							Outcome Var: Technical efficiency	
	No controls	Baseline	Winsorise 1% top & bottom of Dept.Var	Dept.Var – Weighted average by industries	Exclude self-employed firms	Alternative LEV measure	Alternative SIZE measure	Data envelopment analysis (DEA)	Free disposal hull (FDH)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
SIZE	-0.062	0.159**	0.187**	0.742***	0.151**	0.164**		-0.026***	-0.015***
	(0.062)	(0.077)	(0.077)	(0.167)	(0.059)	(0.083)		(0.003)	(0.002)
LEV	-0.024***	-0.019***	-0.019***	-0.054***	-0.021***		-0.017***		0.002***
	(0.006)	(0.006)	(0.007)	(0.013)	(0.006)		(0.004)		(0.000)
LEV×SIZE	0.008***	0.006***	0.007***	0.013***	0.007***				-0.0002**
	(0.002)	(0.002)	(0.002)	(0.005)	(0.002)				(0.000)
LEV_LA						-0.510***			
						(0.187)			
LEV_LA×SIZE						0.137*			
						(0.081)			
LEV×SIZESM2550							0.006		
							(0.006)		
LEV×SIZESM5075							0.023***		
							(0.008)		
LEV×SIZELA75							0.021***		
							(0.005)		
SIZESM2550							0.155		
							(0.117)		
SIZESM5075							0.099		
							(0.136)		
SIZELA75							0.195		
							(0.132)		
NONZERO_LEV								0.023***	
								(0.008)	
NONZERO_LEV×SIZE								-0.017***	
								(0.004)	
Controls									
AGE		-0.495	-0.438	0.916	-0.616*	-0.508	-0.527	-0.015	0.004
		(0.317)	(0.306)	(0.605)	(0.322)	(0.320)	(0.322)	(0.011)	(0.008)
AGE2		0.132**	0.125**	-0.157	0.154***	0.134**	0.136**	0.009***	-0.004**
		(0.059)	(0.057)	(0.124)	(0.059)	(0.059)	(0.059)	(0.002)	(0.002)

(CONTINUED)

(CONTINUED)

	Outcome Var: Technical inefficiency							Outcome Var: Technical efficiency	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
NONPROWKR		0.008***	0.007***	-0.004	0.010***	0.008***	0.008***	-0.000	0.000***
		(0.002)	(0.002)	(0.004)	(0.002)	(0.002)	(0.002)	(0.000)	(0.000)
SKLL		-0.001	-0.001	0.006**	-0.001	-0.001	-0.001	-0.000*	0.000*
		(0.001)	(0.001)	(0.003)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)
PROFL		-0.019***	-0.019***	0.044***	-0.019***	-0.020***	-0.017***	-0.001***	-0.001***
		(0.007)	(0.006)	(0.010)	(0.006)	(0.007)	(0.006)	(0.000)	(0.000)
COMP		0.145*	0.135	-0.306	0.123	0.140	0.131	0.015***	-0.006**
		(0.088)	(0.087)	(0.246)	(0.089)	(0.087)	(0.087)	(0.004)	(0.003)
GOV.TECH		-0.713**	-0.635**	-0.938**	-0.679**	-0.725**	-0.674**	-0.056***	0.028**
		(0.318)	(0.300)	(0.382)	(0.306)	(0.313)	(0.328)	(0.017)	(0.013)
GOV.LOANS		0.013	-0.032	0.381	0.032	0.058	0.039	-0.000	-0.007*
		(0.100)	(0.098)	(0.255)	(0.101)	(0.105)	(0.097)	(0.005)	(0.003)
GOV.TRAINING		0.010	0.029	0.663	0.035	0.003	0.080	0.013	0.001
		(0.235)	(0.244)	(0.582)	(0.236)	(0.233)	(0.239)	(0.011)	(0.008)
INNO1		-0.275***	-0.223***	-0.438***	-0.277***	-0.26***	-0.271***	-0.003	-0.003
		(0.068)	(0.068)	(0.160)	(0.068)	(0.066)	(0.066)	(0.003)	(0.002)
INNO2		-0.057	-0.050	0.177	-0.036	-0.052	-0.030	0.006	-0.009**
		(0.128)	(0.125)	(0.182)	(0.128)	(0.127)	(0.128)	(0.005)	(0.004)
OWNER.EDU		-0.202**	-0.219***	0.078	-0.212**	-0.193**	-0.197**	-0.013***	0.005**
		(0.082)	(0.083)	(0.169)	(0.085)	(0.082)	(0.084)	(0.003)	(0.002)
CONST	-2.242***	-2.989***	-3.172***	0.416	-2.889***	-2.937***	-2.730***	1.300***	0.870***
	(0.568)	(0.657)	(0.625)	(1.028)	(0.649)	(0.659)	(0.644)	(0.025)	(0.018)
3-digit industry, year FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No.obs	4,868	4,868	4,773	4,868	4,675	4,868	4,868	4,868	4,868
Log pseudo-likelihood	2,848.649	2,970.208	3,006.936	-8,514.271	2,887.265	2,975.141	2,974.732	4,303.134	5,733.708
Average Technical efficiency (Std.Dev)	0.860	0.860	0.860	0.434	0.859	0.859	0.859	0.010***	0.006***
or Technical efficiency-Variance (SE)	(0.158)	(0.159)	(0.157)	(0.276)	(0.158)	(0.159)	(0.159)	(0.000)	(0.000)
Wald χ^2	2,949.48	659.82	1,134.64	362.22	796,422.64	601.93	437.65	1,173.31	2,532.51
$(p-value)$	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

Notes: This table presents the heterogeneous effects of financial leverage across firm size on technical efficiency from parametric (Columns 1 to 7) and nonparametric (Columns 8 and 9) estimations. Columns 1 to 7 report the results from inefficiency equation (Eq. 3.2) (The full production frontier regressions of Eq. 3.1 are estimated but not reported) with the *outcome variable* (Outcome Var) technical inefficiency. This Outcome var is a stochastic part of the production frontier estimations, of which the *dependent variable* (Dept. Var) is firms' production output in logs (OUTPUT) (See footnote 12 on how I relate the *outcome* and *dependent variable* terms to the variables). All columns–except column 1–include a full set of controls and 3-digit industry and year fixed effects with columns 3 to 7 reporting alternative tests for the baseline estimate (Column 2). (CONTINUED)

(CONTINUED)

Notes: Interpretation of SFA estimates follow Hanousek et al. (2015)'s inference: a negative (positive) coefficient gauges the movement of the firm closer (farther) to its efficiency frontier and thereby links an increase in the corresponding factor with an increase (a decrease) in the firm's technical efficiency. Average efficiency scores are computed over examined periods (year 2005 to 2013). Nonparametric methods (Columns 8 and 9) report estimates for technical efficiency (Outcome Var.) and its variance. Key variables include SIZE (measured as logs of full-time employees) and LEV (the ratio of total debts to total assets (%)). Controls including years since establishment in logs (AGE); square of firm age (AGE2); percentage share of nonproduction workers (NONPROWKR), skilled workers (SKLL), and professional workers (PROFL) among full-time employees; a dummy of high industry competition (Herfindahl-Hirschman Index (HHI)<0.15) (COMP); dummies of receiving government support in technology (GOV.TECH), loans (LOANS), human resources (GOV.TRAINING); dummies of innovation in existing (INNO1) or new products (INNO2), a dummy of whether owners/managers finish at least upper secondary school (OWNER.EDU). *p <0.10, ** p <0.05, *** p <0.01. Standard errors in parentheses are clustered at the firm level. Source: Authors' calculations.

Of remaining columns in Table 3.3, I apply alternative non-parametric approaches—Data envelopment analysis (DEA) and Free disposal hull (FDH)—which are both commonly used to measure inefficiency from the production frontier.[22] DEA and FDH results are reported in Column 8 and 9 of Table 3.3, respectively. To ease the interpretation, the outcome variable in these estimates is technical efficiency and thus, in contrast with the rationale for SFA estimates; accordingly, a negative (positive) coefficient indicates a decrease (an increase) in efficiency gains. I find robust evidence of heterogeneous effects of leverage by firm size, albeit in rather smaller magnitude than previous estimates. Indeed, the difference in leverage effects between smaller and larger firms appears negligible with a nearly zero interaction term (LEV x SIZE). As argued by Chen et al. (2015) and Johnson & Kuosmanen (2012), DEA approach is less precise than the SFA due perhaps in part to its high correlation between production inputs, outputs and exogeneous factors that are incorporated in the second stage (See details of the techniques in section 3.C of Appendix to Chapter 3).

Broadly, the results in Table 3.3 show robust evidence that smaller firms exhibit higher efficiency gains from increased leverage than larger counterparts, thus providing support for $Hyp1$. Consistent with the management-related agency-costs view (by Jensen & Meckling (1976), among others), the findings prove that smaller (and more financially constrained) firms perceive leverage as a disciplinary function in nudging their managerial decisions toward risk-averse behaviours—to a larger extent than larger firms—and thus sustain higher efficiency gains. As argued, such higher gains are largely driven by two managerial adjustments that are intrinsic to this set of smaller firms. First, they tend to lease their fixed assets, which corroborates the arguments of Eisfeldt & Rampini (2008), Brealey & Myers (2005) in that the smaller firms have ulterior motive of doing so to preserves capital for other investments that give rise to efficiencies. Second, the smaller firms are less sensitive to labour adjustments, thus discouraging managers to make riskier adjustments in labour force and motivating them both to work harder, which is consistent with conjecture by Sharpe (1994) to promote efficiency.

I next move to consider control variables representing for firms' characteristics and

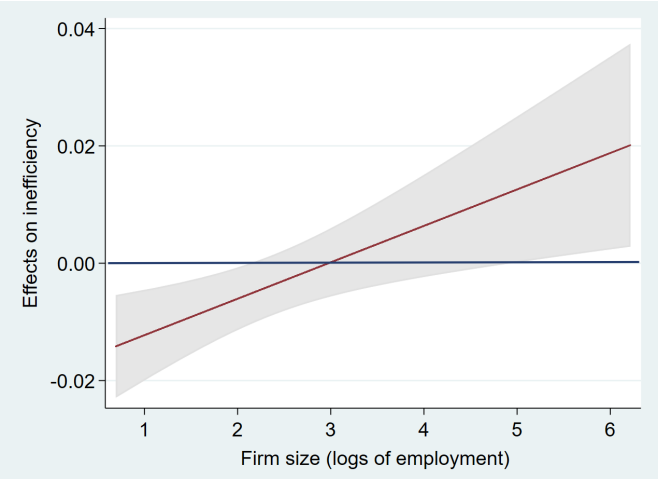
[22] As mentioned earlier, I use these techniques after obtaining functional and distributional assumptions about the production frontier and inefficiency term of the SFA model. Accordingly, DEA and FDH approaches adopt the frontier function in the translog form, the frontier scale of the variable returns-to-scale, and a half-normal distribution for the inefficiency term—See details of these hypothesis tests in Appendix Table A3.4.

the business environment within which they operate. I first start with firm age and its respective quadratic term. Most findings in Table 3.3 indicate a positive impact of firm age on efficiency, yet such effect turns negative and statistically significant regarding the quadratic term. The rationale for the nonlinearity in the effect of age follows a large body of literature (See Burki & Terrell (1998), Coad & Reid (2012), Coad et al. (2016), Daunfeldt et al. (2016) for example) that older firms grow too complacent and are often manifested in strong forces of inertia, outdated technology and machines and kept away from industry frontiers. Given the Vietnamese firms in the sample are rather mature with many informal incumbents, providing better business environment requires older firms improve their performance. Second, for employment characteristics, I find supportive evidence of better quality of workforce in higher efficiency gains in firms in general and manufacturers in particular. Specifically, an additional one percent increase in nonproduction workers among full-time employees (NONPROWKR) is associated with a 0.008 percent increase in efficiency (See Column 2 in Table 3.3). This indicates that efficiency of manufacturers does not rely much on management, but the production process and manufacturing-specific quantify of workforce. However, efficiency gain is found for a higher share of professional workers (PROFL), which is strongly consistent with empirical evidence for Vietnamese manufacturers (e.g., Rand & Torm (2012)). Third, the positive relation between government provision of technology support (GOV.TECH) and efficiency is consistent with Cull et al. (2017), showing that a large resource base of government is conducive to facilitate firms' access to valuable resources. Notably, this effect is rather high: firms that receiving the government support experience 0.713 percent higher efficiency than those without (Column 2 in Table 3.3). This finding gives a strong inclination for government intervention to facilitate better business environment. Fourth, engaging in innovation activities matters for efficiency gains. In particular, firms that improve existing products (INNO1) have 0.275 percent efficiency higher than those without (Column 2 in Table 3.3), which is in line with the literature (See Huergo & Jaumandreu (2004), Cohen & Klepper (1996), Parisi et al. (2006). Lastly, I find a positive relation between education of firms' owners or managers (OWNER.EDU) and efficiency. Firms that are owned or managed by owners/managers finishing at least upper secondary school are associated with higher efficiency gains than those with less-educated owners. This result is in line with the literature that well-educated owners are less prone to principle-agent problems and have stronger management behavior, which often translates into higher efficiency (La Porta & Shleifer 2014, Alvarez & Crespi 2003).

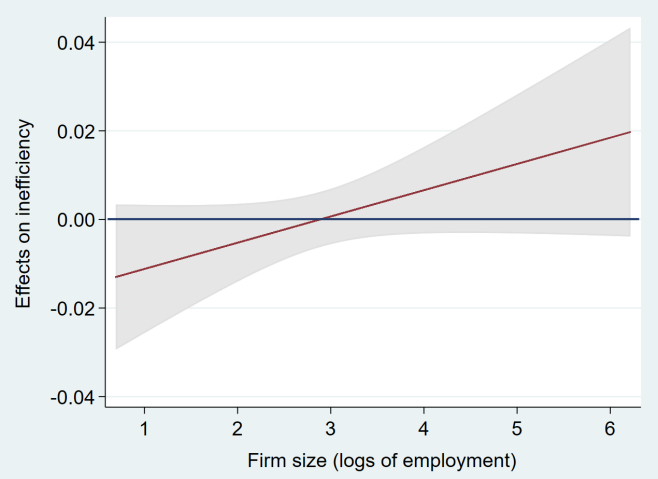
To better understand the heterogeneity of leverage across the entire size range in which firms are distributed, I plot the marginal effects of leverage at each point of firm-size distribution (measured as logs of employment) in the first graph of Figure 3.1.[23] The effects are obtained from the baseline estimate reported in Column 2 of Table 3.3. As predicted, I find a discernible pattern of heterogeneous effects of leverage between smaller and larger firms. Particularly, I observe a significantly positive effect on efficiencies for the former set of firms, and a sign reversal for the latter set, of which only the largest firms (i.e.,

[23]The marginal effects, whereby partial derivatives of the key variable LEV, conditional on SIZE, in technical inefficiency equation (See Eq. 3.2), are derived by: $\frac{\partial u}{\partial LEV} = \hat{\beta}_{2LEV} + \hat{\beta}_{3LEV\times SIZE} \times SIZE$ and the corresponding standard errors are $\hat{\sigma}_{\frac{\partial u}{\partial LEV}} = \sqrt{Var(\hat{\beta}_{2LEV}) + SIZE^2 \times Var(\hat{\beta}_{3LEV\times SIZE}) + 2 \times SIZE \times Cov(\hat{\beta}_{2LEV}, \hat{\beta}_{3LEV\times SIZE})}$ with u denotes technical inefficiency as in Eq. 3.2.

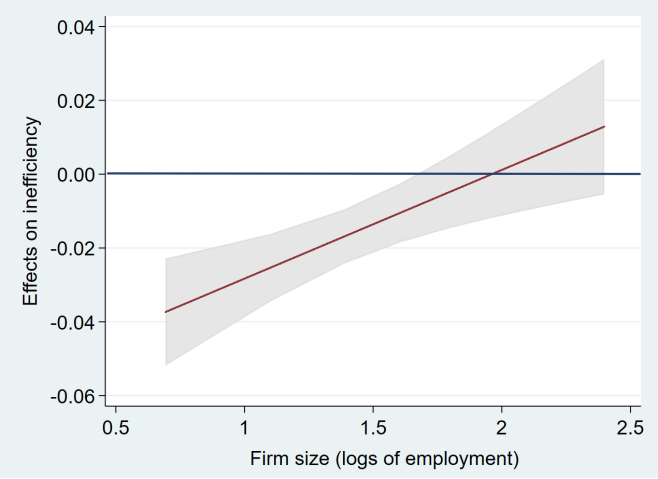
Figure 3.1: Marginal effects of leverage on inefficiencies across firm size distribution for full sample and subsamples by formality



(a) Panel A: All firms



(b) Panel B: Formal firms



(c) Panel C: Informal firms

Notes: The graphs report stochastic frontier (parametric) estimates of the heterogeneous effects of leverage across firm size (captured on the horizontal axis) on inefficiencies of full- and split-sample firms by formality status. The estimates are based on nonlinear predictions with shaded areas presenting 95 percent confidence intervals. Source: Authors' calculations.

those in the far-right tail of firm-size distribution) exhibit statistically significant negative impacts.[24] The pattern suggests that higher leverage is most beneficial for smallest firms in the sample, although such effects appear comparatively decreasing when firms get larger.

3.5.2 Formality status

Table 3.4 analyses the relative efficiency gains in response to increases in leverage across firm size and formality status. Accordingly, I have two subsamples of formal and informal firms and proceed following steps. First, I pool both sets of firms together in a single regression, testing whether the slope coefficient on the interaction LEVxSIZE is significantly different between these firms. To this end, I employ the triple interaction of leverage, firm size and informal firm dummy—LEVxSIZExINF.FIRM. The triple interaction allows me to compare the relative efficiency gains by financial leverage across firm size and then resolve the difference of such gains between two subsamples. Second, I split the whole sample into the categories so as to check whether the results of triple interaction term hold across individual subsamples. I also report an alternative classification of informality (by business registration certificate) in Appendix Table A3.5.

Column 1 represents the full baseline sample and Columns 2 and 3 for subsamples of informal and formal firms, respectively. A negative and statistically insignificant triple interaction term LEVxSIZExINF.FIRM in Column 1 confirms that an additional increase in leverage leads to negligible efficiency differentials between formal and informal firms, given a similar doubling of employees from one to two. The strongly statistically significant coefficients for LEV and LEVxSIZE of -0.024 and 0.008, respectively, hint that labour costs matter for leveraged firms regardless of their formality status, not supporting $Hyp2a$. The results hold to some extent when I split the sample into (in)formality settings (Columns 2 and 3).

Statistically significant estimates for both leverage and its associated interaction in Column 2 confirm that the interpretation of heterogeneity of leverage across firm size is convincingly inclusive for informality status. These estimates suggest that informal firms benefit from leverage at the expense of labour costs and hence, larger informal firms reap lower efficiency gains from leverage than smaller informal counterparts. This is somehow supportive of the informality view that informal firms should nudge their scarce resources toward valuable investments (Bennett 2010, Tokman 1978) to overcome liabilities from debt financing; however, substituting low skilled workers for other capital investments does not seem to be a good move to sustain efficiency for these firms (Amaral & Quintin 2006). As for formal firms, the corresponding estimates for informal firms are relatively

[24] Although leverage clearly exhibits positive (negative) effects on efficiencies with the red line shown below (above) the zero line in first graph of Figure 3.1—See Hanousek et al. (2015) for interpretation of estimates on (in)efficiencies, the significance of such effects turns rampant at some points of the firm-size distribution. Indeed, the marginal effects of leverage at firm-size values in range of approx. 2 and 5, where the zero line is bounded within the relative confidence intervals, are not statistically significant. This pattern remains robust at alternative, for instance, 90 and 99 percent, confidence intervals with subtle differences in magnitude, and could possibly be a reason for lack of regression convergence for firm-size median-split subsamples.

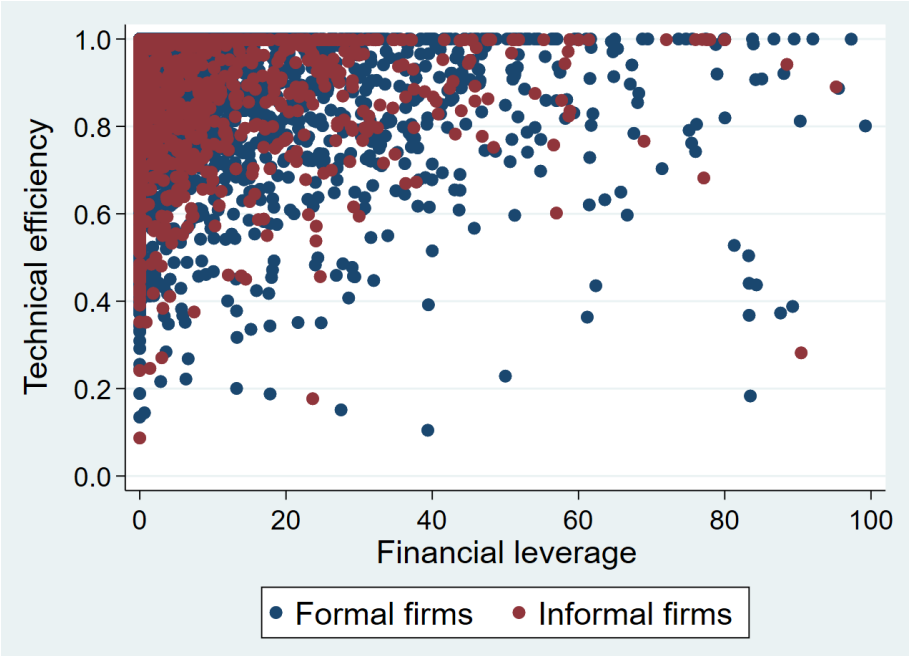
Table 3.4: Heterogeneous effects of leverage on technical efficiency by firm size: by formality

Outcome Var: Technical inefficiency	All firms	Informal firms	Formal firms
	(1)	(2)	(3)
SIZE	0.063	0.356*	0.054
	(0.078)	(0.204)	(0.075)
LEV	-0.024**	-0.058***	-0.017
	(0.010)	(0.013)	(0.011)
LEV×SIZE	0.008***	0.029***	0.006*
	(0.003)	(0.009)	(0.004)
LEV×INF.FIRM	0.012		
	(0.014)		
SIZE×INF.FIRM	0.761***		
	(0.183)		
INF.FIRM	-1.281***		
	(0.317)		
LEV×SIZE×INF.FIRM	-0.007		
	(0.008)		
Controls			
AGE	-0.527*	-1.175*	-0.520
	(0.313)	(0.694)	(0.366)
AGE2	0.137**	0.265**	0.107
	(0.058)	(0.121)	(0.067)
NONPROWKR	0.009***	0.005*	0.009***
	(0.002)	(0.003)	(0.002)
SKLL	-0.002	0.001	-0.002
	(0.001)	(0.003)	(0.002)
PROFL	-0.019***	-0.185***	-0.017***
	(0.006)	(0.029)	(0.006)
COMP	0.137	0.129	-0.011
	(0.089)	(0.136)	(0.112)
GOV.TECH	-0.653**	-1.125*	-0.685**
	(0.316)	(0.620)	(0.311)
GOV.LOANS	0.022	-0.088	0.044
	(0.101)	(0.155)	(0.131)
GOV.TRAINING	0.016	0.477	0.070
	(0.243)	(0.443)	(0.235)
INNO1	-0.285***	-0.537***	-0.047
	(0.068)	(0.110)	(0.085)
INNO2	-0.080	0.024	-0.212
	(0.129)	(0.223)	(0.146)
OWNER.EDU	-0.197**	-0.167	-0.254**
	(0.082)	(0.117)	(0.112)
3-digit industry and year FEs	Yes	Yes	Yes
No.obs	4,868	1,473	3,083
Log pseudo-likelihood	2,993.048	1,115.864	2,096.127
Wald χ^2 $(p-value)$	2.01E+10 (0.00)	24,007.92 (0.00)	2,549.10 (0.00)
Average technical efficiency score (Std.Dev)	0.859 (0.159)	0.870 (0.155)	0.865 (0.148)

Notes: This table presents the relative efficiency gains following increases in leverage and firm size for subsamples by formality. I first employ the triple interaction of leverage, firm size and informal firm dummy (INF.FIRM) for the full sample, and then split into individual subsamples. Columns 1 reports the inefficiency estimations (Eq. 3.3). The remaining columns correspond to baseline estimations of Eq. 3.2) for corresponding subsamples. The outcome variable (Outcome Var) is technical inefficiency. SIZE is measured as logs of full-time employees. LEV is the ratio of total debts to total assets (%). See notes of Table 3.3 and Appendix A3.1 for definition and further details of these main variables and a full set of controls, and a guidance for interpretation of estimation results. Wald χ^2 tests the joint significance of all explanatory variables. In all estimations, constants are included but not reported. *p <0.10, ** p <0.05, *** p <0.01. Standard errors in parentheses are clustered at the firm level. Source: Authors' calculations.

Figure 3.2: Average efficiency scores between formal and informal firms.

(a) Panel A



(b) Panel B

Notes: These figures scatterplots average efficiency scores between formal and informal firms against leverage (in percentiles) and their firm size (in logs) over the period 2005-2013. Source: Authors' calculations.

smaller in magnitude (Column 3). Particularly, the effect of leverage (LEV) on inefficiency for all firms in this subsample is negative and insignificant ($p-value$=0.108), which however turns significant at 1 percent level for an alternative informality classification (See Table A3.5 in Appendix), while the interaction term LEVxSIZE is positive and significant, albeit only at 1 percent level. Thus, firms operating small and formally gain slightly higher efficiencies than larger formal counterparts. The latter set of firms, although having incentives to achieve higher efficiency from economies of scale and higher profits, typically incur economically large monitoring costs and heavy loss of efficiency from rigid management in adjusting capital and labour properly (e.g., Hanousek et al. (2015), Diaz & Sanchez (2008), Margaritis & Psillaki (2010)), which rules out such direct economic incentives of higher efficiency. Taken together, the findings in Columns 2 and 3 support $Hyp2b$.

The second and third graphs of Figure 3.1 plot marginal effects of leverage for the subsamples of formal and informal firms, respectively. These graphs appear to closely resemble the leverage-efficiency pattern for full-sample firms (as in first graph thereof) with positive (negative) effects of leverage for smaller (larger) firms within each subsample, although informal firms are reported with a relatively narrower firm size range than that of formal firms.[25] Particularly, the effects of leverage on efficiencies for formal firms are still size specific yet strongly insignificant (See the second graph of Figure 3.1). The last graph shows that small informal firms, however, exhibit robustly strong positive effects of leverage relative to larger firms in a similar informal setting, which is highly supportive of aforementioned arguments over redundancy of informal workers, less concentrated ownership and degree of control.

To gain a better visual comparison of efficiency scores between formal and informal firms, I scatterplot average efficiency scores obtained in Columns 2 and 3 of Table 3.4 against two key variables of interest—firm size and leverage—in Panel A and B of Figure 3.2, respectively. Note that the movement of a firm' efficiency scores (reported in vertical axes) closer to 1, in which its efficiency frontier lies, shows its efficiency gains. Visually, from Panel A in Figure 3.2, I may rule out the possibility that larger informal firms are systematically associated with higher efficiencies. However, larger formal firms are likely associated with lower efficiency gains than smaller counterparts that operate formally, which is self-evident with a high density of smaller formal firms being distributed closer to the efficiency-frontier line. Panel B of Figure 3.2, using leverage in percentiles, shows that highly leveraged firms, regardless of their formality, appear to somewhat disproportionally benefit efficiencies from such external finance. Additionally, although some zero-leverage firms, perhaps smallest firms, again both formal and informal, are quite inefficient, others—in similar financial position–make very movement to their efficiency frontiers. I again find no systematic relationship between leverage and efficiencies for both formal- and informal-firm subsamples.

Table 3.5: Decomposition into financial resources and maturities

Outcome Var: Technical inefficiency			
Panel A: Decomposition into formal and informal financial resources			
	All firms	Informal firms	Formal firms
	(1)	(2)	(3)
SIZE	0.098	0.425*	0.067
	(0.064)	(0.219)	(0.090)
LEV.F	-0.023***	-0.059***	-0.032***
	(0.007)	(0.014)	(0.012)
LEV.F×SIZE	0.008**	0.031***	0.011***
	(0.003)	(0.009)	(0.004)
LEV.INF	-0.021**	-0.031*	0.015
	(0.010)	(0.016)	(0.019)
LEV.INF×SIZE	0.006	0.009	-0.005
	(0.005)	(0.012)	(0.007)
Full controls	Yes	Yes	Yes
FEs	Yes	Yes	Yes
No.obs	4,868	1,473	3,083
Log pseudo-likelihood	2828.164	1,134.657	2,101.423
Wald χ^2	29,583.35	5.16E+06	4,150.00
$(p-value)$	(0.00)	(0.00)	(0.00)
Panel B: Decomposition into short- and long-term maturity structure			
SIZE	0.166***	0.408**	0.060
	(0.059)	(0.196)	(0.092)
LEV.ST	-0.028***	-0.064***	-0.035**
	(0.007)	(0.013)	(0.014)
LEV.ST×SIZE	0.010***	0.035***	0.012**
	(0.003)	(0.009)	(0.005)
LEV.LT	-0.007	-0.006	0.009
	(0.008)	(0.019)	(0.015)
LEV.LT× SIZE	0.002	-0.011	-0.003
	(0.003)	(0.014)	(0.005)
Full controls	Yes	Yes	Yes
FEs	Yes	Yes	Yes
No.obs	4,868	1,473	3,083
Log pseudo-likelihood	2,970.599	1,140.719	2,102.124
Wald χ^2	2.27E+08	2.28E+06	6,900.62
$(p-value)$	(0.00)	(0.00)	(0.00)

Notes: This table reports the heterogeneous effects of leverage across firm size when I decompose external finance into financial resources (Panel A) and by maturity structure (Panel B). Panels A and B report SFA estimations from Eq. 3.4, respectively, with each showing the implied effects for full sample (Column 1), and subsamples of informal (Column 2) and formal firms (Column 3). The *outcome variable* (Outcome Var) is technical inefficiency. SIZE is measured as logs of full-time employees. LEV.F (LEV.INF) is the ratio of total formal (informal) debts to total assets (%). LEV.ST (LEV.LT) is the ratio of total short (long)-term debts to total assets (%). Wald χ^2 tests the joint significance of all explanatory variables. In all estimations, I include constants, a full set of controls, 3-digit industry and year fixed effects, although not reporting for brevity. *p <0.10, ** p <0.05, *** p <0.01. Standard errors in parentheses are clustered at the firm level. Source: Authors' calculations.

3.5.3 Decomposition into different financial resources and maturities

As argued in Section 3.2.3, different financial resources and maturity structure of external financing perform monitoring function in varying degree of intensity, I extend the analysis one step further by assessing the extent of the heterogeneous leverage effects across firm size between these financial patterns. Results are reported in Table 3.5 for full sample and subsamples based on formality status.

Panel A of Table 3.5 shows the relative importance of leverage along the formal versus informal financial resources across heterogeneous firms. Estimates in Column 1 indicate that formal finance performs a stronger monitoring function for small Vietnamese firms than for larger counterparts, while heterogeneous firms benefit uniformly from informal financial resources. As can be seen in Column 1, a 0.023 percent efficiency gain following a 1 percent rise in leverage from formal financing is, however, attenuated by 0.008 percent when the firm increases its firm size by 1 percent. Additionally, a 1 percent rise in leverage from informal financial resources increase efficiency by 0.021 percent, regardless of their same size. The findings—pointing to efficiency—explore rather a different aspect of financial resources in comparison with other firm performance measures: sales growth (e.g., Degryse et al. (2016), Ayyagari et al. (2010), Beck et al. (2015)); productivity (e.g., Ayyagari et al. (2010)).[26] Thus, large Vietnamese firms might have to forgo other performance objectives so as to sustain their efficiency when they seek for financing from formal versus informal financial resources.

Such financial patterns hold to some extent when I further consider the firm's formality status. Column 2 shows that informal firms, irrespective of firm size, are beneficial from both formal and informal financial resources, and more likely, larger informal firms sustain less efficiency from formal finance than smaller informal counterparts. Estimates for this subsample remain quite similar in sign and statistical significance with Column 1, albeit slightly larger in magnitude. Two speculative explanations may arise from the results. First, costs of remaining informal and large for large informal firms may temporarily outweigh potential benefits of formal finance, whereas these costs are less comparable with benefits of informal finance. Second, in order to have access to formal finance, informal firms have to pledge their land user right certificates, rather than other physical assets, as collateral rather than against other assets; thus, a strict regulation of pledged collateral for informal firms serves to strengthen the monitoring function of formal finance for smaller firms than larger counterparts (Walker & Petty 1978, Rand & Torm 2012).

The impacts of financial resources faced by formal firms, however, are rather different. According to Column 3, an increase in informal finance has no notable effect on efficiency of these formal firms, while there are heterogeneous effects of formal finance across firm size, which is further supportive of a stronger monitoring function that formal finance serves for smaller formal firms. Overall, results in Panel A support $Hyp3a$.

[25] See horizontal-axis ranges of second and third graphs of Figure 3.1; corresponding estimates are obtained from Column 2 and 3 of Table 3.4, respectively.

[26] See, for instance, Degryse et al. (2016) who, by contrast, find the negative effects of informal finance on sales growth for large Chinese firms.

Panel B highlights the relative effects of leverage across firm size along maturity structure aspect. Column 1 of Panel B show strong statistically significant estimates for LEV.ST and the interaction term LEV.STxSIZE, while estimates for LEV.LT and LEV.LTxSIZE are not statistically significant. The results clearly suggest that short-term financing holds a stronger monitoring advantage over long-term financing for Vietnamese firms, although being larger dilutes the explanatory power of short-term financing. These effects along short- versus long-term borrowing hold irrespective of firms' formality status (Columns 2 and 3). Overall, in most columns, I find a stronger monitoring advantage of short-term over long-term financing, which is supportive of *Hyp3b* and consistent with a large share of literature on firm performance (e.g., Jeanne (2009), Calomiris & Kahn (1991), Harris & Raviv (1991), Stulz (1990)), and more recent efficiency research (e.g., Agostino & Trivieri (2019)).

3.5.4 Additional economic factors

I extend the comparison analysis between formal and informal firms in Table 3.4 by assessing whether relative efficiency gains are deemed as intrinsic to some economic factors that may account for managerial differences between these sets of firms. For instance, firms that possess property rights, hold high levels of cash or operate in less competitive markets can manage to devote their scare resources intensely to guard benefits of increased leverage and labour. I take following form for the inefficiency equation:

$$\begin{aligned} u_{i,s,t} =& \beta_0 + \beta_1 SIZE_{i,s,t} + \beta_2 LEV_{i,s,t} + \beta_3 LEV_{i,s,t} \times SIZE_{i,s,t} \\ &+ \beta_4 TYPE^m_{i,s,t} + \beta_5 LEV_{i,s,t} \times TYPE^m_{i,s,t} + \beta_6 SIZE_{i,s,t} \times TYPE^m_{i,s,t} \\ &+ \beta_7 LEV_{i,s,t} \times SIZE_{i,s,t} \times TYPE^m_{i,s,t} + \beta_8 Z_{i,s,t} + d_{s,t} \end{aligned} \tag{3.5}$$

where $u_{i,s,t}$ is the one-sided inefficiency term. TYPE^m $\in$ {CLUR_1, CLUR_2 and CLUR_3, LEASELAND, CASH_MED, HANOI}. The key variables of interest, triple interaction terms LEV×SIZE×TYPE^m, allow me to examine if small versus large firms having those factors react to increased leverage differently.[27] The results in Table 3.6, while largely showing no systematic evidence of leverage by firm size, display heterogeneous interaction effects with individual factors for the subsamples of formal and informal firms.

First, columns 1 to 4 focus on the possession of property rights with TYPE^m dummies being taken from responses of the survey question *Is the land housing the main production facility of the enterprise owned or rented?*; its responses are coded as follows: *Enterprise owner has a Certificate of Land Use Rights (CLUR) which was purchased (1);*

[27] The key motivation for inclusion of the triple interaction terms is to record whether smaller firms having such individual economic factors have more or less efficiency gained from leverage than those without. It is better to look at the leverage-efficiency link throughout the firm size distribution in Figure 3.1 and hypothetically consider a smallest firm at the far-left tail of the distribution with and without an economic factor. For example, a smallest informal firm without formal purchases of property rights is unlikely to have access to formal loans. In contrast, a similarly smallest informal firm with these formal arrangements can have formal financing at favourable financial terms possibly by pledging such arrangements as collaterals and therefore the firm can devote its resources to other business opportunities while maintaining efficiency gains from leverage. Although this example might not hold true for firms at different size levels throughout the firm size distribution, a key point here is for smallest firms at the far-left tail of the firm size distribution.

Enterprise owner has a CLUR which was inherited (2); Enterprise owner has an informal arrangement to use the land (3); Rented/Leased (4).[28] Accordingly, the CLUR dummies (CLUR_1, CLUR_2 and CLUR_3) are taken from the first three responses with each being respectively targeted at firms that possess, formally inherit and informally use CLUR; LEASELAND corresponds to the last response.

I direct the understanding toward informal firms with formal arrangements of property rights through purchases (Column 1) and inheritance (Column 2) and informal arrangements (Column 3). A negative and significant coefficient of the triple interaction term LEV×SIZE×CLUR_1 (Column 1) on the inefficiency variable shows that, for larger informal firms, a CLUR-owning firm benefits a 0.046 percent higher efficiency gain from a hypothetical 1 percent increase in leverage than those of the same firm size yet without CLUR-purchases. However, when extending arrangements of property rights to inheritance and informal arrangements, I cannot track such benefits of property rights associated with leverage and firm size, which is reported with insignificant triple interaction terms LEV×SIZE×CLUR_2 (Column 2) and LEV×SIZE×CLUR_3 (Column 3). The findings support *Hyp*4*a* and suggest that although loans with property rights are likely secured, the possibility of higher efficiencies from leverage for informal firms depends on the way in which the firms own property rights and in this

[28]Source: https://www.wider.unu.edu/

Table 3.6: Heterogeneous effects of leverage on technical efficiency by firm size and economic factors: Formal versus informal firms

Outcome Var: Technical inefficiency									
	Informal firms			Informal firms	Formal firms	Informal firms	Formal firms	Informal firms	Formal firms
	TYPE[1]: CLUR_1	TYPE[2]: CLUR_2	TYPE[3]: CLUR_3	TYPE[4]: LEASELAND		TYPE[5]: CASH_MED		TYPE[6]: HANOI	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
LEV	-0.061***	-0.165*	-0.045***	-0.055***	-0.030***	-0.061***	-0.034***	-0.053***	-0.019*
	(0.013)	(0.095)	(0.017)	(0.015)	(0.011)	(0.016)	(0.011)	(0.015)	(0.011)
LEV×SIZE	0.033***	0.090***	0.017	0.028***	0.011***	0.031***	0.011***	0.026***	0.007*
	(0.009)	(0.034)	(0.011)	(0.010)	(0.004)	(0.011)	(0.004)	(0.010)	(0.004)
LEV×SIZE×TYPE^m	-0.046*	0.051	0.019	-0.002	-0.013**	0.004	-0.017***	0.719***	-0.007
	(0.025)	(0.072)	(0.016)	(0.023)	(0.006)	(0.018)	(0.006)	(0.200)	(0.009)
SIZE	0.394	0.456	0.412*	0.348	0.056	0.695**	0.205	0.423*	0.094
	(0.267)	(0.666)	(0.223)	(0.223)	(0.099)	(0.273)	(0.127)	(0.218)	(0.094)
TYPE^m	-0.126	-0.293	0.090	-1.794**	-0.490	0.390	-0.021	1.308	0.639
	(0.440)	(6.554)	(0.589)	(0.787)	(0.453)	(0.446)	(0.374)	(2.371)	(0.577)
SIZE×TYPE^m	0.057	-0.481	-0.031	0.873*	0.095	-0.582*	-0.118	-0.486	-0.317
	(0.313)	(2.013)	(0.410)	(0.491)	(0.163)	(0.304)	(0.148)	(1.467)	(0.213)
LEV×TYPE^m	0.062*	-0.056	-0.016	0.009	0.035**	-0.008	0.051***	-1.378***	0.010
	(0.036)	(0.202)	(0.023)	(0.037)	(0.017)	(0.029)	(0.019)	(0.385)	(0.028)
Full controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No.obs	1,473	1,473	1,473	1,473	3,083	1,473	3,083	1,473	3,082
Log pseudo-likelihood	1,134.425	723.077	1,127.794	1,136.745	2,112.012	1,114.868	2,124.422	1,146.379	2,116.356
Wald χ^2	3.48E+06	7657.33	17868.00	1.00E+06	13,246.87	54,932.00	5,896.98	9.68E+06	4,630.39
$(p-value)$	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

Notes: This table reports the heterogeneous effects of leverage by firm size and a range of economic factors (TYPE^m), including Certificate of Land Use Rights (CLUR) through own purchases (CLUR_1), inheritance (CLUR_2) and informal arrangements (CLUR_3); leasing land (LEASELAND); high cash-holdings (over the subsample median) (CASH_MED) and operating location Hanoi (HANOI). The *outcome variable* (Outcome Var) is technical inefficiency. SIZE is measured as logs of full-time employees. LEV is the ratio of total debts to total assets (%). Wald χ^2 tests the joint significance of all explanatory variables. In all estimations, I include constants, a full set of controls, 3-digit industry and year fixed effects, although not reporting for brevity. *p <0.10, ** p <0.05, *** p <0.01. Standard errors in parentheses are clustered at the firm level. Source: Authors' calculations.

case, CLUR-purchases are most beneficial for Vietnamese informal firms. Because of high cost of land-rights purchases and associated annual fee payments, smallest informal firms are less likely to reap full benefits from the purchases: they may not receive bank loans regardless (Tenev et al. 2003). Such costs make large informal firms not uniformly react to higher leverage; indeed, the firms that can afford to purchase the land rights and devote their scare resources intensely ought to attain high efficiency. This is partly in line with the general finding that property rights are associated with greater financial inclusion of informal firms (Rand & Torm 2012); however, a disciplinary function that property rights perform on efficiencies varies and seems strongest for CLUR-purchasing owners as opposed to other forms of possession, which is analogous to the principle-agent problem (Jensen & Meckling 1976, Myers 1977, Grossman & Hart 1982). An intuitive interpretation is a complementarity between being larger—which gives rise to management-related agency costs associated with labour adjustments—and possession of property rights as collateral for loans—which raises expected costs of bankruptcy for firms and reduces the potential of shifting risks to creditors and thus, lowers agency costs. I also report additional tests for large informal firms—of which firm size falls over the sample median—in Appendix Table A3.6. I find that increased leverage for these firms with property-rights legal purchases are associated with the reduction of inefficiencies or efficiency gains (Columns 1 and 4, Table A3.6). However, the informal use of property rights seems to attentuate the positive effects of higher leverage on technical efficiencies (Columns 3 and 6, Table A3.6).

I also attempt to understand whether property leasing affects the leverage-efficiency link for informal and formal firms with results reported in columns 4 and 5 of Table 3.6, respectively. Triple interaction coefficients of interest LEV×SIZE×LEASELAND show that property leasing enables formal firms at a certain size level to preserve capital to finance other valuable investments that serve for efficiency gains from increased leverage (Column 5) (Brealey & Myers 2005). Informal firms, however, do not seem to reap such benefits from property leasing, which perhaps hardly outweigh associated agency costs (Column 4). This finding partially supports *Hyp4b* which holds for formal firms and does not hold for informal firms. Pointing to Vietnam in context, Tenev et al. (2003) emphasise that land-leasing arrangements—which are, too often, made with state or non-state enterprises or with other informal firms—suffer (1) a high degree of administrative sanctions with a long process and (2) a marked decline in capital (due to leasing rents) and labour resources, and thereby pose a real risk to efficiencies of the smallest firms.

Second, columns 6 and 7 show the role of cash holdings in the leverage-firm size-efficiency relation through the triple interaction coefficients LEV×SIZE×CASH_MED. Formal firms with a high level of cash holdings gain higher efficiencies from increased leverage than those of the same firm size yet with otherwise lower cash holdings (Column 6), which supports the view that high cash-holdings signal external creditors about the firm's profitability and thus easier access to external finance or at lower costs of capital (Guariglia 2008). I, however, do not find similar pattern for informal firms. Therefore, this finding partially supports *Hyp4c* which does not hold for informal firms.

Third, in remaining columns, I further point to the role of location in which firms, especially informal ones, operate. Location has long been noted to be highly associated with market competition or cost-related competitive advantages. Intriguingly, the Vietnamese

sample shows that there are efficiency differences between formal and informal firms that operate in and outside the capital Hanoi. Informal firms operating in Hanoi become less efficient than informal counterparts elsewhere given a similar increase in leverage and firm size (Column 8); by contrast, operating in Hanoi does not alter heterogeneous effects of leverage by firm size for formal firms, some of which perhaps benefit from other supports from government or local authorities (Column 9). This finding is supportive of $Hyp4d$ and consistent with the general consensus that higher competition and a lower share of micro firms, by which a fair share of informal firms are formed, in an urban city Hanoi than rural areas (Hansen et al. 2009, Nguyen et al. 2012).

3.6 Conclusion

Overall, by pointing to firm size, the analysis conjectures the importance of upholding access to external finance among smaller and more financially constrained firms. Enriching a more contextualised understanding through lenses of (in)formality settings within real and financial sectors helps gauge a desired outcome of a likely mainstay for efficient resource allocation of the developing country. Particularly, I find that Vietnamese smaller firms robustly derive higher efficiencies from an additional increase in leverage than larger counterparts, in supportive of the Jensen & Meckling (1976)'s fundamental agency cost theories whereby leverage widely manifests itself as a strong disciplinary device in the finance-efficiency literature—to a certain extent. Smaller firms within informal sector exhibit stronger positive impacts of leverage than corresponding larger firms, while such heterogeneous effects of leverage are less pronounced for firms operating formally. The evidence highly supports the view that a paucity of separation between ownership and some degree of control, which is largely seen in smaller informal firms, gives owners-cum-managers of these owners-managed firms a full bearing on decisions of using external finance, fewer conflicts of interests, and thus more benefits in firm performance. For larger firms, some economic factors matter with varying degrees upon their formality: property-rights purchases—as opposed to inheritance or informal arrangements—are associated with higher efficiencies of larger informal firms than those without such purchases; property leasing and cash holdings benefit larger formal firms. In addition, I find the heterogeneous effects of leverage by firm size are largely engineered through formal financial channels and short-term financing, as opposed to informal and long-term financing, to varing degrees within formal versus informal firms. The finding regarding financial maturities is perhaps largely due to the prioritisation of short- over long-term financing to overlap and overshadow high cost of external financing for smaller firms.

These findings have important policy implications. First, a concreted push to facilitate provision of formal loans and property-rights for informal firms is likely to give rise to efficiency. A key point here is not to enlarge the size of informal sector within the economy, and neither has it been to make benefits of nonregistration (e.g., access to official services such as formal loans or property rights on land) outweigh costs of nonregistration. Rather, policymakers shall support the informal firms to the degree where they consider transition into formal sector. This is because the registration decisions often boil down to benefits and costs of registration versus costs of nonregistration. Informal firms that have not become

formal at start-up could struggle to afford registration costs and need financial demand to maintain efficiency and productivity before making a crucial decision of registration. Second, paying due attention to firm-size differences in the formal and informal sector is a way to facilitate efficient capital allocation from financial markets to real sector. There are differences in managerial adjustments following an increase in formal finance with smaller firms exhibiting less sensitivity to adjust production costs, which suggests credit supply be more available to the smaller firms to accommodate more efficient capital allocation within the real sector. Third, policymakers should provide better business environment with stronger enforcement to favour formality by reducing the demand from informal financial markets. Informal finance fails to perform a disciplinary function for investment activities being financed, resulting in lower social values of such activities and welfare consequences. However, in countries where the cost of capital from informal finance is not as high as that from formal finance, possibly micro-credit schemes could help small firms that used to heavily rely on informal finance to satisfy credit demand.

Appendix

3.A Stochastic frontier approach

The stochastic frontier approach (hereafter SFA), which was pioneered by Aigner et al. (1977) and Meeusen & van den Broeck (1977) and further developed for panel data by Schmidt & Sickles (1984), Battese & Coelli (1995) and Greene (2005), is a widely used econometric technique in the contemporary line of research on production frontiers to estimate the technical inefficiency effects of the production process. The technique has several unique features that can be appropriately applied in our analysis. First, it allows for hypothesis testing which is not applicable in non-parametric approach. Second, the SFA estimates a set of exogenous factors of production process by accommodating these factors into inefficiency effects, ruling out the least squares estimation of average (Coelli et al. 1998, Bhaumik et al. 2012).

The SFA starts with the production function as follows: $y^*_{i,s,t} = f(x_{i,s,t};\alpha)$. Given x production inputs, an individual firm i in sector s at time t is able to produce the maximum output level $y^*_{i,s,t}$. However, due to the inefficiency effects in the production process, the production function is modified to $y_{i,s,t} = f(x_{i,s,t};\alpha).exp(-u_{i,s,t})$ with $exp(-u_{i,s,t})$ presents one-sided (i.e., non-negative) technical efficiency term (TE). The estimated TE is written as the ratio between observed output and frontier output $exp(-u_{i,s,t}) = \frac{y_{i,s,t}}{y^*_{i,s,t}}$. As the observed output ($y_{i,s,t}$) is bounded below the frontier output ($y^*_{i,s,t}$), $0 < TE \leq 1$ where $TE = 1$ if a firm is fully efficient and able to make use of its resource allocation. A set of values that TE takes other than one indicate inefficiency effects in the production. Such inefficiency, as presented as X-inefficiency in Leibenstein (1966), is from the environment within which the production is operated, making a firm unable to attain its desired production frontier which is unobserved (Battese & Coelli 1995, Battese & Broca 1997). The modified production function is then transformed with natural logarithm:

$$lny_{i,s,t} = \alpha_0 + \sum \alpha_{i,s,t} lnx_{i,s,t} + v_{i,s,t} - u_{i,s,t} \qquad (i)$$

where $v_{i,s,t}$ is the two-sided noise term presenting the measurement error of the production and following normal distribution $v_{i,s,t} \sim i.i.d.N(0,\sigma^2_v)$. $u_{i,s,t}$ presents one-sided technical inefficiency term following half-normal distribution $u_{i,s,t} \sim i.i.d.N^+(0,\sigma^2_u)$. Based on distribution assumptions, technical efficiency (TE) are obtained after taking the maximum likelihood function for parameter estimates.[29]

[29] A drawback of the maximum likelihood function in SFA is that the lack of convergence may arise for

To take into account of changes in technical efficiency and unobserved heterogeneity across firms, we accommodate a set of factors ($w_{i,s,t}$) into the function of variance of inefficiency:

$$u_{i,s,t} = f(w_{i,s,t}; \beta) \qquad (ii)$$

with the application of true fixed effects approach for our panel as suggested by Greene (2005). The use of true fixed effects estimation method is motivated by two reasons. First, this approach allows us to make assumption that the unobserved heterogeneity (e.g., based on different risk preference of managers or owners, effects in resource allocation of inputs in the production vary differently across firms) is correlated with the explanatory variables and error terms in the model. However, the bias arising from unobserved heterogeneity can be controlled by using the true fixed effects model. In this way, this model outperforms traditional time-varying firm-level inefficiency models (e.g., Battese & Coelli (1995)) that fail to control unobserved heterogeneity. Second, this approach mitigates the major limitation of fixed effects and random effects panel data models which treat inefficiency as time-invariant. Third, empirically, this method facilitates the one-stage estimation, rather than the traditional two-stage procedures proposed by Battese & Coelli (1995) (See Hossain & Karunaratne (2004)).

3.B Definition and expectation of variables

First, firm size (SIZE) is measured by the logarithm of number of employees as suggested by Rand & Torm (2012) and Gorodnichenko & Schnitzer (2010) among others. The effects of firm size on efficiency are rather mixed. On the face of it, larger firms may have incentives to achieve economies of scale from product diversification and technological advances, and thus earn higher profits, which are then transferred into higher efficiency (e.g., Margaritis & Psillaki (2007), Oczkowski & Sharma (2005), Tybout (2000), Alvarez & Crespi (2003)). That said, these firms typically incur economically large monitoring costs and heavy loss of efficiency from rigid management in adjusting capital and labour properly (e.g., Hanousek et al. (2015), Diaz & Sanchez (2008), Margaritis & Psillaki (2010)), which rules out such direct economic incentives of higher efficiency from profit earnings.

Second, firm age (AGE), which is measured as natural logs of years in operation since establishment, has a general finding that older firms grow too complacent and are often manifested in strong forces of inertia. Burki & Terrell (1998), for instance, depict these incumbent firms with overly outdated technology and machines, while younger firms adopt latest technology and rise to the frontier efficiency. Yet, while getting older, they are on a stronger competitive position within their established industries than new entrants regarding the learning-by-doing experience from which scale efficiency is derived. This view on nonlinearities in the effect of age on efficiency is far less pronounced than on other firm performance measures (e.g., firm growth (Evans 1987)); the similar rationale is, however, still applicable and thus, we include the square of firm age (AGE2) in the efficiency equation.

our estimations under the iterative procedure, especially when we run a small sample subset with poorly fitting observations.

Third, we include several employment characteristics to control the general quality and manufacturing-specific quantity of workforce. We start with NONPROWKR which captures the percentages of nonproduction workers among full-time employees. As one of essential elements of manufacture is otherwise production workers, which may not hold true for other sectors, NONPROWKR is expected to be associated with lower efficiency gains. Next, to account for quality of workforce which potentially determines the control system and production outcomes given certain inputs, we use information on shares of skilled (SKLL) and professional (PROFL) workers among full-time employees (e.g., Rand & Torm (2012)).[30]

Fourth, we control for owners' or managers' characteristics among which their educational level is often characterised as a likely driver of efficiency, especially for small or informal firms. Indeed, well-educated owners/managers are deemed a strong indicator of employing better educated workers (Rosenbaum et al. 1999) and less prone to the principle-agent problem (Alvarez & Crespi 2003), which is subsequently transferred into increased efficiency. It is often seen in formality literature that skilled and well-educated owners are more likely to have access to formal finance (La Porta & Shleifer 2014). We use a dummy (OWNER.EDU) as to whether owners/managers finish upper secondary school and higher. To further control human capital effects, we use information on owners' experience in manufacturing (OWNER.EXP1) and general business experience (OWNER.EXP2). A general expectation is that firms gain a higher degree of efficiency if they are managed by owners with prior knowledge and expertise required in manufacturing, irrespective of industries (Burki & Terrell 1998), and with experience of business management.

Fifth, we capture the market competitive aspect which has long been characterised as an essential determinant of technical efficiency as posited in a seminal work by Leibenstein (1966). In his arguments, increased market competition is squarely transferred to efficiency gains at the firm level through reduced costs of production inputs, added incentives to adopt new technology; thus, firms facing such competition are far from complacency over the principle-agent problem (See Dilling-Hansen et al. (2003) for empirical evidence). In contrast, others argue that excessive competitive nature can result in lower efficiency for certain firms and industries (e.g., Bailey (1992), Caves & Barton (1990), Green & Mayes (1991), and most recently Hanousek et al. (2015)). Employing Valta (2012)'s competition definition, we define a competition dummy (COMP) that takes the value 1 if the Hefindahl-Hirschman Index (HHI) score at the 3-digit ISIC code industry level is below 1.50.[31]

[30] While being part of skilled workforce, professional workers are viewed as highly skilled ones that hold university and college degrees (e.g., engineers, accountants, technicians). Although Rand & Torm (2012) use these two variables as alternative proxies for labour quality mostly due to dominance of zero PROFL values, we believe that a meagre share of professional workers can make nuanced effects on efficiency gains. La Porta & Shleifer (2014), for instance, point out that a certain form of control system, particularly an accounting system that hardly functions without an accountant professional, is a requirement of formal loans, implying that the accounting system shows how properly and efficiently firms control production inputs and resources. Also, variables PROFL and SKLL have a weak correlation (See Appendix Table A3.2) and deem no severe collinearity; thus both are included.

[31] Note here that, although we exclude firms that appear in one wave for the SFA estimations as these estimations necessitate temporal variations within panels (as mentioned in Section 3.2), we still include these firms for HHI computation regardless. The reason is that HHI is measured as the market share of a firm within the industry to which it belongs at a certain surveyed year; thus, exclusion of these firms

Sixth, I control the impact of innovation on technical efficiency in two different types of innovation activities: improving existing products (INNO1) and introducing new ones (INNO2). The impact of improving existing products on firm performance is often found to be positive (See empirical studies by Parisi et al. (2006) for Italian firms, Huergo & Jaumandreu (2004) for Spanish manufacturers). This is because this type of innovation shifts firm performance through different ways: increased physical capital expenditures (Parisi et al. 2006); higher corresponding R&D spending along with technological change, internal learning capabilities, wide diffusion from first-introducers (Huergo & Jaumandreu 2004, Cohen & Klepper 1996). The relation between introduction of new products and efficiency is rather mixed. On the one hand, firms, especially newly established ones that are binding to constrained managerial and financial resources, become manifestly vulnerable when offering radically innovative products or services due to high-risk and resource-consuming undertaking, increases in demand of substantial resources and capabilities to generate and reap large rewards (Eisenhardt & Martin 2000, Li & Atuahene-Gima 2001, Rosenbusch et al. 2011). Thus, they take time to catch up with well-established incumbents regarding productivity levels (Nightingale & Coad 2013). On the other hand, pursuing this innovation strategy is particularly advantageous for (1) "first" producers and (2) young innovative firms that perhaps grow from established chains rather than new and inexperienced firms. Indeed, radically innovative products and services create new demand with resultantly persistent above-average profitability that can positively translate into high productivity (Johnston 1966).

Seventh, I control the impact of government efforts including government support in technology (GOV.TECH), loans (GOV.LOANS) and human resources (GOV.TRAINING) on firm efficiency. As argued by Cull et al. (2017) for the case of China, government assistance in arranging loans, and provision of technical support for production and training are conducive to increase firm efficiency. In this way, the government helps facilitate firms' access to valuable resources by making use of the larger resource base at the government's disposal. However, it seems that government grants and loans are more likely for larger firms with a large pool of employment, which is a primary goal of government support. Overall, there are positive relations between these government supports and firm efficiency.

3.C Data envelopment analysis (DEA) and free disposal hull (FDH) analyses

Data envelopment analysis (DEA) and free disposal hull (FDH) analyses are alternative nonparametric approaches to measure efficient frontier and firm-specific efficiencies.[32] These approaches do not specify a particular production function, which means they does not assume underlying assumption for the production function through which the firm-

with respect to HHI scores can alter temporary market concentration while the otherwise inclusion allays concerns over market dominance or excessive competition in a specific industry.

[32]Stochastic frontier analysis (SFA), however, follow parametric techniques which assume underlying assumption of data such as half-normal distribution as in this chapter, while the nonparametric approaches do not rely much on underlying assumptions.

specific efficiencies are estimated. This feature has a great advantage of reducing the possibility of model misspecification in constructing production frontiers. However, a major drawback is that they are deterministic techniques and have a high degree of sensitivity to outliers as well as the number of input and output dimensions studied (Chen et al. 2015, Banker et al. 1984).[33] Using DEA and FDH as robustness checks verifies the leverage-firm size-efficiency link that I have formulate using SFA.

For measurement of efficiency scores, each approach has unique ways to construct production frontiers and measure firm-specific efficiencies. Note that although these models do not rely much on production distribution, the assumption of variable returns-to-scale (VRS) is used to obtain consistency with SFA models (See details of hypothesis testing for this assumption in Appendix Table A3.4). Also, production inputs include physical capital (K), labour (L), and intermediate materials (M) as in SFA models.

The DEA efficiency scores for production frontiers in the sample are first constructed and obtained for each time period and industry using "dea" command in Stata with production inputs and VRS assumption mentioned above. The DEA efficiency scores are then regressed on explanatory variables of interest including financial leverage, firm size, the interaction term between leverage and size, and all controls. Estimates from the tobit estimations are reported in Table 3.3.

Very similarly, the FHD model efficiency scores are estimated using "teradial" command in Stata under assumption of VRS technology with three production inputs mentioned. Next, tobit estimations of obtained efficiency scores on explanatory variables are employed with results reported in Table 3.3.

[33] Particularly, for illustrations of simple models and further explanation for the difference between DEA and SFA techniques, see more in Chen et al. (2015).

Table A3.1: Variable definition

Variable	Variable definition
Output (Level)	Real output ('000 VND)
OUTPUT	Real output (in logs)
Size (Level)	Number of full-time employees
SIZE	Full-time employees (in logs)
Assets	Total assets ('000 VND)
Debt	Total amount of debts ('000 VND)
Debt.F	Total amount of debts from banks and other financial institutions ('000 VND)
Debt.INF	Total amount of debts from family members, friends, money lenders and other informal sources ('000 VND)
Debt.ST	Total amount of debts with the maturity of up to a year ('000 VND)
Debt.LT	Total amount of debts with the maturity of over a year ('000 VND)
LEV	Ratio of total debts to total assets (%)
LEV.F	Ratio of total formal debts to total assets (%)
LEV.INF	Ratio of total informal debts to total assets (%)
LEV.ST	Ratio of total short-term debts to total assets (%)
LEV.LT	Ratio of total long-term debts to total assets (%)
Controls	
Age (Level)	Firm age (Years since establishment)
AGE	Firm age (in logs)
AGE	Square of logs of firm age
NONPROWKR	Nonproduction workers share of full-time employees (%)
SKLL	Skilled workers share of full-time employees (%)
PROFL	Professional workers share of full-time employees (%)
COMP	=1 if the firm faces high industry competition (Herfindahl-Hirschman Index (HHI)$\leq$0.15), =0 if moderate and low competition
GOV.TECH	=1 if the firm received government support from Quality and Technology Improvement Programmes, =0 otherwise
GOV.LOANS	=1 if the firm received government support from social development banks, =0 otherwise
GOV.TRAINING	=1 if the firm received government support from Human Resource Training Programmes, =0 otherwise
OWNER.EDU	=1 if the firm's owner/manager finished upper secondary school and higher, =0 otherwise
OWNER.EXP1	=1 if the firm's owner/manager previously owned other businesses, =0 otherwise
OWNER.EXP2	=1 if the firm's owner/manager previously worked in manufacturing industries, =0 otherwise
INNO1	=1 if the firm improved existing products
INNO2	=1 if the firm developed a new product
INF.FIRM	=1 if the firm is a household businesses and does not have a tax code
HI.IND	=1 if the firm is classified in the high-industry firm group (See section 3.B)

Notes: Values that are expressed in real terms exclude inflation effects for corresponding years; inflation rates were collected from www.gso.gov.vn.

Table A3.2: Correlation matrix between firm output, leverage and firm-level controls

	OUTPUT	LEV	SIZE	AGE	NON-PROWKR	SKLL	PROFL	COMP	GOV. TECH	GOV. LOANS	GOV. TRAIN-ING	OWNER. EDU	OWNER. EXP1	OWNER. EXP2	INNO1	INNO2
OUTPUT	1															
LEV	0.191*	1														
SIZE	0.775*	0.208*	1													
AGE	-0.212*	-0.175*	-0.138*	1												
NONPROWKR	-0.177*	-0.004	-0.206*	0.038	1											
SKLL	-0.093*	0.032	-0.119*	-0.043	0.262*	1										
PROFL	0.398*	0.098*	0.336*	-0.158*	0.117*	0.049	1									
COMP	-0.122*	0.006	-0.087*	0.045	-0.067*	0.011	-0.119*	1								
GOV.TECH	0.059$^{\zeta}$	0.014	0.075*	-0.009	-0.042	0.027	0.02	0.024	1							
GOV.LOANS	0.026	0.181*	0.080*	-0.031	-0.107*	0.026	-0.014	0.057$^{\zeta}$	0.066*	1						
GOV.TRAINING	0.074*	0.047	0.102*	0.008	-0.006	0.005	0.063*	-0.015	0.116*	0.032	1					
OWNER.EDU	0.264*	0.086*	0.196*	-0.155*	0.045	0.034	0.212*	-0.091*	0.005	-0.032	0.037	1				
OWNER.EXP1	0.123*	0.096*	0.119*	-0.056$^{\zeta}$	0.012	0.02	0.067*	-0.011	0.023	0.036	0.035	0.039	1			
OWNER.EXP2	-0.014	0.014	-0.032	0.077*	-0.017	0.013	0.000	0.024	-0.016	0.015	0.003	-0.067*	0.149*	1		
INNO1	0.160*	0.072*	0.164*	-0.103*	-0.121*	0.026	0.080*	0.029	0.027	0.108*	0.039	0.039	0.037	-0.006	1	
INNO2	0.042	0.031	0.086*	-0.100*	-0.171*	0.066*	0.045	0.008	0.062*	0.145*	0.039	-0.014	0.033	-0.028	0.276*	1

Notes: (*), ($^{\zeta}$) and ($^{\psi}$) denotes statistical significance at Bonferroni-adjusted levels of 0.01, 0.05 and 0.1, respectively Source: Authors' calculations.

Table A3.3: Unbalanced panel structure of the dataset

	All firms		Formal firms		Informal firms	
Panel A: Frequencies of firms over years						
No. years per firm	No. firms	No. obs	No. firms	No. obs	No. firms	No. obs
2	537	1,074	434	868	194	388
3	405	1,215	319	957	119	357
4	276	1,104	172	688	82	328
5	295	1,475	114	570	80	400
Total	1,513	4,868	1,039	3,083	475	1,473
Panel B: Firm-year observations per year						
Year	No.obs	(%)	No.obs	(%)	No.obs	(%)
2005	1,042	(21.41)	577	(18.72)	340	(23.08)
2007	1,061	(21.80)	637	(20.66)	345	(23.42)
2009	1,057	(21.71)	680	(22.06)	316	(21.45)
2011	945	(19.41)	661	(21.44)	259	(17.58)
2013	763	(15.67)	528	(17.13)	213	(14.46)
Total	4,868	(100.00)	3,083	(100.00)	1,473	(100.00)

Notes: The total number of observations of formal and informal firms is not equal to that for the full sample because SFA estimations only consider observations appearing in at least 2 waves and firms may change their formality status across years. Source: Authors' calculations.

Table A3.4: Hypothesis tests for production frontier assumptions

Panel A: Log likelihood ratio tests	$\chi^2 - statistic$	χ^2 critical values	Decision
(1) Specification of production frontier H0: Cobb-Douglas frontier HA: Translog frontier	6,616.24	$\chi^2_{(0.01,15)} = 29.93$	Reject H0, translog model is preferred
(2) Distribution for inefficiency term H0: Half-normal distribution ($\mu = 0$) HA: Truncated-normal distribution	-12,844.85	$\chi^2_{(0.01,1)} = 5.48$	Cannot reject H0, inefficiency effect is assumed to follow a half-normal distribution
Panel B: Wald test	$\chi^2 - statistic$	$p - value$	Decision
(3) Returns-to-scale (RS) H0: Constant-RS (CRS): $\alpha_K + \alpha_L + \alpha_M = 1$; $\alpha_{K^2} + \alpha_{KL} + \alpha_{KM} = 0$; $\alpha_{L^2} + \alpha_{KL} + \alpha_{LM} = 0$; $\alpha_{M^2} + \alpha_{KM} + \alpha_{LM} = 0$ HA: Variable-RS (VRS)	 0.54 7.94 1.85 3.30	 0.46 0.00 0.17 0.07	Reject H0, VRS assumption is preferred

Notes: Panel A reports likelihood ratio tests for specification of production frontier and inefficiency distribution with $\chi^2 - statistic$ calculated as $\lambda = -2[Log - likelihood(H0) – Log - likelihood(HA)]$ and the corresponding critical value taken from mixed χ^2 distribution as suggested by Kodde & Palm (1986). Panel B reports the Wald test for returns-to-scale assumption of the preferred translog production frontier as a result of tests in Panel A; our hypothesis testing for the translog frontier follows Kumbhakar & Lovell (2000). Source: Authors' calculations.

Table A3.5: Heterogeneous effects of leverage by firm size and formality status: Alternative classification of formality

Outcome Var: Technical inefficiency	All firms	Formal firms
	(1)	(2)
SIZE	0.077	0.024
	(0.086)	(0.086)
LEV	-0.024**	-0.022*
	(0.011)	(0.012)
LEV×SIZE	0.008**	0.007*
	(0.003)	(0.004)
LEV×INF.FIRM2	0.013	
	(0.015)	
SIZE×INF.FIRM2	0.608***	
	(0.197)	
INF.FIRM2	-1.012***	
	(0.343)	
LEV×SIZE×INF.FIRM2	-0.006	
	(0.008)	
Controls		
AGE	-0.552*	-0.477
	(0.322)	(0.362)
AGE2	0.142**	0.084
	(0.060)	(0.068)
NONPROWKR	0.008***	0.009***
	(0.002)	(0.002)
SKLL	-0.001	-0.003*
	(0.001)	(0.002)
PROFL	-0.019***	-0.012*
	(0.007)	(0.007)
COMP	0.134	0.088
	(0.087)	(0.112)
GOV.TECH	-0.643**	-0.709**
	(0.324)	(0.355)
GOV.LOANS	0.013	0.055
	(0.101)	(0.131)
GOV.TRAINING	-0.004	0.118
	(0.231)	(0.245)
INNO1	-0.284***	-0.043
	(0.069)	(0.085)
INNO2	-0.100	-0.151
	(0.127)	(0.156)
OWNER.EDU	-0.185**	-0.329***
	(0.083)	(0.115)
Constant	-2.731***	-2.200***
	(0.662)	(0.780)
FEs	Yes	Yes
No.obs	4,868	2,992
Log pseudo-likelihood	2,986.975	2,050.146
Wald χ^2	494.62	143,909.47
$(p-value)$	(0.00)	(0.00)

Notes: This table presents the alternative measure of formality (INF.FIRM2) which classifies formal versus informal firms by their holding of business registration certificate. Results for informal-firm subsamples are not reported due to lack of convergence in SFA estimations. Results for the full sample and subsample of formal firms appear robust to Table 4. See notes in Table 3 for more details. *p <0.10, ** p <0.05, *** p <0.01. Standard errors in parentheses are clustered at the firm level. Source: Authors' calculations.

Table A3.6: Heterogeneous effects of leverage and property rights (CLUR dummies) on larger informal firms (firm size over subsample median)

Outcome Var: Technical inefficiency							
Panel A: LEV (total debts/total assets)				Panel B: LEV.F (total formal debts/total assets)			
	(1)	(2)	(3)		(4)	(5)	(6)
LEV	0.008	0.002	-0.017**	LEV.F	0.017*	0.005	-0.019**
	(0.008)	(0.007)	(0.007)		(0.010)	(0.010)	(0.009)
LEV×CLUR_1	-0.038***			LEV.F×CLUR_1	-0.067***		
	(0.015)				(0.014)		
CLUR_1	-0.129			CLUR_1	-0.010		
	(0.205)				(0.179)		
LEV×CLUR_2		-0.006		LEV.F×CLUR_2		-0.018	
		(0.010)				(0.015)	
CLUR_2		0.023		CLUR_2		0.142	
		(0.190)				(0.176)	
LEV×CLUR_3			0.038***	LEV.F×CLUR_3			0.046***
			(0.013)				(0.013)
CLUR_3			0.001	CLUR_3			0.076
			(0.219)				(0.206)
SIZE	0.680**	0.987***	0.785*	SIZE	0.735**	0.728*	0.860***
	(0.317)	(0.294)	(0.445)		(0.353)	(0.395)	(0.255)
Full controls and FEs	Yes	Yes	Yes	Full controls and FEs	Yes	Yes	Yes
No.obs	904	904	904	No.obs	904	904	904
Log pseudo-likelihood	628.899	866.021	840.524	Log pseudo-likelihood	805.375	760.788	869.667
Wald χ^2	7,061.34	3.37E+09	2.66E+07	Wald χ^2	87,604.89	4,886.06	9.90E+08
$(p-value)$	(0.00)	(0.00)	(0.00)	$(p-value)$	(0.00)	(0.00)	(0.00)

Notes: This table provides robustness checks for columns 1 to 3 of Table 5 over the role of property rights in the leverage-firm size-efficiency relation. We narrow down our sample to larger informal firms of which firm size falls above the median and investigate total debts (Panel A) and formal debts (Panel B) on efficiencies of these large informal firms. The interaction terms between LEV (LEV.F) and CLUR dummies, including holding property rights through own purchases (CLUR_1), inheritance (CLUR_2) and informal use (CLUR_3), are of particular interest. For larger informal firms, increased leverage for firms with property-rights legal purchases are associated with reductions of inefficiencies or with efficiency gains (Columns 1 and 3). However, the informal use of property rights seems to attentuate the positive effects of higher leverage on technical efficiencies (Columns 3 and 6). See additional information in notes of Table 3 in main text. Source: Authors' calculations.

Chapter 4

Does the registration reform doubly welcome informal firms to formal financial markets?

Abstract

The fourth chapter studies the effect of the reform that streamlined formalisation process on increased formal and/or informal financing of Vietnamese micro-firms. The difference-in-differences estimations identify the heterogeneity of the associated impact by firm age. The reform increased the propensity to use informal debt for young registered firms by 18.2 percentage points relative to those remaining informal, likely in the form of using informal finance only. The reform, under strong local governance, offered advantages for young firms in using formal finance only. Older counterparts continued to benefit from more access to formal finance with a resultant reduction in informal finance after the reform. The findings question whether access to formal financing is an ostensible benefit of formalisation for many young informal firms and whether the formalisation change in the real sector could provide an additional impetus for more flexibility in formal financial markets.

4.1 Introduction

Informal firms are cyclically viewed as an unwelcome imposition for formal institution environment (La Porta & Shleifer 2014). Inducing these firms to register as legal businesses has long been imperative for policy makers especially in developing countries. To this end, the governments of many countries have introduced business registration reforms, which is viewed as a first welcome for these firms to the real sector.[1] Such reforms have

[1]The report "Doing Business 2008" and subsequent versions by World Bank show that there are many ways of registration reforms worldwide ranging from simplified pre- and post-registration procedures (tax registration, licensing, notarization), to introduction or enhancement of online platforms or the one-stop

shown to greatly contribute to increased formality and improved productivity, profitability and growth for registered firms.[2] Another important follow-up question is whether the registration reforms doubly welcome the firms to formal financial markets since one of major benefits of formalisation is to have better access to formal finance, or whether they continue to rely on informal finance as in the ex ante period. There is however little empirical evidence on the relative use of formal and/or informal finance for firms that start formality after the introduction of the reform. Following the same nationwide reform, firms can have different financial behaviour depending on how long they start their informality and the local institutional settings in which they locate.

This chapter aims to study the effects of the reform that streamlined formalisation process on increased formal and/or informal financing of micro firms in Vietnam. To date, this research has been widely neglected in research on informal firms for a following reason. Existing studies often focus on the effects of formalisation on the amount of loans, or propensity to use formal finance or to use informal finance and little focus on the relative use—that is co-funding, or sole-funding—of formal and informal finance.[3] Co-funding may become well positioned when firms have certain access to both financial sources; firms could rely on either finance (i.e., sole-funding) for their operations. These forms of financing however play an increasingly important role in most recent research starting from the work by Allen et al. (2012), Degryse et al. (2016), Lee & Persson (2016): co-funding performs the best function to increase sales of small firms. Given the importance of different forms of formal and informal financing on firm performance, the analysis of the reform on these financial forms should be of equal importance.

I focus on the reform that Vietnam implemented in 2010 to introduce a new registration process as, in words by the World Bank Group, a one-stop shop with fewer complex document requirements and eliminated confusion over previous registration system. It appears to reduce initial registration costs from non-monetary perspectives since monetary costs such as registration fees are already relatively low in the country.[4] Initial registration costs, as Williams et al. (2017), Assenova & Sorenson (2017) argue, are liabilities for informal firms, especially young firms that most often face other "liabilities of newness". In contrast, older firms with depleted long-standing liabilities of newness can afford such initial and ongoing registration costs. Hence, those remaining unregistered longer may

shop. See https://www.doingbusiness.org/en/reforms. For example, Brazilian tax simplification program "Integrated System for the Payment of Taxes and Social Security Contributions of Micro and Small Enterprises" program (SIMPLES for its initials in Portuguese) and Mexican procedure simplification program "System of Fast Opening of Firms" (SARE in Spanish) were introduced in 1996 and 2002, respectively.

[2]Registration reforms show outsized impacts for informality in two main ways: first, the increased number of registered firms (See Bruhn (2011), Kaplan et al. (2011) for Mexican "SARE" program, and Monteiro & Assunção (2012) for Brazilian "SIMPLES" program, although certain industries gain more benefits from reforms than others); and second, informal firms' performance in various measures, including revenues and profits (See Fajnzylber et al. (2011), Monteiro & Assunção (2012) for Brazil micro-enterprises), and wage employment (See Bruhn (2011) for Mexican firms).

[3]Boly (2018), Rand & Torm (2012) find positive effects of formalisation and increased formal finance; Bruhn (2014), de Andrade et al. (2014), Mel et al. (2013), McKenzie & Sakho (2010) however report no significant impact. See Straub (2005) for theoretical review of formalization and informal finance.

[4]The perceived costs associated with registration could be in the form of monetary costs (e.g., initial registration fees, direct and indirect tax payments, briberies) and/or non-monetary costs (e.g., overly burdensome regulations, time consumed to obtain relevant registration information) (De Paula & Scheinkman 2011, Fajnzylber et al. 2011, McKenzie & Sakho 2010)

reap more formalisation benefits—one of which could be better access to formal finance with possibly resultant reduction in informal finance.[5] Also, the same nationwide reform may not have uniform effects due to differential local governance with better legal enforcement and support for the formalisation reform implementation in some provinces.

Methodologically, I perform a difference-in-differences test which is a frequently used method in impact and policy evaluation studies. A major advantage of this method is to find estimated effects both prior to and after the introduction of the reform for two comparison groups of interest: firms that registered after the reform was introduced and otherwise firms that remain informally. Thus, this method helps to evaluate an ex-ante return of formality status on financing activities.

By understanding different forms of formal and informal financing induced by the registration reform, I advance the literature in three important ways. First, the analysis is the first one to empirically examine whether the introduction of registration reform impacts the way in which the dual financial systems are functioning for unregistered firms. Unregistered firms, when becoming formal, experience dual financial systems with each exposing its failings: informal finance that some firms use from quite early on when starting up unregistered is less likely to contribute to scaling-up performance as registered ones (Degryse et al. 2016);[6] formal finance could be costly and not necessarily accessible if firms have no good historical record of performance. Co-funding therefore may become well positioned when firms have certain access to both financial sources.

Second, this study is the first one to empirically demonstrate whether the number of years in which firms operate as unregistered conditions the reform-induced use of formal and informal finance. A young firm that spends less time operating unregistered before becoming formal may have less (more) access to formal (informal) finance to cover for its liabilities of newness. Using more informal finance, although satisfying immediate demand of finance, turns out to be a tragedy for its performance since informal loans are less likely scalable (Degryse et al. 2016). An incumbent with longer years operating unregistered, more social ties, may view the reform as a great opportunity for reduced registration costs and also as a way to open up greater opportunities of having better access to formal finance. Accordingly, the firm may respond differently to its ex-ante use of informal finance.

Third, from a policy perspective, the introduction of reform signals the efforts of the government and policy makers in conferring certain formality on firms that start formalised. The introduction of government and policy makers in registration reforms, as a first welcome these firms to real sector with a change to formality status, but whether it is also a double welcome these firms to formal financial markets since one major benefit of formalisation is to have access to formal finance. Performing a comparison analysis between registered firms and those remaining informal studies to study whether the reform offers ostensible advantages for increased use of formal financing relative to the latter

[5] Williams et al. (2017), Assenova & Sorenson (2017) find that firms start up unregistered longer have better subsequent performance.

[6] As argued by (Degryse et al. 2016), informal finance can satisfy immediate financial demand, however, the funding from this source is quite often limited and unlikely to be sufficient to finance larger projects that potentially scale-up firms

group. Centring on real-side implications for the reform-induced use of external finance, this analysis demonstrates the need of action from policymakers to mark the contours in which unregistered firms, especially young firms, are facing around the passage of the formalisation, and to govern formal financial markets more malleable so that the financial markets can well align with such contours. Also, narrowly targeting firms based on their years of starting unregistered plays a decisive role in identify their use of informal finance and alleviating informal financial markets long-run.

There are three two findings of this chapter. First, I identify the heterogeneous impact of the formalisation reform on formal and/or informal decisions by firm age. Particularly, the reform had no immediate impacts on formal financing of young registered firms; however, it increased their propensity to use informal debt by 18.2 percentage points relative to those remaining informal, likely in the form of using only informal finance. Old registered firms experienced an increase in different forms of employing formal financing and a reduced use of informal financial source. Second, young firms confer advantages of increased sole-funding of formal finance under stronger local governance, whereas, under weaker local governance, the reform reduced the propensity to use formal finance only in these firms. Old firms that start registered after the reform are unlikely to gain any advantages from the location in which they operate.

This chapter is organised as follows. Section 4.2 reviews the literature. Section 4.3 provides institutional settings of the reform, while section 4.4 describes the empirical estimation. Section 4.5 presents the descriptive statistics. Section 4.6 analyses estimation results with robustness checks. Section 4.7 provides limitations and avenues for future research, followed by concluding remarks in Section 4.8.

4.2 Literature review

The literature review is composed of three parts. The first part focuses on the effects of registration reform on the relative use of formal and informal finance; second is whether the length of staying unregistered matters; and the last part is on the role of local governance quality.

4.2.1 Registration reform affects relative use of formal and informal finance

Existing theory suggests that informal firms often forgo financing opportunities that are linked with otherwise formality status.[7] These financing opportunities through banks or other financial intermediaries require a high degree of legal enforcement requirements: high costs of capital (interest rates payments), collaterals, and a historical record of revenue.

[7] Quintin (2008) argues that informal firms, which evade taxes to reduce a financial burden, have limited access to formal financial markets due to official means of contract enforcements. This becomes more evident in developing countries with large informal sector, a heavy tax burden on registered firms, and a low degree of contract enforcement.

Informal firms, however, hardly meet such requirements to have access to formal finance, leaving them to mostly or entirely rely on an alternative financial channel—informal finance such as funds from family, relative, or friends. These funds are quicker to have access yet limited and therefore unable to scale up firms' performance.

Becoming formal therefore serves as a way to make the participation of these informal firms in formal financial markets possible, which is perceived as a major benefit of formalisation. Theoretically, Straub (2005) shows a model arguing that the formalisation ensures access to formal markets under certain conditions of efficient credit markets, better rule of law and judicial enforcement. Empirically, there is rather mixed empirical evidence on the immediate impact of formalisation and formalisation reform on formal sources of financing with little evidence on positive effects thereof. A paper by Rand & Torm (2012) finds positive effects of formalisation on formal credit access for Vietnamese micro-firms for over formalisation periods 2007 and 2009. Similarly, Medvedev & Oviedo (2016) find a positive association between formality and better access to formal credit at start-up for the case of Ecuador.

There is, however, a large body of related empirical literature showing no significant impact of formalisation or formalisation reform on formal loans.[8] Boly (2018) uses Vietnamese surveys in the period 2005-2013, finding that formalisation, irrespective of the year that a firm started formalised, does not lead to better access to formal finance.[9]. Regarding formalisation reforms, Mel et al. (2013) find no impact of formalisation reform in Sri Lanka—particularly providing information and reimbursing registration costs—on opening a business bank account, obtaining business loan or receiving other official forms of financial support through government schemes for registered firm. Rather similar results are found in the paper by McKenzie & Sakho (2010) for firms in Bolivia through reforms in business simplification procedures. A field experiment by de Andrade et al. (2014) on a city in Brazil about government efforts as proxy for formalisation reforms to encourage informal firms to register (e.g., informing firms, reducing registration costs, increasing enforcement of rules) finds that a perceived benefit of bank financing is not attractive to informal firms. A possible explanation for little impact of registration or registration reform on access to formal finance is because the formal financial markets with many contract enforcement requirements cannot fully support newly registered firms which are often low-profile with lack of collaterals and accounting records. The formal status from reduced registration costs of becoming formal is unlikely to bring any private benefit. This explanation appears to hold for developing countries with a more concentrated banking sector or lower financial openness (Massenot & Straub 2016, Capasso & Jappelli 2013).

Given no access to formal sources of financing and depleted self-financing, firms that start registered may rely on informal finance, of which the literature on the impact of formalisation reform on the use of informal finance appears to have suspicion. To my

[8] See Bruhn (2014) for a review of such perceived benefit of formalisation reforms reported in the World Bank Doing Business project.

[9] Note that Rand & Torm (2012) use the same surveys as mine, however, limits to two survey years 2007 and 2009, and does not cover the formalisation reform year 2010 in Vietnam, while Boly (2018) uses extensive data waves 2005-2013 that cover the formalisation reform year

knowledge, there is very limited empirical evidence supporting this argument except for a study by Straub (2005). Analysing the World Business Environment Survey dataset for 10,000 firms in 80 countries in 1999 and 2000, Straub (2005) finds that costly registration costs in either form is linked with increased use of informal financing. Alternatively put, the introduction of registration reforms which involve with reduced registration fees or streamlined registration process is less likely to favor informal credit. This is because becoming formal entails costs. Initial registration costs either in monetary (e.g., registration fees) or non-monetary forms (e.g., number of procedures) are costly for informal firms.

Limited yet growing literature has been shifting the focus of financial decisions to the relative use of formal and informal finance—co-funding or sole-funding—in the firm-level analysis. Co-funding becomes well-position in firms' financial decision when the firms have certain access to both sources of financing; otherwise, firms may rely on either source (i.e., sole-funding) of formal or informal financing. These forms of financing play an increasingly important role in most recent research starting from the work by Allen et al. (2012), Degryse et al. (2016), Lee & Persson (2016): co-funding performs the best function to increase sales of small firms. Given the importance of different forms of formal and informal financing on firm performance, the analysis of the reform on these financial forms should put equal emphasis of importance.

4.2.2 Length of staying unregistered matters

This part is comprised of two arguments. First is the extent to which a firm starting up unregistered longer differs from an otherwise firm. On the one hand, becoming formal, both firms face initial registration costs. These costs could be in form of monetary costs (e.g., initial registration fees, direct and indirect tax payments, briberies) and/or non-monetary costs (e.g., overly burdensome regulations, time consumed to obtain relevant registration information) (De Paula & Scheinkman 2011, Fajnzylber et al. 2011, McKenzie & Sakho 2010). On the other hand, starting up also entails costs, which as coined by Stinchcombe (1965) are perceived as "liabilities of newness". These liabilities include maintaining stronger routines and establishing relationships with suppliers and customers, among others. However, limited recent literature shows that the firm which starts unregistered longer or delays registration at start-up has better subsequent performance than an otherwise firm (Williams et al. 2017). The former—perhaps becoming a mature firm once starting registered—has depleted long-standing liabilities of newness and thereby can afford initial and ongoing registration costs. The otherwise firm that starts up its business registered bears dual costs involved: registration costs and liabilities of newness. The dual costs may leave the firm little resources to overcome.

The second argument therefore links the length of staying unregistered before formalisation and better financial position in which firms legally register. The link has been an implication from findings by Williams et al. (2017). Williams et al. (2017) analyse World Bank Enterprise Survey data for 127 countries and find better subsequent firm sales, employment and productivity growth for those delaying registration longer. This finding, although not explicitly focusing on the performance of these firms during nonregistration

period, somehow suggests that these firms preserve resources by avoiding high costs of registration and still maintain social ties and social legitimacy through such period. Thus, my prediction is that those remaining unregistered longer with stronger social ties and reduced long-standing liabilities of newness may reap more benefit of formalisation—one of which is better access to formal finance with possibly resultant reduction in informal finance.

4.2.3 The role of local governance quality

This part relates to a popular idea in policymaking that improving institutional settings through better regulations and enforcement conditions more efficient financial markets and more access to formal finance at the firm level. Massenot & Straub (2016), Straub (2005) have argued that registration reforms entailing lighter registration procedures, better rule of law, and stronger judicial enforcement (e.g., in property rights) lay concrete foundation for better access to formal credit markets and resultantly render informal finance less attractive. Although these are both cross-countries studies using World Bank Enterprise Surveys (WBES) dataset with Massenot & Straub (2016) analysing a total of over 20,000 firms in 62 countries between 2002-2006, and Straub (2005) doing so for 10,000 firms in 80 countries in more dated years 1999 and 2000, the key implication is that registration reforms along with improving the enforcement quality can have positive effects on access to formal credit.

The same argument applies for a contextual understanding at a lower level: municipal or provincial settings. Although the registration reform occurs nationwide, there may not have uniform effects across provinces. This is because there are differences in provincial characteristics in local governance, legal enforcement, and support for formalisation reform implementation. However, there has been relatively limited evidence of the link between better local governance and access to formal finance. The exception of a study by Nguyen & Canh (2020) for Vietnamese firms, which, however, shows a somewhat surprising prediction. In this analysis, the finding of interest is that better local governance quality appears to increase both co-funding and sole-funding of either formal or informal sources of financing, with slightly higher preference for using informal finance only.

To date, there is scant evidence on whether delaying registration and regional governance matter for financial decisions. However, following Nguyen & Canh (2020), Massenot & Straub (2016), Straub (2005) on the link between light registration procedure, better regulations, and access to both formal and informal finance, and Williams et al. (2017) on benefits of delaying registration to initially overcome liabilities of newness as argued in the previous part, the prediction is that firms operating in stronger local governance can benefit more efficient product and financial markets.

Based on the empirical discussion, I draw following hypotheses on whether the registration reform uniformly resulted in the co-funding and sole-funding of formal and informal finance and whether the associated effects differ depending on the length of time firms stay unregistered before formalisation and local governance quality.

$Hyp1$: The registration reform induces no increase in formal finance for registered firms, leaving the increased use of informal finance—in the form of informal finance only.

$Hyp2$: The longer firms stay unregistered before formalisation, the more use of formal finance (in either form of co-funding or sole-funding).

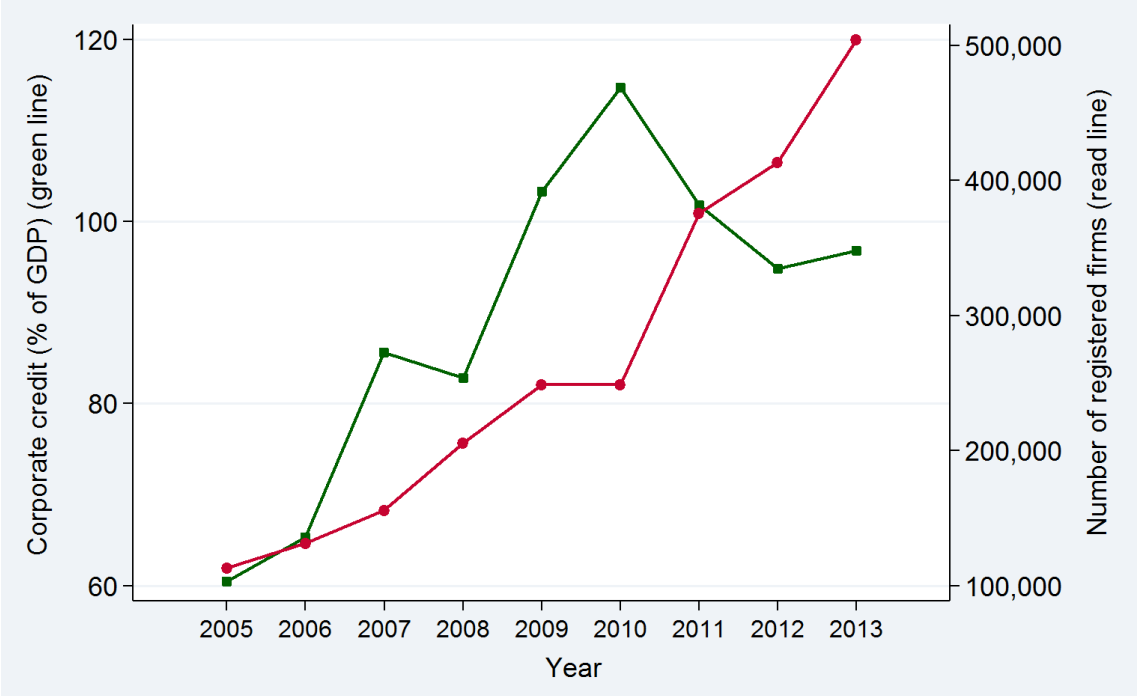
$Hyp3$: Firms operating in provinces with stronger local governance benefit more access to both formal and informal finance—in either form of co-funding or sole-funding—from the registration reform. This effect is stronger for firms staying unregistered longer.

4.3 Institutional setting

Vietnam implemented a momentous reform in an endeavour to reduce barriers to business registration. The Decree 43/2010/ND-CP dated 15 April 2010 streamlines and improves the previously introduced registration procedure which refers to several processes: obtaining a business registration certificate and a tax registration certificate—all together to earn a single seal for company licensing. Indeed, the new registration system combines processes of obtaining these two registration certificates into—in words by the Group (2011)—a one-stop shop with fewer complex document requirements and eliminated rigidity of using a single seal. This reform is proven to make it easier for firms to start a legally registered business: it eases much confusion over registration processes and usages of each certificate associated; it reduces the number of registration days; it requires less information over pre-registration preparation and less time involved for likely information- and resources-scare firms.

I next consider Vietnam in the context of her business and the development of formal financial markets around the passage of the formalisation reform by drawing on the World Bank and national data. Figure 4.1 presents the domestic credit growth to private sector as a share of GDP in the right vertical axis and the number of firms registered in the left one. There is clear evidence of an exponential increase in the number of firms which are newly registered. Indeed, by end 2013, the increase was five times larger than a starting number of roughly 100,000 firms in 2005. Noticeably, the change after the reform is over twice as large in magnitude as that in pre-reform periods. Such rapidly growing number of firms indicates the sizeable demand for formal credit to the financial sector over the examined period. As regards corporate credit, another line plotted in Figure 4.1 presents the total amount of credit that was granted to private sector as percent of GDP. A surge in the fraction of credit growth and GDP is only recorded over the first few years, reaching a peak of 120 per cent in 2010—the year in which the registration reform was taken into effect—and preceding a slight decline in post-reform years. Despite radical changes in formal financial markets, the higher involvement of financial markets into private sector does not seem proportional to markedly sizeable number of firms registered, leaving the quest as to whether these firms seek external finance from informal financial markets. This chapter aims to understand the involvement of informal firms in the dual financial system around the passage of the formalisation reform.

Figure 4.1: Development of financial and real sectors, 2005-2013



Notes: This figure reports domestic corporate credit as percent of GDP (right y-axis and green line) and the number of registered firms in Vietnam (left y-axis and red line) over the period 2005-2013. Source: Authors' calculations based on World Bank and gso.gov.vn data.

The dual financial systems of formal and informal financial channels in Vietnam have two features that are worth highlighting (Rand 2007, Rand & Torm 2012, Nguyen & Canh 2020): first, Vietnamese unregistered firms can secure formal loans by pledging land use rights certificates as collateral; second, informal finance is not that costly relative to formal finance, as opposed to higher borrowing costs in Chinese informal financial markets as argued by Degryse et al. (2016). Thus, the common use of informal finance in this country is understandable.

4.4 Empirical estimation

4.4.1 Test strategy

As the business registration reform benefits informal firms which start a legally registered business in the reform year and afterward, I perform a difference-in-differences test prior to and after the introduction of the reform to make an ex-ante return of formality status on financing activities. I first assign two comparison groups of interest: a treatment group represents firms which start out as informal but then become formalised in the reform year and following years, and the other group (a control group) consists of otherwise firms which remain informal in the corresponding year.

To gauge the impact of the reform on the propensity of using formal or informal financing, I begin with the corrected random-effects probit difference-in-differences specification as follows:[10]

$$Financing_{it} = \begin{cases} Financing^{*}_{it} = E(Y|Reform, Formalised, Z)\ if\ Financing_{it} = 1 \\ 0\ if\ Financing_{it} = 0 \end{cases} \tag{4.1}$$

where

$$\begin{aligned} E(Y|Reform, Formalised, Z) =& \alpha + \beta Reform_{it} + \gamma Formalised_{i} \\ &+ \delta Reform_{it} \times Formalised_{i} + \eta Z_{it} + \zeta \bar{Z}_{it} + d_t + \varepsilon_{it} \end{aligned} \tag{4.2}$$

where $Financing^{*}_{it}$ denotes a series of observed dependent indicators on different forms of formal and/or informal financing of firm i in survey year t: co-funding, sole-funding, or either funding. $Cofunding_{Formal>Informal}$ ($Cofunding_{Informal>Formal}$) are dummies equal to one if a firm co-funded by both formal and informal finance with a higher share of the former (latter) and zero otherwise. $Sole\text{-}funding_{Formal}$ ($Sole\text{-}funding_{Informal}$) are dummies for firms solely funded by formal (informal) finance. $FormalFinance$ ($InformalFinance$) are dummies for firms funded by formal (informal) finance in either form of $Sole\text{-}funding_{Formal}$ ($Sole\text{-}funding_{Informal}$) or co-funding. d_t denotes time-specific fixed effects, capturing aggregate time-varying or exogeneous shocks in financial markets and real sector. ε_{it} is the idiosyncratic error term. I estimate the Eq. (4.1) with standard errors clustered at the firm level.[11] Z is a vector of covariates including firm age, firm size (total assets), owner's education, degrees of financial constraints when firms started up, shares of skilled labour, innovation activities: product improvements and producing new products, owner past experience in manufacturing industries or (non)SOEs, owning land-use rights. $\bar{Z}$ is a vector of time averages of certain time-varying controls including age, size, shares of skilled workers.

The key coefficient of interest is on the interaction term $Reform \times Formalised_{it}$. $Reform$ is a dummy that equals one for time periods that follow the reform year and

[10]The tuition behind the probit correlated random-effects (CRE) model is that the probit random-effects model applied to the Chamberlain-Mundlak approach (Chamberlain 1982, Mundlak 1978) in an unbalanced panel setting leads to robust fixed-effects estimation (Wooldridge 2019). Indeed, this CRE model is more efficient than a fixed-effects model mainly because the later—in a nonlinear fashion—fails to control for unobserved time-invariant components and often obtains biased results. This model with application of Chamberlain-Mundlak approach adds averages of time-varying controls ($\bar{Z}_{it}$: age, size, shares of skilled workers) as additional explanatory variables, thereby allowing serial correlation between the history of these controls and time-varying unobserved shocks ($\bar{Z}_{it}$ is collinear with Z_{it}, by construction) or heteroskedasticity in ε_{it}. The addition of averages of these controls, on the one hand, satisfies the assumption of fixed-effects estimation as in a linear standard model; on the other hand, this exercise can violate or weakly maintain the ideal assumptions of random-effects model—serial independence and homoskedasticity in ε_{it}. Additionally, CRE has more advantages than bias-adjusted FE models by Fernández-Val & Weidner (2016) or conditional maximum likelihood estimations since the CRE model is proper to the sample with large number of observations yet short panels and arbitrary time independence while others do not. (See Wooldridge (2019) for more details).

[11]This setting of clustering by firm, along with the inclusion of year dummies to absorb the year-specific effects, is a common approach in empirical financial studies to control both serial correlation (e.g., correlation betweenε_{it} and ε_{ih}) and cross-correlation (e.g., correlations between ε_{it} and ε_{kt}) for short panels. (See Petersen (2008) with panel-data simulations applicable for nonlinear regressions).

zero for preceding years. *Formalised* is a dummy that takes the value of one if the firm i belongs to the treated group (i.e., informal firms that become formalised in the reform year and afterward), and zero for those in the control group. The interaction term therefore measures the relative outcome in formal and/or informal financing associated with the introduction of reform between these groups. Alternatively put, it is the cross-difference of the dependent variable after taking first differences in each group of interest (i.e., post- and pre-reform differences).

The interaction term between groups across time, or a probit difference-in-differences estimator, following Puhani (2012), is measured by taking difference of conditional expectation of the observed outcome $Financing_{it}^{1}$ and of the counterfactual outcome $Financing_{it}^{0}$, first individually (i.e., to measure cross differences) and second jointly (i.e., to measure a difference). Accordingly, each of the cross differences represents differences in conditional expectations between these two comparison groups (i.e., treated versus control) across post- and pre-reform periods for either observed or counterfactual outcome of dependence; a joint measure or a difference gauges a relative performance of these two cross differences. The interaction term therefore is a difference in cross differences.[12]

4.4.2 Difference-in-differences assumptions and potential bias

The link between the reform and financing might pick up confounding effects of alternative, concurrent legislative changes with possibly higher changes in formal financing for registered firms. In order to avoid such potential bias, I give a brief account of such changes with paid attention to reported implementation and economic responses. There was the Decree 56/2009/ND-CP dated 30 June 2009 to support the development of micro, SMEs with one of central pillars being to raise the availability and accessibility of formal financial sources through reduced lending rates or increased assistance over lending application process to these firms. The Decree, although dated a year prior to the reform with the Enterprise-development-fund potentially formed around the passage of the reform to provide timely support, appeared far from effectiveness and transparency of implementation due to limited human and technical capacity in assistance. Similarly, financial institutions, pursuant to the Decree, ostensibly started to facilitate supportive lending products and services (See the Resolution No. 22/NQ-CP dated May 5, 2010). However, it was not until the Vietnamese government passed the SME Support Law 04/2017/QH14 dated June 12, 2017 that start-ups and SMEs are genuinely targeted and supported. As the Law's passage is much later than my studied time periods, the Decree may not be an extra identification problem to my difference-in-differences setting.

The launch and implementation of the business registration reform was categorically exogeneous to informal firms and policy decision making is strongly determined by politics and experts. The reform was a result from a continuum of a decade-long preparation, in-

[12] Mathematically, the interaction term is measured as
$\alpha_{Reform \times Formalised} = E(Y^1|Reform = 1, Formalised = 1, Z) - E(Y^0|Reform = 1, Formalised = 1, Z)$
$= \Phi(\alpha_0 + \alpha_{Reform} + \alpha_{Formalised} + \alpha_{Reform \times Formalised} + \beta Z) - \Phi(\alpha_0 + \alpha_{Reform} + \alpha_{Formalised} + \beta Z)$
where $\Phi(.)$ is cumulative distribution function of standard normal distribution and is presumably a strictly monotonic function. (See how to derive this equation in full from Eq. 14 and 10* in Puhani (2012)).

depth survey studies, and also part of wider business environment reforms following the country's five-year Socio-Economic Development Plan 2006-2010 in the quest for more efficient contours of SME business environment development, growth and competitiveness (Tas & van Oyen 2000, UNIDO 2011).[13] Notably, the government policy decision over the reform design and implementation was conditioned by studies and technical support from external partners (e.g., CIEM and UNIDO) and therefore become comprehensively reliable and not endogenous.

4.5 Data descriptives

I use Vietnamese SME surveys for the period 2005-2013 as introduced in section 3.4.1 of Chapter 3 but limit the dataset to two firm groups of interest: firms that start formalised after the reform was introduced (treated); firms that remain informal throughout examined period (control). I define formality of firms by a threshold of 10 employees and owning a tax registration certificate (See footnote 13 in Chapter 3 for more details of the definition). The proportion of groups is reported in Panel B of Table 4.1. I also use the alternative classification by acquisition of a business registration certificate, rather than by a tax registration certificate, for robustness checks.[14]

4.5.1 Sample means of financial variables

Panel A of Table 4.1 reports summary statistics of different forms of formal and informal financing. Informal finance in either form is, on average, more preferable than formal finance: 29.2 percent of firms in the sample are funded by informal finance, which is slightly higher than the fraction of firms funded by formal finance (22.8 percent). Among firms using informal finance, most are entirely financed by such financing while a small fraction of them are co-funded. And as are firms financed by formal finance.

4.5.2 Parallel trend assumption

Although quick legal checks in Section 4.3.2 help rule out the possibilities of confounders from concurrent legislative changes, it is worth further allaying concerns thereof through a key feature of my probit difference-in-differences analysis: a parallel trend assumption.

[13]This reform is part of largest national administrative simplification program since "Doi moi" with markedly extensive coverage on several regulatory reform tools (e.g., regulatory impact assessment, stakeholder consultation). The program is collectively known as Project 30, aiming to enhance global and regional economic integration and competitiveness.

[14]Sample selection steps are as follows. The original dataset after data cleaning process has a totalling number of over 13,000 firm-year observations. As I aim to investigate manufacturing and mining sector, nearly 400 observations are dropped. Outliers of financial leverage account for over 100 observations dropped. As this chapter requires control and treated firms, I drop firms that hold formality status throughout surveyed years, and firms that have registered before the introduction of the reform. This step removes a totalling number of around 8,700 observations. The final sample used for this chapter has a total number of 3,703 observations.

Table 4.1: Descriptive statistics

Panel A	Mean	Std. Dev.
$FormalFinance$	0.228	0.419
$InformalFinance$	0.292	0.455
$Cofunding_{Formal>Informal}$	0.044	0.205
$Cofunding_{Informal>Formal}$	0.011	0.105
$Sole\text{-}funding_{Formal}$	0.167	0.373
$Sole\text{-}funding_{Informal}$	0.232	0.422
N	3703	
Panel B	**Young**	**Old**
Treated	272	524
Control	1,148	1,759
N	1,420	2,283

Notes: Table 4.1 reports descriptive statistics of financial outcomes for all-firms sample for the period 2005-2013 (Panel A) and the number of firms by the treatment variable and firm age (Panel B). Outcome variables include $Cofunding_{Formal>Informal}$ ($Cofunding_{Informal>Formal}$) are dummies equal to one if a firm co-funded by both formal and informal finance with a higher share of the former (latter) and zero otherwise. $Sole\text{-}funding_{Formal}$ ($Sole\text{-}funding_{Informal}$) are dummies for firms solely funded by formal (informal) finance. $FormalFinance$ ($InformalFinance$) are dummies for firms funded by formal (informal) finance in either form of $Sole\text{-}funding_{Formal}$ ($Sole\text{-}funding_{Informal}$) or co-funding. The treated groups include informal firms that become registered in the reform year and afterward; control groups for those remaining informal throughout examined periods. I assign firms to young and old firms based on a threshold of 15 years since establishment. Source: Authors' calculations.

The assumption holds should the differences in the outcome variables between the treated and control groups follow similar or parallel trends in pre-reform periods, and such differences do non-parallelly in post-reform horizons. Alternatively put, in absence of the reform, such differences otherwise remain unchanged with pre-reform differences.

To verify the assumption of parallel trends, I first investigate changes in outcome variables in preceding years of the reform. Table 4.2 reports the average change in the probability of using different forms of formal and informal finance for treated and control groups by firm age in certain years prior to the reform. For young firms, some changes in certain preceding years display differential trends between these groups (Column 3). For instance, two years prior to the reform, the change in the probability to use informal finance in any forms across these groups is statistically different from zero (Column 3); however, going back further a few more years, the change turns more equal. For old firms (Column 6), there are no marked differences in trends of all outcome variables of interest across all pre-reform horizons.

Next, I make double verification of parallel trends through covariates. Panel B of Table 4.2 reports the means of covariates in the nearest year of the reform for control and treated groups within each subsample of young versus old firms.[15] For a majority

[15]That said, the length of time periods going back prior to the reform is disproportional to the shrinking number of firms and observations to be compared. This may be problematic for the subsample of young firms for operational years fail to reach a six-year pre-reform horizon. Thus, to best gauge the plausibility of the common trends, I focus on the nearest examined year of the reform year for the largest number of

Table 4.2: Changes in outcome variables, means of covariates for years preceding the reform, t-tests between treated and control groups: Young versus old firms.

	Young firms			Old firms		
	Registered firms (Treated)	All-years informal firms (Control)	p-value (Test: treated =control)	Registered firms (Treated)	All-years informal firms (Control)	p-value (Test: treated =control)
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Changes in outcome variables						
$FormalFinance$						
Two	0.041	-0.059	0.232	-0.083	-0.063	0.701
Four	0.080	-0.165	0.056	-0.044	-0.119	0.247
Six	0.143	-0.197	0.041	0.025	-0.133	0.117
$InformalFinance$						
Two	0.163	-0.154	0.002	-0.050	-0.079	0.634
Four	0.080	0.082	0.987	0.000	0.025	0.718
Six	0.214	0.000	0.302	0.075	-0.085	0.159
$Cofunding_{Formal>Informal}$						
Two	0.000	-0.015	0.799	-0.033	-0.023	0.723
Four	-0.040	0.012	0.528	-0.022	0.004	0.353
Six	0.071	0.015	0.550	0.000	-0.042	0.429
$Cofunding_{Informal>Formal}$						
Two	0.020	-0.015	0.099	-0.017	-0.003	0.395
Four	0.040	-0.024	0.092	0.011	0.000	0.473
Six	0.071	-0.030	0.075	0.025	0.006	0.276
$Sole\text{-}funding_{Formal}$						
Two	0.041	-0.029	0.342	-0.033	-0.033	0.993
Four	0.080	-0.141	0.069	-0.033	-0.123	0.158
Six	0.071	-0.167	0.132	0.000	-0.097	0.261
$Sole\text{-}funding_{Informal}$						
Two	0.163	-0.125	0.003	0.000	-0.049	0.367
Four	0.080	0.106	0.839	0.0110	0.021	0.874
Six	0.143	0.030	0.550	0.050	-0.048	0.341
Panel B: Means of covariates						
Firm size	12.428	11.348	0.000	12.792	11.564	0.000
Start up constrained$_{no}$	0.176	0.183	0.896	0.183	0.173	0.803
Start up constrained$_{moderate}$	0.279	0.335	0.395	0.350	0.301	0.318
Start up constrained$_{severe}$	0.544	0.482	0.370	0.467	0.525	0.264
Skilled labour (%)	74.605	78.871	0.286	73.930	72.224	0.698
Innovation$_{improveproduct}$	0.382	0.243	0.025	0.417	0.189	0.000
Innovation$_{newproduct}$	0.000	0.009	0.430	0.008	0.011	0.824
Owners' characteristics						
- Education	0.338	0.427	0.196	0.442	0.328	0.024
- Past experience$_{industry}$	0.118	0.106	0.779	0.108	0.093	0.630
- Past experience$_{SOE}$	0.176	0.193	0.767	0.300	0.261	0.408
- Past experience$_{nonSOE}$	0.294	0.133	0.002	0.175	0.077	0.002
- Own land	0.662	0.670	0.904	0.717	0.787	0.113

Notes: Table 4.2 reports the average change in the probability of using different forms of formal and informal finance in preceding years prior to the reform (Panel A) and mean statistics of covariates in the nearest year of the reform (Panel B) for treated and control groups and t-tests for equality between these groups. Each row in Panel A reports statistics for certain years preceding the reform. As Vietnamese surveys were taken at two-year intervals, I compute the change going back two years at least and all the way back to the beginning of examined periods (six years). Young (old) firms are reported in the first (last) 3 columns where the first 2 columns present the average change in financing variables (mean of covariates) for treated and control groups and the last column gives the p-value of the t-test under the null hypothesis that the mean of each change (covariate) is the same across control and treated informal-firm groups for Panel A (Panel B). See definition of financing variables and treated groups in notes in Table 4.1. Source: Authors' calculations.

of controls in both subsamples, these groups have very similar patterns of specific characteristics. However, there are some characteristics that differ between these groups in plausible, reasonable explanation: firms that remain informal (control group) are older, smaller, less innovative with less educated owners than formalised firms (treated group). I also conduct a placebo test in robustness checks.

4.6 Empirical results

In this section, I start by reporting and discussing the overall causal effects of formalisation reform on propensity to use external financing of different forms for all studied Vietnamese firms before presenting the heterogeneity of the effects by firm age. Next, I show the impact varies depending on local governance quality. I also run additional tests on the volume of financing other than propensities. In the remaining section, I run robustness checks including propensity score matching, alternative specifications.

4.6.1 Baseline estimations: Firm age

Table 4.3 presents difference-in-differences estimates of the reform on propensity to use external financing of any forms by formality. All columns employ random effect probit specifications as in Eq.4.1 with marginal effects reported for each form of financing. For each specification, I report the "difference" estimates and corresponding DiD estimators. The difference estimates therefore compare marginal effects of the treated group—informal firms that become formalised in the reform year and afterward—to that of the control group—firms that remain informal throughout examined periods. The DiD indicator takes the value of one for formalised firms in the post-reform period (or the interaction term as in Eq. 4.1) and therefore is the cross-difference after taking first differences in each group of interest. The DiD indicator also is the average treatment effect on the treated of reform on corresponding propensities to use external finance. I first start the analysis for all sample firms (Panel A) and then move to subsamples of young and old firms (Panels B and C respectively).

For all sample firms, "difference" estimates are all reported positive, although some being statistically insignificant, ranging from as low as 0.1 percentage points to as high as 11.1 percentage points. These estimates suggest that, in pre- and post-reform years, the probability of a formalised firm that registered in or after the reform year to have external finance of any forms is higher than those remaining informal. More importantly, there are positive shifts in magnitude in these estimates around the passage of the reform. First, for formal finance, the estimated coefficient on "post-reform difference" for formal finance (Column 1, Panel A) remains positive and becomes almost twice as large in magnitude as pre-reform difference coefficient. That means the incongruence in propensity to use formal finance of either co-funding or sole-funding between formalised firms and all-years informal firms increased from 6 to 11.1 percentage points. When further disentangling

observations considered.

such impact into different forms of funding, I could attribute such changes to the increase in proportion of sole-funded firms by formal finance (Column 5, Panel A) with rather similar positive and increasing pattern. Second, for informal finance, the propensity of using informal finance in any form is significant and higher in after-reform years (Column 2, Panel A) and it appears that co-funding with a higher share of formal finance induce such change (See Column 3).

The DiD indicators of all forms of external financing are positive but none is statistically different from zero. Amongst them, the estimated coefficient for the probability of a firm co-funded with a higher share of informal finance has a smallest value of 0.005 (Column 4, Panel A), with particularly modest "difference" treated-control estimates relative to other forms of financing. The finding indicates that, after the introduction of reform, the probability thereof of a formalised firm increased by 0.5 percentage points more than that of an otherwise firm remaining informal. However, one could erroneously understand these values without taking into consideration of the mean. In so doing, this point estimate accounts for 50 (=0.005/0.01) percent of the average proportion of sample firms co-funded by informal finance, which is a sheer magnitude. In another DiD estimate of propensity to use formal finance, regardless of funding forms, has the highest value of 0.051 (Column 1, Panel A), amounting to a positive change of roughly 22 percent (=0.051/0.228) of sample mean.

This finding, although failing to support the $Hyp1$ with the prediction of increased use of informal finance only for registered firms, is in line with a large body of empirical literature that shows no significant impact of formalisation reform on formal financing such as Boly (2018) for the case of Vietnamese firms, and Bruhn (2014), de Andrade et al. (2014), Mel et al. (2013), McKenzie & Sakho (2010) for different reforms introduced for firm-level analyses of different countries.

Table 4.3: Marginal effects of the reform on propensity to use formal and informal financing between control and treated groups: All firms, young versus old firms

	Finance		*Co-funding*		*Sole-funding*	
	Formal	*Informal*	*Formal > Informal*	*Informal > Formal*	*Formal*	*Informal*
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: All firms						
Pre-reform difference	0.061**	0.026	0.016	0.001	0.052**	0.014
	(0.029)	(0.025)	(0.012)	(0.006)	(0.025)	(0.023)
Post-reform difference	0.111***	0.076***	0.030**	0.006	0.082***	0.040
	(0.027)	(0.028)	(0.013)	(0.006)	(0.023)	(0.028)
DiD (After – Before)	0.051	0.050	0.013	0.005	0.030	0.026
	(0.034)	(0.037)	(0.016)	(0.009)	(0.031)	(0.035)
N	3703					
Panel B: Young firms						
Pre-reform difference	-0.003	-0.025	0.006	-0.019**	0.017	-0.014
	(0.041)	(0.038)	(0.019)	(0.007)	(0.037)	(0.036)
Post-reform difference	0.085*	0.157***	0.036	0.013	0.042	0.119**
	(0.049)	(0.050)	(0.026)	(0.016)	(0.037)	(0.053)
DiD (After – Before)	0.088	0.182***	0.030	0.032*	0.025	0.132**
	(0.062)	(0.061)	(0.032)	(0.018)	(0.051)	(0.060)
N	1,420					
Panel C: Old firms						
Pre-reform difference	0.105***	0.062*	0.024	0.013	0.077**	0.031
	(0.037)	(0.033)	(0.015)	(0.008)	(0.032)	(0.030)
Post-reform difference	0.128***	0.060*	0.029**	0.005	0.099***	0.026
	(0.033)	(0.033)	(0.015)	(0.005)	(0.028)	(0.032)
DiD (After – Before)	0.023	-0.002	0.006	-0.008	0.022	-0.005
	(0.043)	(0.046)	(0.020)	(0.019)	(0.039)	(0.042)
N	2,283					

Notes: The table presents marginal effects of the difference-in-differences (DiD) estimates of the reform on propensity to use external financing of different forms for all sample firms (Panel A), and subsamples of young and old firms in Panel B and C, respectively. All columns report marginal effects from random-effect probit estimations as in Eq. 4.1 with Panel A including a full set of covariates and remaining panels excluding a firm age variable and its quadratic term. Dependent indicators equal 1 if the firm uses the corresponding financing form. First two rows of each panel report the "difference" estimates that compare marginal effects of the treated group—informal firms that become formalised in the reform year and afterward—to that of the control group—firms that remain informal—for pre- and post-reform periods. Last rows within each panel display the DiD estimator that equals 1 for formalised firms in the post-reform period and is the cross-difference after taking first differences in two corresponding rows above. See notes in Section 4.3.1 for more information about treatment indicators. *p <0.10, ** p <0.05, *** p <0.01. Standard errors in parentheses are clustered at the firm level. Source: Authors' calculations.

Next, in Panel B and C of Table 4.3, I examine heterogeneous effects of the formalisation reform on different forms of external financing by firm age. The difference-in-difference estimations that I conduct for two separate subsamples of young and old firms are similar with the above estimations for all-firms sample except for the inclusion of a firm age variable and its quadratic term in the set of controls. Generally, the positive treated-control "difference" estimates in Columns 1, 2, 3, and 5 of Panel C indicate that the propensity of treated firms—which are older and get formalised—to use external finance, regardless of any forms, is higher than that of firms remaining unregistered and in same age group in both pre- and post-reform periods. Younger firms, however, exhibit rather different patterns. In pre-reform periods, there are negative "difference" coefficients when I estimate the probability of using informal finance in either co-funding or sole-funding and in both of these forms; these values then turn positive in post-reform periods (Columns 2, 4, and 6, Panel B). This suggests that the reform prompted an avalanche of young firms that start formalised to rely more on informal finance. This is further confirmed by a marked difference in DiD estimators obtained for subsamples of young versus old firms.

Among DiD estimates, only those estimated for young firms on models over the probability of using informal finance in any forms are statistically different from zero (see again Columns 2, 4, and 6, Panel B). In particular, in Column 2, the strongly significant, positive point estimate suggests that the reform increased the probability of a young, registered firm using informal finance in form of either co-funding or sole-funding by 18.2 percentage points more than that of a young, otherwise unregistered counterpart. This is quite a considerable effect, given an increase to 62 percent (=0.182/0.292) of the average fraction of firms funded in a similar form in the sample. Such effect is mostly driven by the increase in probabilities of using informal finance only of 13.2 percentage points (Column 6, Panel 2). Neither are DiD estimated effects of the reform on propensity to use formal finance of any forms significant; nor are most post-reform difference estimates. These findings suggest that registered, young firms did not stand to benefit more formal finance from the reform than otherwise unregistered firms.

The remaining panel of Table 4.3 reports estimates for old, registered firms. There are positive, significant differences emerging in the post-reform period in probability to use formal finance at a higher magnitude than pre-reform period (See Columns 1 to 3 and panel C). The corresponding DiD estimates are positive yet insignificant over the full period examined. Columns 4 and 6 show negative DiD estimates for probability of using more informal finance in co-funding and informal finance only. Overall, these findings suggest that the reform reduced the use of more informal finance, while it increased the use of formal finance.

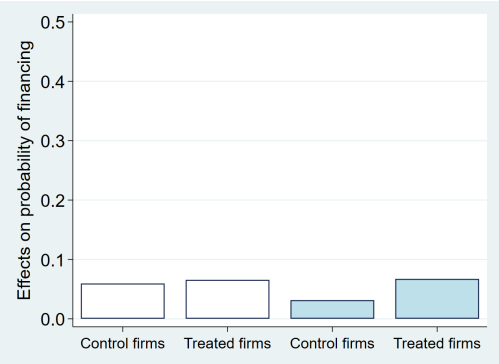
Next, to show the marginal effects of pre-post reform estimators for each firm group of interest, I plot the marginal effects on co-funding and sole-funding as outcome indicators for subsamples of young and old firms. A series of graphs in Figure 4.2 lends a strong support for estimations reported in Table 4.3. Transparent (blue) bars present estimates in pre-reform (post-reform) periods. Overall, I find strong, consistent evidence that in any forms of external finance, regardless of firm age, post-reform estimators of the treated group are higher than that of the control group, which implies a higher degree of demand-side coverage in financial markets emerging in the post-reform period from the registered

firms relative to those remaining informal.

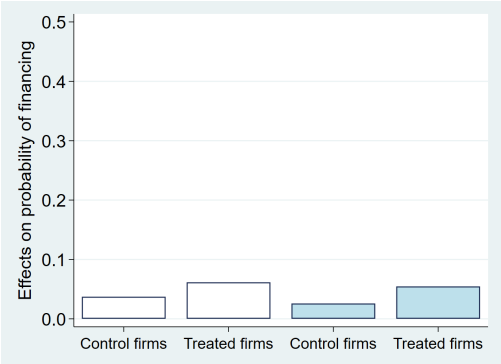
I first consider the pre-reform period when none of firms are registered. Noticeably, financial patterns in the pre-reform period of young firms are highly similar between registered (treated) and unregistered (control) firms (See transparent bars of graphs in left-hand side of Figure 4.2). In contrast, during such period, registered old firms (treated group) experienced higher probabilities of using external finance in any forms than unregistered old firms (control group) (See graphs in the right-hand side). Two interesting viewpoints are worth highlighting here. First, although some might question the possibility of unregistered firms in having access to formal finance, an explanation boils down to Vietnamese contextualised understanding that Vietnamese unregistered firms can secure formal loans by pledging land use rights certificates as collateral (Rand & Torm 2012). Second, a possible rationale for difference in financial patterns currently discussed is that some large informal firms are more productive and educated than others, and even capable to outperform small formal firms in formal financial markets with strong revenue profiles and social ties. This is more common in less developed countries where weak institutional environment is associated with a strong presence of informational asymmetries in financial markets (Distinguin et al. 2016). The latter suggests that the old unregistered firms in the treated group, even before getting formalised, could have been in good financial position with better access to formal loans than those in the control group. Hence, such treated firms—although seeing the formalisation reform as ordained to obtain formality status—may regard it as a way for their pre-existing advantages of credit access to amount to greater continued benefits, rather than as a way that offers a quantum leap of advantages as younger counterparts that start registered.

I then consider pre- and post-reform comparison practice within each firm-age group. Interestingly, after the reform, young registered firms if using informal finance, prefer to use it only without in combination with formal finance. This is explained by rather inconsiderable fraction of those co-funded by both formal and informal finance with a higher share of the latter (see Panels a and c, Figure 4.2) and also a nearly double increase in the propensity to use informal finance only of registered firms in post- and pre- reform periods (Panel g). Two bottom graphs in Panels g and h of Figure 4.2 show that the reform increased marginal effects of propensities to use informal finance only in young firms nearly twice as much as that for older firms (40 versus 25 percentage).

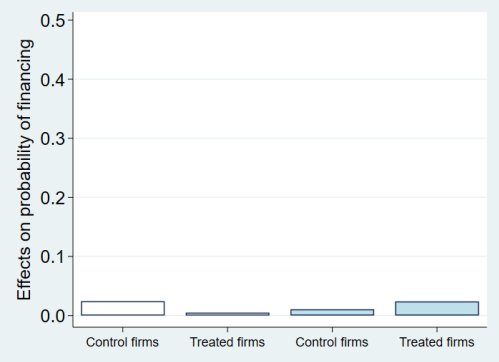
Figure 4.2: Estimates of the reform on probability of using formal and/or informal finance: Young versus old firms



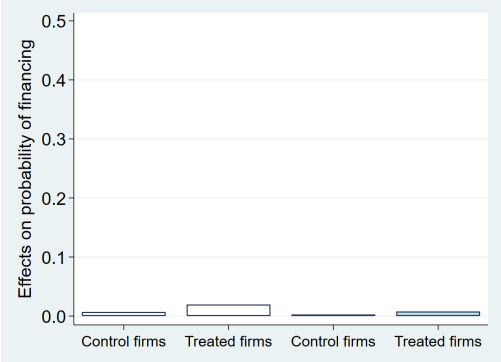
(a) Young firms, $Co\text{-}funding_{Formal>Informal}$



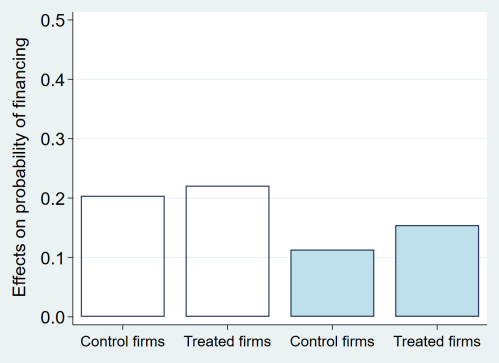
(b) Old firms, $Co\text{-}funding_{Formal>Informal}$



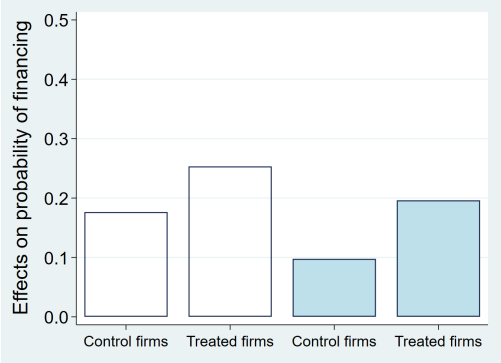
(c) Young firms, $Co\text{-}funding_{Informal>Formal}$



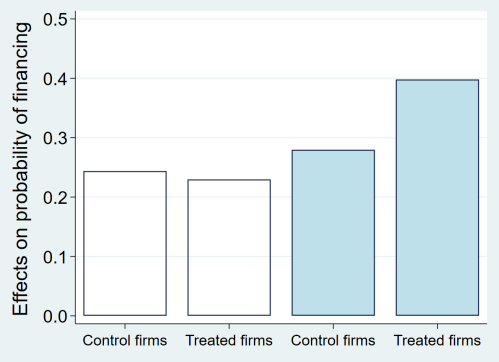
(d) Old firms, $Co\text{-}funding_{Informal>Formal}$



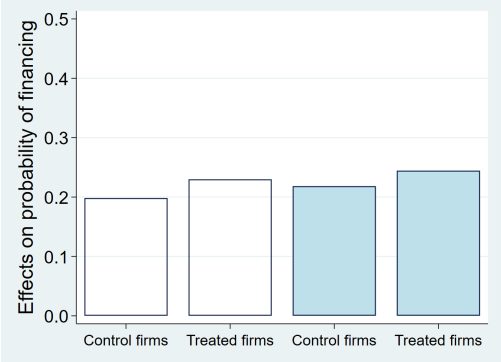
(e) Young firms, $Sole\text{-}funding_{Formal}$



(f) Old firms, $Sole\text{-}funding_{Formal}$



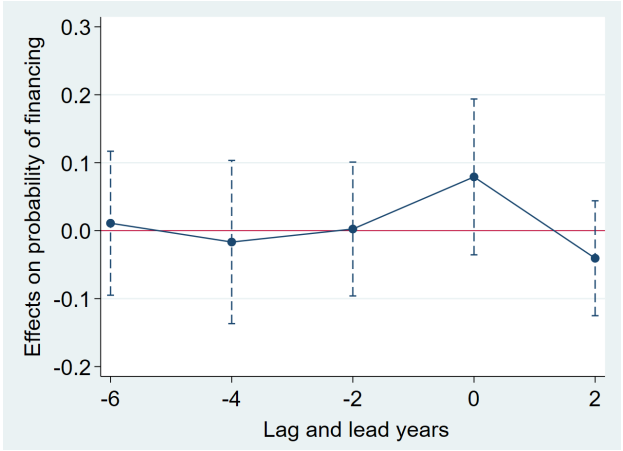
(g) Young firms, $Sole\text{-}funding_{Informal}$



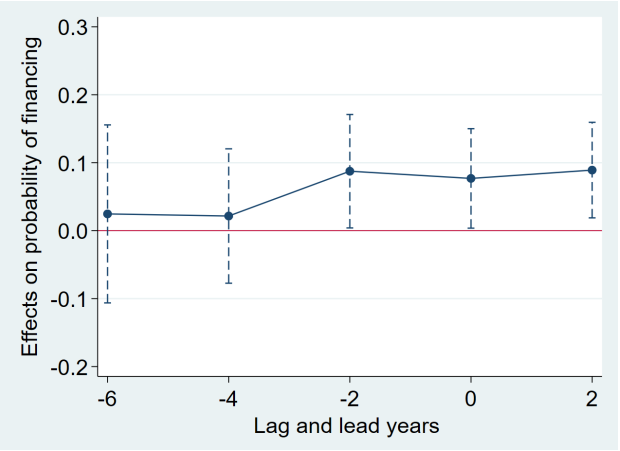
(h) Old firms, $Sole\text{-}funding_{Informal}$

Notes: The graphs plot marginal effects of the reform on the probability of using formal and/or informal finance for young and old firms in pre-reform (transparent bars) and post-reform (blue bars) periods. Source: Author's calculations.

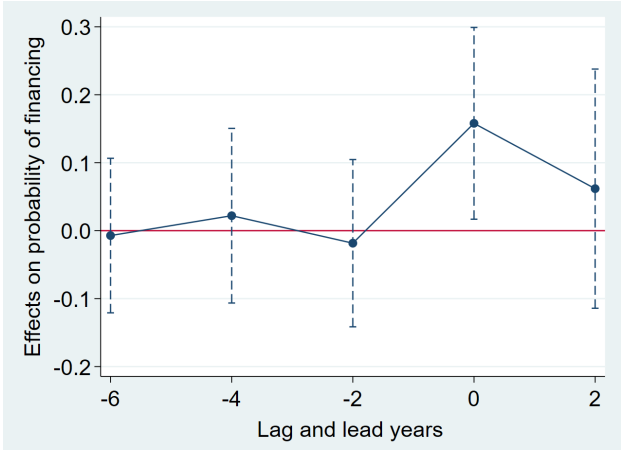
Figure 4.3: Dynamic estimates of the reform on probability of sole-funding by either formal or informal finance: Young versus old firms



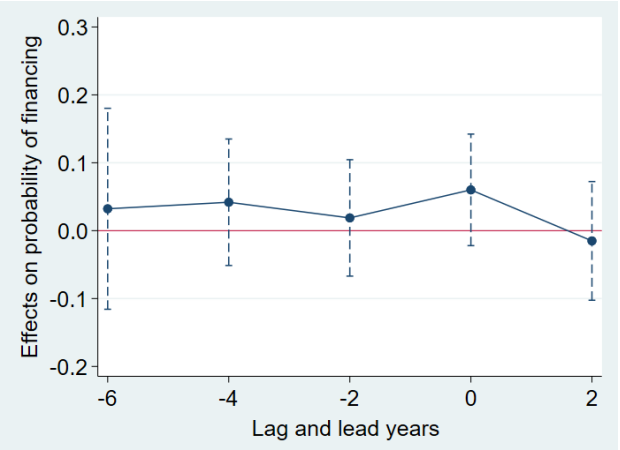
(a) Young firms, $Sole\text{-}funding_{Formal}$



(b) Old firms, $Sole\text{-}funding_{Formal}$



(c) Young firms, $Sole\text{-}funding_{Informal}$



(d) Old firms, $Sole\text{-}funding_{Informal}$

Notes: The graphs plot the dynamic marginal effects of the reform on the probability of using formal or informal finance only for young and old firms across lag and lead years relative to the reform year. The capped spikes present 95 % confidence intervals. Source: Author's calculations.

Dynamic estimates

In order to fully substantiate heterogeneous effects accompanied by the reform, I further examine the dynamic effects of the reform year by year in the following probit DiD regression for young and old firms:

$$Financing_{it} = \begin{cases} Financing^{*}_{it} = E(Y|Years, Formalised, Z) \; if \; Financing_{it} = 1 \\ 0 \; if \; Financing_{it} = 0 \end{cases} \tag{4.3}$$

where

$$\begin{aligned} E(Y|Reform, Formalised, Z) =& \alpha + \sum_{\rho=-6}^{2} \beta_{\rho} Years_{i\rho} + \gamma Formalised_{i} \\ &+ \sum_{\rho=-6}^{2} \delta_{\rho} Years_{i\rho} \times Formalised_{i} + \eta Z_{it} + \zeta \bar{Z}_{it} + \varepsilon_{it} \end{aligned} \tag{4.4}$$

and $Years_{i\rho}$ denotes a set of dummies for lag $(-\rho)$ and lead $(+\rho)$ years relative to the year in which the reform was passed and first implemented ($Years_0$). I use all lag and lead dummies from $Years_{-6}$ to $Years_{+2}$ at 2-year intervals to cover an entire time horizon considered. I plot the marginal effects obtained from the regression above. As the reform is reported to make little differences in the use of co-funding between registered firms and those remaining informal as shown in bar graphs, I only display difference estimates for sole-funding of either formal or informal finance as outcome variables in Figure 4.3. The capped spikes present 95 percent confidence intervals of the estimates.

As predicted, for young firms, the estimated differences in sole-funding of either finance are very close to zero until the first implementation of the reform but increase and turn significant and positive in $Years_0$. The differences, while become negative in $Years_{+2}$ for firms using informal only (Panel a , Figure 4.3), or remain positive in lesser magnitude for those solely funded by informal finance (Panel c). Among counterparts staying informal longer, those funded by formal finance only showed the positive estimated differences across all lag and lead dummies (Panel b), while the comparatively positive effects fade quickly in $Years_{+2}$ for those using informal finance only (Panel d). These findings show evidence that the reform increased (reduced) the probability of using informal finance for young (old) firms and sustained continued advantages in better access to formal finance for old firms.

In sum, there are possibilities that old firms within the treated group continue to benefit from more access to formal finance with a resultant reduction in informal finance after the reform and that young firms struggle to increase their access to formal finance and have a continued use of informal finance instead. This finding supports $Hyp2$. This finding is first in line with the empirical studies that firms starting up unregistered longer benefits more from later formalisation (Assenova & Sorenson 2017, Williams et al. 2017). The rationale is that younger firms face liabilities of newness and registration costs and thefore lack opportunities to spare resources to applying for more formal loans. The con-

tinued use of informal finance however helps satisfy the immediate financial demand. In contrast, older firms with depleted long-standing liabilities of newness can afford such initial and ongoing registration costs and more formal finance. Second, pointing to Vietnam in context, an increased use of informal finance may not increase total borrowing costs if otherwise using formal finance since informal loans are not that costly relative to formal finance in Vietnam in comparison with other countries (See Degryse et al. (2016) for a Chinese sample).

4.6.2 Local governance

I add an extra layer of contextualised understanding of Vietnamese business environment by controlling additional provincial factor in the baseline estimations: local governance quality. The same nationwide reform may not have uniform effects due to differential municipal and provincial characteristics. To this end, I follow Nguyen & Canh (2020) and use Provincial Competitive Indices (PCI) which show the degree of law enforcement efficiency at the provincial level.[16] The indices are scored in the range from 0 to 100 with a higher index indicating more transparent, less corrupted local governance and implications of better legal enforcement and support for the formalisation reform implementation. I assign firms located in provinces where the PCI is over (below) median PCI of yearly sample distribution to strong (week) governance. As discussed above, firms that start formalised in provinces with strong local governance may benefit from the way in which the local authorities control financial markets: increased (decreased) formal (informal) finance.

[16]This set of indices of local governance quality is measured on a broad panel of 63 provinces and constructed by VCCI under the technical support from USAID (See a report by Malesky (2008) for details and further information via the link https://pcivietnam.vn/) Note that the indices are not available for the year 2005 studied so replacement values are from the nearest year 2006 in which construction of the indices commenced.

Table 4.4: Marginal effects of DiD estimates with local governance quality: All firms, young and old firms

	$FormalFinance$		$InformalFinance$		$Sole\text{-}funding_{Formal}$		$Sole\text{-}funding_{Informal}$	
	Weak	Strong	Weak	Strong	Weak	Strong	Weak	Strong
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: All firms								
DiD	0.022	0.065	0.083	0.075*	-0.048	0.058	0.020	0.066*
	(0.053)	(0.043)	(0.068)	(0.042)	(0.047)	(0.039)	(0.067)	(0.038)
N	1,504	2,199	1,504	2,199	1,504	2,199	1,504	2,199
Panel B: Young firms								
DiD	-0.092	0.185**	0.211**	0.202**	-0.174**	0.141**	0.128	0.157**
	(0.094)	(0.079)	(0.090)	(0.079)	(0.079)	(0.067)	(0.098)	(0.074)
N	569	851	569	851	569	851 569	851	
Panel C: Old firms								
DiD	0.080	-0.000	0.025	0.025	0.021	0.016	-0.028	0.040
	(0.062)	(0.053)	(0.087)	(0.050)	(0.055)	(0.049)	(0.084)	(0.043)
N	935	1,348	935	1,348	935	1,348	935	1,348

Notes: The table presents marginal effects of the difference-in-differences (DiD) estimates for baseline estimations with local governance quality for all firms (Panel A), and subsamples of young and old firms (Panels B and C). The strong (weak) local governance dummies take the value of 1 if firms are located in provinces where the Provincial Competitive Indices has over (below) median of yearly sample distribution. *p <0.10, ** p <0.05, *** p <0.01. Standard errors in parentheses are clustered at the firm level. See notes in Table 4.3 for more details of financial variables and more. Source: Authors' calculations.

The results are reported in Panel A of Table 4.4 for entire sample and in Panel B and C for subsamples of young and old firms, respectively. For DiD estimates for all firms, there is no difference in the probability of using formal finance between strong and weak local governance. The DiD estimate for informal finance under strong governance is slightly significant at 10 percent level (See Column 4, Panel A). Despite the impossibility of conducting estimations on co-funding,[17] this effect is largely driven from firms funded by formal finance only since the estimator in Column 8 is similarly large.

Moving further to young firms in Panel B, I find that the DiD estimates vary substantially across the degree of local governance and the forms of financial loans. The effect on formal finance in either form (Column 2, Panel B) is positive and statistically significant at 5 percent level, indicating that the reform increased the propensity to use formal finance by 18.5 percentage points for young, formalised firms more than young counterparts that remained informal under stronger local governance. This effect amount to 81 percent (=0.185/0.228) of the baseline sample mean. This effect is majorly driven from firms funded by formal finance only since the magnitude of the DiD coefficient in Column 6 of Panel B is readily comparable. Interestingly, under weaker local governance, the reform however reduced the propensity to use formal finance only in young registered firms by 17.4 percentage points (significant at 5 percent level), which is quite sizeable effect (75 percent = 0.174/0.232 of the mean). The marked difference in sign of DiD estimates under weak versus strong governance makes the estimates offset against each other, further explaining why the totalling effect for young firms becomes insignificant in previous section (See Panel B, Table 4.3). Turning to informal finance, I find that the estimated effects are both positive and slighter larger in magnitude in weak local governance (Columns 3 and 4, Panel B). However, such effect is only seen in an increase in the probability of firms solely funded by informal finance under stronger local governance (Column 8, Panel B).

For Panel C of old firms, quite surprisingly, there is no reform-induced change in the propensity to use external finance in any degree of local governance. Collectively, the results in Table 4.4 partially support $Hyp3$ in two ways. First, the impossibility of obtaining results for co-funding (in all panels) keeps the impact of registration reform on co-funding remain unanswered. However, the finding that the reform is associated with an increase in the use of both formal and informal finance for young, registered firms with stronger local governance is consistent with the finding by Nguyen & Canh (2020). The authors analysing Vietnamese firms find that those operating in strong local governance benefit access to both formal and informal finance in either form of co-funding or sole-funding. Moreover, under weaker local governance, the reform led to a significant reduction in the probability of a young firm solely funded by formal finance. This finding verifies the suggestion by Straub (2005) that better enforcement reduces the need for registered firms to rely on informal finance. Second, the finding that old firms starting registered after the reform are unlikely to gain any advantages from the location in which they operate does not support the $Hyp3$.[18]

[17] In the previous section, I visually show the small fractions of co-funded firms in subsamples of young versus old firms, let alone in smaller subsamples by a regional control. Thus, the outcome indicators can be perfectly predicted by DiD estimators, leading to dropped observations.

[18] Instead of running separate regressions for subsamples of firms located in provinces with weak and strong local governance, I conduct the triple differences estimations by employing triple interaction terms

Table 4.5: Marginal effects of financial conditions in early establishing years on financing variables: Young versus old firms.

	Finance		*Co-funding*		*Sole-funding*	
	Formal	*Informal*	*Formal* > *Informal*	*Informal* > *Formal*	*Formal*	*Informal*
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Young firms						
Start up constrained$_{moderate}$	0.061*	-0.002	0.024*	0.011	0.029	-0.034
	(0.034)	(0.041)	(0.014)	(0.008)	(0.028)	(0.038)
Start up constrained$_{severely}$	0.124***	0.016	0.030**	0.014*	0.086***	-0.018
	(0.033)	(0.038)	(0.014)	(0.007)	(0.027)	(0.036)
N	1,420					
Panel B: Old firms						
Start up constrained$_{moderate}$	0.097***	0.051*	0.032***	0.002	0.061***	0.018
	(0.027)	(0.027)	(0.010)	(0.003)	(0.023)	(0.025)
Start up constrained$_{severely}$	0.118***	0.081***	0.025***	0.008**	0.081***	0.048**
	(0.025)	(0.024)	(0.009)	(0.003)	(0.021)	(0.023)
N	2,283					

Notes: The table presents marginal effects of the degree of financial constraints that an informal firm started up on the probability of using formal and informal loans for separate subsamples of young (Panel A) versus old firms (Panel B). These characteristics are pulled from the baseline estimations for corresponding subsamples. *p <0.10, ** p <0.05, *** p <0.01. Standard errors in parentheses are clustered at the firm level. See notes in Table 4.3 for more details of financial variables and more. Source: Authors' calculations.

4.6.3 Additional tests

Start up financially constrained

Table 4.5 presents the marginal impacts of a set of firm-specific characteristics on the probability of using formal and informal loans for separate subsamples of young versus old firms, although the focus is on dummies related to financial position: the degree of financial constraints that an informal firm started up with. These dummies are taken from responses of the survey question "Which difficulties were encountered when the enterprise was established / bought for the first time? Lack of capital?"; its responses are coded as "Severe difficulty (1); moderate difficulty (2); insignificant difficulty (3)". The dummies in Table 4.5 include dummies of severely and moderately financial constraints with the reference category referring to a dummy of insignificant constraints.

Broadly, regardless of firm ages, firms starting up severely and moderately constrained had higher probability of using external finance than those without significant constraints and the probabilities estimated are higher for the former than the latter. Particularly, as in Panel A of Table 4.5, young firms that faced a severe lack of capital in establishment years appear to prefer to use more formal finance than those facing no constraints: a higher

between$Reform$, $Formalised$ and $HighPCI$ where $HighPCI$ takes the value of 1 if firms located in provinces under stronger local governance quality. These estimations enable me to keep the sample size and degrees of freedom as many as possible and to technically test the differential impacts across different firm groups. See results in Table A4.3 in Appendix to Chapter 4.

probability of 8.6 percentage points (significant at 1 percent level) in using formal finance only and another higher propensity to use co-funding of more formal (informal) finance of 3.0 (1.4) percentage points at 5 (10) percent level. Also, there is no difference between young firms with and without financial constraints in using informal finance; neither is the difference in using external finance between young firms with moderate constraints and those starting up with no significant financial constraints whatsoever.

For old firms, Panel B of Table 4.5 shows that those severely and moderately lacking capital in early establishing years appear more reliant upon informal and formal finance in the examined periods than those without financial constraints. Interestingly, the fraction of firms solely funded by formal finance for constrained firms relative to unconstrained firms (Column 5) is higher than that of firms co-funded (Columns 3 and 4). Those being severely constrained early on experienced higher probabilities of 5 percent in using informal finance only (Column 6).

Overall, these findings suggest that informal firms starting up unregistered in different time periods—before or after the "Doimoi"—experience varying degrees of likelihood of using formal and informal finance throughout examined years depending on severity of financial constraints that they were binding to in early establishment years. Regardless of varying amounts of time operating in the market, firms starting up severely constrained rely more on external finance than counterparts having a financially unconstrained start: young firms use more formal finance only while old firms rely on both. In this way, the liabilities of newness (as in Williams et al. (2017)) matter to the demand of finance both short-and long-run. However, younger firms prefer to use formal finance to meet their financial demand, while older firms are still in the habit of using informal finance.

Volume of finance

An important follow-up question is whether the volume of formal and informal finance of treated firms is any different to that of untreated firms. Note that here estimations follow Tobit regressions in which I left-censor the dependent variables to estimate the nonzero leverage of interest. The reason is because there are a large majority of firms not using external finance (See Table 4.1), the inclusion of zero leverage could bias the results. I report the results in Table 4.6 for all firms and subsamples of young versus old firms. Column 1 shows that the registration reform, on average, increased formal leverage for registered firms by 6.6 percentage points more than untreated firms. This effect is sizeable and statistically significant at 5 percent level. Although when dividing the sample by firm age, the effect does not hold. The remaining columns report the estimates on the amount of informal finance for all firms, then young and old firms. From Column 5, I observe that the reform increased informal leverage for young registered firms by 7.5 percentage points more than that for firms unregistered. By contrast, the reform decreased the volume of informal finance for old, treated firms by 0.8 percentage points more than old, untreated firms, albeit insignificant effects. In all, the results obtained suggest that the reform induced young (old) firms to use informal finance more (less).

Table 4.6: Volume of finance: Tobit regressions left-censoring at zero formal and informal leverage: All firms, Young vs Old

	Formal leverage			Informal leverage		
	All	Young	Old	All	Young	Old
	(1)	(2)	(3)	(4)	(5)	(6)
Reform	-0.109***	-0.108***	-0.047	0.008	0.004	0.004
	(0.037)	(0.042)	(0.030)	(0.018)	(0.021)	(0.013)
Formalised	0.047**	0.012	0.072**	0.008	0.004	0.019
	(0.024)	(0.034)	(0.029)	(0.011)	(0.018)	(0.013)
Reform×Formalised	0.061**	0.080	0.040	0.021	0.073**	-0.007
	(0.029)	(0.060)	(0.034)	(0.016)	(0.031)	(0.016)
N	3,703	1,420	2,283	3,703	1,420	2,283

Notes: This table presents estimations for following tobit regressions in which I left-censor dependent variables to estimate corresponding nonzero leverage:

$$fLeverage = \alpha + \beta Reform_{it} + \gamma Formalised_i + \delta Reform_{it} \times Formalised_i + \eta Z_{it} + \zeta \bar{Z}_{it} + d_t + \varepsilon_{it} \quad (4.5)$$

Where $fLeverage_{it}$ is the ratio of formal or informal debts to total assets for firm i in survey year t. For definition of variables in the right-hand side of the equation, see notes of Eq. 4.2 in Section 4.3.1. Source: Authors' calculations.

4.6.4 Robustness checks

I run several robustness checks with propensity score matching, triple differences effects for heterogeneous of firm age, different variables for registered firms, and different specifications.

Propensity score matching

To allay concerns over possibilities of overlap for covariates that follow differential trends in the pre-reform period (See Panel B, Table 4.2), I estimate propensity scores to match all-years informal firms (control group) and registered firms (treated group) based on the similarity of all covariates included in the baseline estimations.

First, I follow the literature on matching techniques, running the balancing test to compute the statistical difference of variables included in the matching. I employ the regression approach as suggested by Arnold & Javorcik (2009), Smith & Todd (2005). The key mechanism is to regress each variable included in the propensity score on the quartic function of propensity score estimated and its interaction terms with Formalised the treatment variable in a following model:

$$\begin{aligned} Z_k =& \beta_0 + \beta_1 \hat{P}(Z) + \beta_2 \hat{P}(Z)^2 + \beta_3 \hat{P}(Z)^3 + \beta_4 \hat{P}(Z)^4 \\ &+ \beta_5 Formalised + \beta_6 Formalised \times \hat{P}(Z) + \beta_7 Formalised \times \hat{P}(Z)^2 \\ &+ \beta_8 Formalised \times \hat{P}(Z)^3 + \beta_9 Formalised \times \hat{P}(Z)^4 + \eta \end{aligned} \quad (4.6)$$

where $\hat{P}(Z)$ is estimated propensity score; Z_k denotes a set of covariates used in

Table 4.7: Propensity score matching

	Finance		*Co-funding*		*Sole-funding*	
	Formal	*Informal*	*Formal > Informal*	*Informal > Formal*	*Formal*	*Informal*
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: All firms						
ATT	0.081	0.013	0.037**	0.010	0.029	-0.041
	(0.055)	(0.098)	(0.017)	(0.009)	(0.052)	(0.084)
Treated	796					
Control (matched)	2,446					
Panel B: Young firms						
ATT	0.055	-0.067	0.041	-0.002	0.002	-0.115
	(0.104)	(0.099)	(0.044)	(0.006)	(0.050)	(0.141)
Treated	272					
Control (matched)	977					
Panel C: Old firms						
ATT	0.151*	0.054	0.057***	0.025**	0.085**	-0.013
	(0.087)	(0.088)	(0.015)	(0.012)	(0.037)	(0.082)
Treated	524					
Control(matched)	1,468					

Notes: This table reports propensity score matching estimations on different forms of formal and informal financing. Propensity scores are first estimated in a probit model of the treatment indicator on all covariates included in the model. Then, the nearest score matching only selects all-years informal firms (control group) that are most closely similar with each registered firms (treated group) based on above covariates to make comparison. Note that all matching estimations are based on covariates in the pre-reform year 2009. *p <0.10, ** p <0.05, *** p <0.01. Source: Author's own calculations.

the matching techniques. The essential statistic is under the null hypothesis that the coefficients on all terms involving with the Formalised treatment dummy are jointly equal to zero. This hypothesis therefore tests whether the Formalised treatment variable is correlated with covariates Z_k conditional on a quartic function of propensity score.

The Table A4.4 (reported in Appendix to Chapter 4) shows that in most tests, there are no statistically significant differences regarding firm characteristics between the treated and control groups. Note that few low p-values in some balancing conditions, for example, own land, or firm size, could be due to the poorly determined propensity scores or the strict order of the polynomial in the regression, which is a downside of this balancing regression approach. Second, after obtaining propensity scores that satisfy balancing condition on covariates of interest, I use the nearest-neighbor matching technique which restricts the control group to the nearest-neighbor matches for each registered firm (Dehejia & Wahba 2002).[19]

Second, I estimate the average treatment on the treated estimators corresponding to a set of financial forms and the number of actual matches. The results are reported in Table 4.7. The matching results are robust to the baseline estimations in Table 4.3 to some extent. In Panel C, significant matching estimators highlight strong effects of the reform on increased use of formal finance in both forms of co-funding and sole-funding for firms that delay their registration long enough, while there appear no significant effects of the reform on using informal finance only. Although the strong positive effects of reform on different forms of formal finance is not well present in DiD estimators of baseline results, the "difference" estimates (See Panel C, Table 4.7) alongside Figure 4.2 suggest so. This finding further reassures that the registration reform, although often viewed as ordained to obtain formality status, is an added advantage for informal incumbents for continued benefits of having access to formal finance in either form of co-funding or sole-funding. There appears a higher number of older firms funded by formal finance after the introduction of registration reform. This finding further confirms the immediate access to finance after becoming formal; however, it holds true for those delaying registration at start-up. The propensity score matching stresses the major benefit of formalisation, which is access to formal finance, consistent with the theoretical and empirical literature on the link between reduced registration procedures and more efficient financial markets (Straub 2005, Quintin 2008).

Placebo estimations

To further verify the parallel trends assumption, I conduct placebo regressions for restricted time periods to pre-reform years only; the studied sample size is reduced accordingly. I falsely assume that Vietnam passed the reform two years earlier; that year is the nearest preceding year of the reform since the sample is available at two-year intervals. To this end, I replicate the baseline DiD specification as in Eq. 4.1; however, I instead use the

[19]Note that the balancing test using regression approach is not restricted to only nearest-neighbour matching observations in the control group. Although this may not be the most ideal balancing test for the analysis which uses the nearest-neighbour matching method, the results should be valid because the number of controls assigned for nearest-neighbour matching method, for my case, is quite close to the number of all potential observations in the group.

Table 4.8: Placebo estimates

	Finance		*Co-funding*		*Sole-funding*	
	Formal	*Informal*	*Formal* > *Informal*	*Informal* > *Formal*	*Formal*	*Informal*
	(1)	(2)	(3)	(4)	(5)	(6)
All firms	0.061	0.020	0.006	0.010	0.031	-0.001
	(0.044)	(0.050)	(0.026)	(0.013)	(0.041)	(0.044)
N	2,162					
Young firms	0.000	-0.015	-0.033	-	-0.017	-0.014
	(0.063)	(0.080)	(0.039)	-	(0.056)	(0.070)
N	923					
Old firms	0.073	0.032	0.023	-	0.040	0.002
	(0.056)	(0.063)	(0.033)	-	(0.055)	(0.056)
N	1,239					

Notes: This table provides a placebo test with restriction to pre-reform years only. I falsely assume that Vietnam passed the reform two years earlier and re-estimate the Eq. 4.1 by using the following DiD regression:

$$Financing_{it} = \begin{cases} Financing^{*}_{it} = E(Y|PlaceboReform, Formalised, Z) \; if \; Financing_{it} = 1 \\ 0 \; if \; Financing_{it} = 0 \end{cases} \tag{4.7}$$

where

$$\begin{aligned} E(Y|Reform, Formalised, Z) =& \alpha + \beta PlaceboReform_{it} + \gamma Formalised_{i} \\ &+ \delta PlaceboReform_{it} \times Formalised_{i} + \eta Z_{it} + \zeta \bar{Z}_{it} + d_{t} + \varepsilon_{it} \end{aligned} \tag{4.8}$$

Where the $PlaceboReform$ equals 1 for the year of the falsely implemented reform and zero otherwise. All other variables remain same as in Eq. 4.1. See notes in Table 4.3 for details of other variables and controls. Note that it is impossible to compute estimated coefficients on $Co\text{-}funding_{Informal>Formal}$ as an outcome indicator since using smaller sample in pre-reform years leads to many dropped observations and this outcome indicator can be perfectly predicted by DiD estimators of $PlaceboReform$ and $Formalised$. *p <0.10, ** p <0.05, *** p <0.01. Source: Author's own calculations.

placebo reform indicator which equals 1 for the year of the falsely implemented reform and zero otherwise. The estimated model is specified in notes in Table 4.8. The aim is to test the null that the coefficients associated with interaction term PlaceboReformxFormalised is statistically different from zero. The corresponding placebo estimates in Table 4.8 for all firms, young and old firms are not statistically significant at any significant levels, showing no effect of the placebo reform on different financial decisions of formalised firms. This finding provides evidence that, in pre-reform periods, informal firms that become formal after the introduction of the reform made similar financial decisions with those informal throughout examined years.

Triple differences estimations (DDD)

As a robustness check of the baseline estimation as in Eq. 4.1, I conduct the corrected random-effects probit model yet employ the triple interaction terms between $Reform$, $Formalised$ and Old (where Old is a dummy equal one for incumbent firms older than 15

years and zero otherwise) for the whole sample to highlight the heterogeneous effects of the reform on registered firms by firm age. In this way, instead of running separate regressions for subsamples of young versus old firms, the triple interactions allow the explorations of the relative probabilities to use external finance for treated versus untreated firms and then resolve the difference between two subsamples of young and old firms. Alternatively put, the DDD estimations enable me to keep the sample size and degrees of freedom as many as possible and to technically test the differential impacts across different firm groups. All controls are included as detailed in Eq. 4.1. The marginal effects of the DDD estimates are reported in Panel A of Table 4.9. The DDD estimators for ReformxFormalisedxOld report differential changes in financial decisions between young and old registered firms after the introduction of reform. A positive and statistically significant coefficient of 17.3 in column 6 of Panel A shows that the reform reduced the use of informal finance only of old registered firms relative to young registered firms by 17.3 percentage points (significant at 5 percent level). This finding is robust with the baseline estimation, futher supporting the finding of Boly (2018), Bruhn (2014), de Andrade et al. (2014) that there is no significant impact of formalisation reform on formal finance.

Alternative measure of formalised firms

To further gauge the plausibility of the effects, I conduct another probit difference-in-differences test with an alternative classification of informality by using business registration certificate. As discussed in footnote 13 of Chapter 3, after the reform, a new registration law applies so a registered firm obtains a business registration certificate that embeds a tax code as opposed to the old registration system requires a separate tax code apart from the certificate. Also, the treated group considers surveyed firms registered in the last two ways of data, so the previous registration system does not matter in this context. Thus, instead of using tax code, I use the acquisition of a business registration certificate to identify a group of firms that start registered after the introduction of the reform. Although this classification might yield a more appropriate measure of formality for the contextualised understanding of this study, the formality definition by using tax code corresponds to more broad literature (for instance, Rand & Torm (2012) for Vietnamese firms, and Fajnzylber et al. (2009), McKenzie & Sakho (2010) for Mexican micro-firms)

The results are reported in Panel B of Table 4.9. For all firms estimations, the DiD estimator for formal finance is positive yet statistically significant at 10 percent level and there is not clear whether it comes from co-funding or formal only since all following coefficients. Moving to Panel B and C for young and old firms respectively, I find that reform increased the probability of a young registered firm having informal finance by 15.3 percentage points more than unregistered firms (Column 2, Panel B)—quite close with the findings in Table 4.3, while the reform increased the propensity to use formal finance by sole-funding, although coefficients are significant at 10 percent level (Columns 1 and 5, Panel B). Overall, using this alternative classification yields slightly different results but most are robust with the baseline estimations, especially the results of young firms and the use of informal finance around the passage of the reform. The difference is perhaps due in part to the smaller number of observations since there are not as many firms reported with the business registration certificate as with the tax code.

Table 4.9: Other robustness checks

	Finance		*Co-funding*		*Sole-funding*	
	Formal	*Informal*	*Formal > Informal*	*Informal > Formal*	*Formal*	*Informal*
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Triple differences estimations						
All firms: DDD	0.065	-0.174**	0.003	-0.026	0.080	-0.173**
	(0.072)	(0.070)	(0.037)	(0.019)	(0.062)	(0.068)
N	3,703					
Panel B: Alternative measure of formalised firms						
All firms: DiD	0.068*	0.028	0.024	0.006	0.041	-0.003
	(0.036)	(0.037)	(0.017)	(0.007)	(0.033)	(0.035)
N	3,144					
Young firms: DiD	0.042	0.152**	0.044	-	-0.031	0.084
	(0.062)	(0.062)	(0.034)	-	(0.054)	(0.060)
N	1,188					
Old firms: DiD	0.084*	-0.016	0.016	-	0.076*	-0.023
	(0.045)	(0.046)	(0.021)	-	(0.041)	(0.042)
N	1,956					
Panel C: Alternative specification: Fixed-effects Linear probability model						
All firms: DiD	0.053	0.030	0.011	0.001	0.039	0.017
	(0.035)	(0.040)	(0.018)	(0.010)	(0.033)	(0.038)
N	3,703					
Young firms: DiD	0.125*	0.191**	0.028	0.031	0.083	0.148*
	(0.074)	(0.086)	(0.042)	(0.021)	(0.067)	(0.080)
N	1,420					
Old firms: DiD	0.035	0.013	0.015	-0.010	0.027	0.005
	(0.046)	(0.050)	(0.022)	(0.014)	(0.042)	(0.046)
N	2,283					

Notes: This table reports alternative estimations of baseline estimations to check heterogeneous effects by triple differences estimations (Panel A), alternative DiD estimations on the treatment variable (Panel B) or on model specification (Panel C). See notes in Table 4.3 for more details of financial variables and more. *p <0.10, ** p <0.05, *** p <0.01. Source: Author's own calculations.

Alternative method

I re-estimate the correlated random-effects probit model with a fixed-effects linear probability model which includes all controls as in Eq. 4.1. An advantage of this fixed-effects linear probability model is that it controls firm-specific unobserved heterogeneity. The key variables of interest are interaction terms between reform and formalised firms. The coefficients for the interaction terms are positive and statistically significant at 5 and 10 percent significant levels in Column 1, 2 and 6 of Panel B. Taken together with the coefficients for Reform, the registration reform reduced (increased) the use of formal (informal) finance for registered, young firms relative to those remain unregistered. There is no evidence in effects of reform on older firms on any changes in their financial decisions. The findings are quite robust with baseline estimates in Table 4.3.

4.7 Limitations and avenues for future research

Within the scope of the chapter, there are nonetheless several limitations and alternative steps forward to further investigate the business environment of Vietnamese micro firms.

First, future research should place great emphasis on the reasons that a firm draws on to make decision of registration and rank these reasons in the order of importance. Although this chapter centres on real-side implications for the use of external finance, the Vietnamese surveys used provide little information as to whether having better access to formal finance is a mostly considered reason of starting formalised among other reasons, for instance, receiving support from the government, avoiding bribes, establishing more relationships with formal firms, to name just a few. If the initial intention of registering is not formal finance and then the firm ends up using informal finance, there still necessitates full attention to policy measures in controlling the extensive use of informal finance. If the initial intention is formal finance and then the firm ends up being unable to get it and continues to use informal finance instead, there necessitates fuller attention since firms rationally exit the formal sector when the perceived benefits of formality are outweighed by the associated costs—this is the exit view by Levy (2008), Maloney (2004). Exiting the market is yet to be a focus of the analysis, it should be taken into consideration for policy makers in a wider research of formality. Either way, understanding the reasons why the firm decides to register legally is decisively important to provide certain support best suited to its registration needs and expectations for united goals of maximise business performance to the full along with fostering national performance. This can be applicable to formalisation in any year; from that point, other related questions specific for formalisation reform are whether the firm was fully aware of the reform before registering and by which ways, whether any connection with formal firms (e.g., suppliers, consumers, creditors) informed the firm of the reform. These questions help policy makers to shape how information will be circulated to reach firms that need it most.

Second, neither has the thesis been able to make comparison analysis with formalisation-induced financing of firms that start registered prior to the reform year 2010 for the application of difference-in-differences estimations. The major reason is because of highly potential confounders from concurrent legislative changes in the year 2009—which there-

fore violates a key feature of a probit difference-in-differences analysis. The changes include the fiscal and monetary stimulus package launched by the Vietnamese government in 2009 to subside 4-percent interest rates of lending loans, in response to the 2008 global financial crisis and potential national economic recession; besides that, the government also announced credit guarantees for export activities, buying machinery and equipment that served production activities (Cling et al. 2011)). Although survey questions about financing sources for the survey-year 2009 data wave ask the amount of formal or informal debt in 2008—prior to the year of government's stimulus package, there is a likelihood that formalised firms in 2008 benefit from the government support in the following rounds of applying for loans, causing potential biases in the difference-in-differences estimations.

4.8 Conclusion

This chapter studies the effects of the Vietnamese reform that streamlined formalisation process on the relative use of formal and/or informal financing with respect to how long firms start up unregistered and the quality of the local governance settings in which firms operate. I employ the difference-in-differences technique often used in policy evaluation. Main findings are the reform increased the propensity to use only informal finance for young registered firms, and to a much lesser extent, co-funding with a higher share of informal finance. Older counterparts continued to benefit from more access to formal finance with a resultant reduction in informal finance after the reform. The reform, under strong local governance, offered advantages for young firms funded by formal finance only.

Centering on real-side implications for the reform-induced use of external finance, this analysis demonstrates the need of several following responses from policymakers.

First, policymakers shall make the contours in the real sector in which unregistered firms, especially young firms, are facing around the passage of the reform, before taking a further step of governing formal finance markets be more malleable to well align with such contours. Introducing registration reform signals a first welcome of the government and policymakers for unregistered firms to confer certain formality status in the real sector. However, supporting newly registered firms to have more access to formal finance, which is long considered as a major benefit of formalisation, extends a double welcome to formal financial markets, where formality status links. A direct way to support these firms in formal financial markets is concessions or financial incentives through which young firms with lack of strong revenue profiles cannot otherwise have full access to formal loans. An indirect way that has been analysed in this chapter is a concreted push for stronger local governance that indicates more transparent, better legal enforcement and support for the formalisation reform implementation and an increased use of formal finance for these firms.

Second, along with stronger support in formal financial markets, alleviation of an alternative channel of informal finance long-run should be emphasised. The results shows that the registration reform induces the use of informal finance for young firms, suggesting that informal finance helps satisfy the immediate need of credit demand within these firms. However, as discussed earlier, the use of informal finance cannot promote long-term scalability for firms. In this way, policymakers should find ways to narrowly target firms

based on their years of starting unregistered in identifying their use of informal finance to alleviate informal financial markets long-run.

Appendix

4.A Definition and expectation of covariates

In this section, I provide a review on how covariates can determine different types of formal/informal financing.

First, firm age and size measured as logs of operating years since establishment and logs of total assets normalised by inflation, respectively, have general findings that older and larger firms have more financial needs and seek for more external borrowings in either formal or informal finance. I therefore link higher probabilities of using formal and informal finance for these firms. In particular, formal finance, from the supply side, appear to favour such firms since smallness and newness are often associated with being financially constrained and a high degree of uncertainty and default risk due to lack of assets to use as collateral, or established credit history record. Small and young firms may rely more on informal borrowings in their external finance (See Rand & Torm (2012), among others).

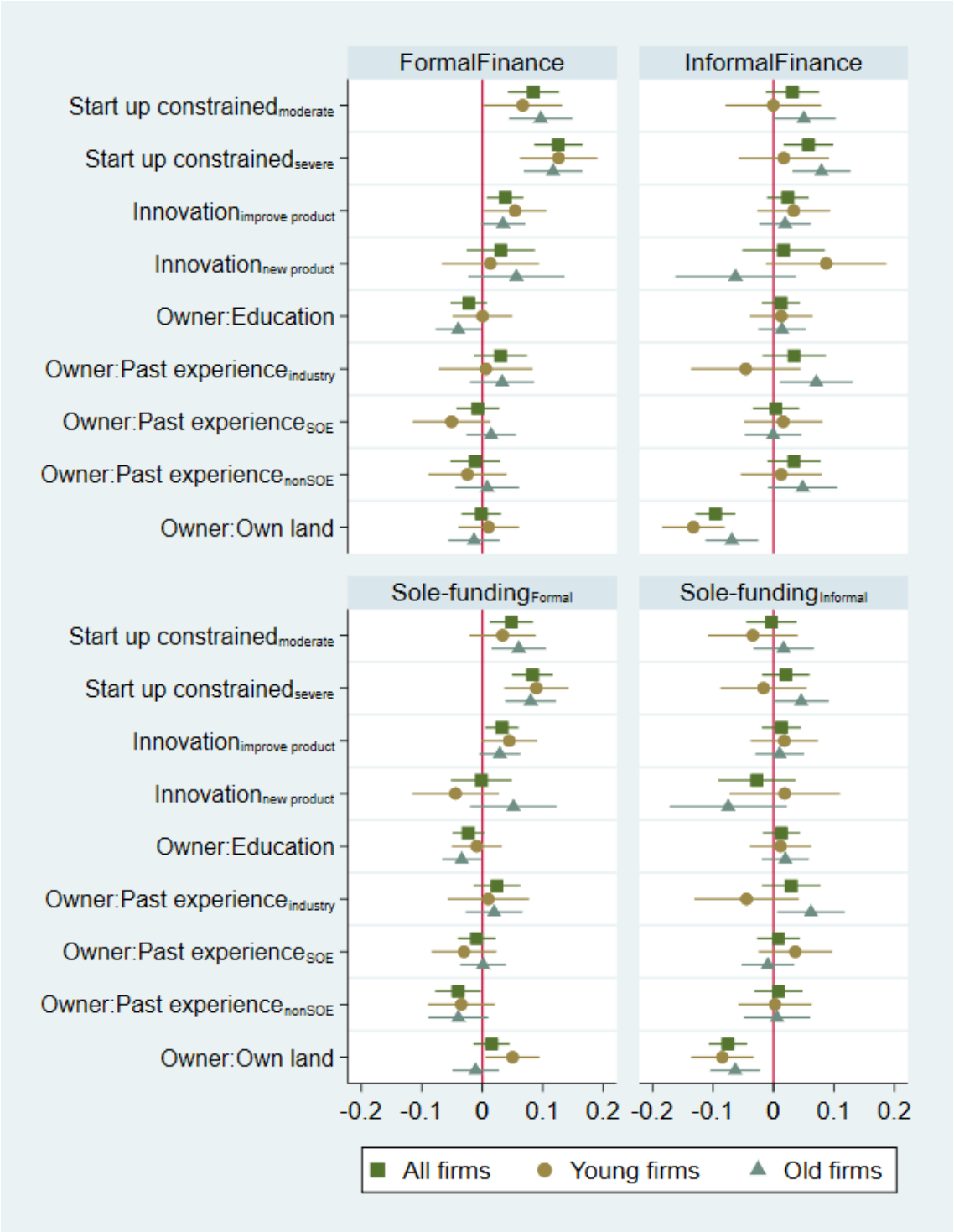
Second, I also control the financial position when firms started up. A general expectation that firms that started up financially constrained are more likely to seek for external finance with a higher probability for those with severe constraints. That said, firms may change the status quo at the surveyed years, such expectation may still hold for small and newly established firms. I use dummies taken from responses of the survey question "Which difficulties were encountered when the enterprise was established/bought for the first time? Lack of capital?"; its responses are coded as "Severe difficulty; moderate difficulty; insignificant difficulty". Little is however known about the use of formal/informal finance when controlling for these variables; results are reported in section 5.3.1.

Third, I also capture the effects of engaging in innovation activities on different types of financing by using dummies: $\text{Innovation}_{improveproduct}$ (improving existing products) and $\text{Innovation}_{newproduct}$ (developing new products). Although the innovation activities of informal firms may not be as pro-active or at a large-scale as those in formal sector, the way in which informal firms rely on formal/informal loans to finance these activities is still applicable. From a borrower side, as Ughetto (2008), Guariglia et al. (2011) suggest, innovative firms are reluctant to use formal finance as a way to protect their competitive advantages from imitation. From a lender side, banks may lack appetite for innovative firms that are small and young due to a potential risk of bankruptcy and a higher probability of financial constraints, let alone unregistered firms. Thus, innovation-active firms

are less likely to use formal finance, yet they can use informal finance (from family or friends) to satisfy their investment needs.

Fourth, I add a decisive role of human capital effects—owners and employees—in determining the way informal firms do business and make financial transactions. Shares of skilled workers (e.g., professional workforce with university or college degrees, technicians with and without certificates) among full-time employees account for the general quality of workforce, which shows the potential for using external finance. More importantly, skilled, well-educated and property-owned owners of informal firms, quite often, signal increased probability of obtaining bank loans (La Porta & Shleifer 2014, Rand & Torm 2012). A general expectation is that an informal firm—which is well-managed by educated owners with prior knowledge in manufacturing or, more broadly, in doing business, and holding property rights—shows a strong indicator of less risk shifting to banks and a broad network of suppliers, customers, and creditors. An underlying rationale is that (i) such owners are associated with possibility of employing equally educated workers or training them with their expertise (Rosenbaum et al. 1999), (ii) they are capable of running business against potential risk of personal losses with principles of sustained liquidity, and (iii) firms can use property rights as pledgeable collateral for bank loans. This means lower agency costs of debt generated, or lower possibility of principle-agent conflicts incurred between the firm's owners and banks as debt holders (Jensen & Meckling 1976, Myers 1977). I use a dummy Education for owners finishing upper secondary school or higher, which is commonly used in Vietnamese context (See Nguyen & Canh (2020), Rand & Torm (2012)), and a list of dummies: Past experience$_{industry}$ for owner's past experience in manufacturing; Past experience$_{SOE/NonSOE}$ for their past employment history in SOE and nonSOE; Own land if owners hold property rights through own purchases or inheritance. I therefore expect these dummies are associated with higher probability of using formal finance, either in form of formal finance only or co-funding with a higher share of formal finance.

Figure A4.1: Plots of marginal effects of binary covariates: All firms, young versus old firms



Notes: These plots display estimated marginal effects of a full set of binary covariates on the probability of using formal and/or informal finance for the full sample and subsamples of young and old firms as in baseline estimations. The spikes display 95 percent confidence intervals. Note that due to small fractions of co-funded firms, the outcome indicators can be perfectly predicted by these covariates so the estimated effects are not displayed here but reported in Table A4.2.

Table A4.1: Definition of covariates

Variable	Variable definition
Firm age	Log of firm age (years since establishment) and its quadratic term
Firm size	Log of total assets normalised by inflation rates
Start up constrained$_{no}$	=1 if firms started up with insignificant lack of capital, 0 otherwise
Start up constrained$_{moderate}$	=1 if firms started up with moderate lack of capital, 0 otherwise
Start up constrained$_{severe}$	=1 if firms started up with severe lack of capital, 0 otherwise
Skilled labour (%)	Skilled workers share of full-time employees (%)
Innovation$_{improveproduct}$	=1 if the firm improved existing products, 0 otherwise
Innovation$_{newproduct}$	=1 if the firm developed a new product, 0 otherwise
Owners' characteristics	
- Education	=1 if the firm's owner/manager finished upper secondary school and higher, =0 otherwise
- Past experience$_{industry}$	=1 if the firm's owner/manager previously worked in manufacturing industries, =0 otherwise
- Past experience$_{SOE}$	=1 if the firm's owner/manager previously worked in State-owned enterprises(SOE), =0 otherwise
- Past experience$_{nonSOE}$	=1 if the firm's owner/manager previously worked in non-SOE, =0 otherwise
- Own land	=1 if the firm holds property rights through own purchases or inheritance, 0 otherwise

Notes: Values that are expressed in real terms exclude inflation effects for corresponding years; inflation rates were collected from www.gso.gov.vn.

Table A4.2: Marginal effects of binary covariates: All firms, young versus old firms

	Finance		*Co-funding*		*Sole-funding*	
	Formal	*Informal*	*Formal > Informal*	*Informal > Formal*	*Formal*	*Informal*
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: All firms						
DiD (After – Before)	0.051	0.050	0.013	0.005	0.030	0.026
	(0.034)	(0.037)	(0.016)	(0.009)	(0.031)	(0.035)
Start up constrained$_{moderate}$	0.084***	0.031	0.028***	0.006	0.049***	-0.002
	(0.022)	(0.022)	(0.009)	(0.004)	(0.018)	(0.021)
Start up constrained$_{severe}$	0.126***	0.059***	0.027***	0.010***	0.086***	0.023
	(0.021)	(0.021)	(0.008)	(0.004)	(0.017)	(0.020)
Innovation$_{improveproduct}$	0.035**	0.017	0.006	0.005	0.029**	0.006
	(0.016)	(0.018)	(0.007)	(0.004)	(0.014)	(0.016)
Innovation$_{newproduct}$	0.030	0.016	0.027**	0.003	-0.003	-0.030
	(0.029)	(0.035)	(0.013)	(0.007)	(0.026)	(0.033)
Owners' characteristics						
- Education	-0.023	0.010	-0.002	0.001	-0.024*	0.010
	(0.015)	(0.016)	(0.007)	(0.003)	(0.013)	(0.016)
- Past experience$_{industry}$	0.029	0.033	0.014	-0.006	0.023	0.028
	(0.022)	(0.027)	(0.011)	(0.006)	(0.020)	(0.025)
- Past experience$_{SOE}$	-0.008	0.001	-0.001	0.001	-0.012	0.004
	(0.018)	(0.020)	(0.009)	(0.004)	(0.016)	(0.018)
- Past experience$_{nonSOE}$	-0.012	0.030	0.026***	-0.011*	-0.042**	0.003
	(0.021)	(0.022)	(0.009)	(0.006)	(0.019)	(0.020)
- Own land	-0.003	-0.098***	-0.008	-0.007*	0.013	-0.078***
	(0.017)	(0.017)	(0.008)	(0.004)	(0.015)	(0.016)
N	3703					

(CONTINUED)

(CONTINUED)

Panel B: Young firms						
DiD (After – Before)	0.088	0.182***	0.030	0.032*	0.025	0.132**
	(0.061)	(0.060)	(0.032)	(0.018)	(0.051)	(0.060)
Start up constrained$_{moderate}$	0.061*	-0.002	0.024*	0.011	0.029	-0.034
	(0.034)	(0.041)	(0.014)	(0.008)	(0.028)	(0.038)
Start up constrained$_{severe}$	0.124***	0.016	0.030**	0.014*	0.086***	-0.018
	(0.033)	(0.038)	(0.014)	(0.007)	(0.027)	(0.036)
Innovation$_{improveproduct}$	0.049*	0.030	0.015	0.004	0.039*	0.014
	(0.027)	(0.031)	(0.012)	(0.008)	(0.023)	(0.028)
Innovation$_{newproduct}$	0.015	0.089*	0.042**	0.008	-0.041	0.021
	(0.041)	(0.051)	(0.019)	(0.013)	(0.036)	(0.047)
Owners' characteristics						
- Education	0.001	0.012	-0.010	0.013*	-0.010	0.010
	(0.025)	(0.026)	(0.012)	(0.008)	(0.021)	(0.026)
- Past experience$_{industry}$	0.002	-0.047	0.006	-0.006	0.007	-0.045
	(0.040)	(0.046)	(0.019)	(0.013)	(0.034)	(0.044)
- Past experience$_{SOE}$	-0.047	0.016	-0.025	-0.004	-0.028	0.035
	(0.033)	(0.033)	(0.017)	(0.009)	(0.027)	(0.031)
- Past experience$_{nonSOE}$	-0.022	0.013	0.014	-0.016	-0.034	0.000
	(0.033)	(0.034)	(0.015)	(0.011)	(0.028)	(0.031)
- Own land	0.013	-0.132***	-0.021*	-0.011	0.052**	-0.084***
	(0.026)	(0.026)	(0.013)	(0.007)	(0.023)	(0.026)
N	1,420					

(CONTINUED)

(CONTINUED)

Panel C: Old firms						
DiD (After – Before)	0.023	-0.002	0.006	-0.008	0.022	-0.006
	(0.043)	(0.046)	(0.019)	(0.010)	(0.039)	(0.042)
Start up constrained$_{moderate}$	0.097***	0.050*	0.033***	0.002	0.060***	0.017
	(0.027)	(0.027)	(0.010)	(0.003)	(0.023)	(0.025)
Start up constrained$_{severe}$	0.118***	0.081***	0.025***	0.008**	0.081***	0.048**
	(0.025)	(0.024)	(0.009)	(0.003)	(0.021)	(0.023)
Innovation$_{improveproduct}$	0.033*	0.012	-0.001	0.007*	0.027	0.002
	(0.019)	(0.022)	(0.009)	(0.003)	(0.017)	(0.020)
Innovation$_{newproduct}$	0.056	-0.066	0.005	0.001	0.051	-0.079
	(0.041)	(0.051)	(0.018)	(0.007)	(0.037)	(0.050)
Owners' characteristics						
- Education	-0.040**	0.012	0.000	-0.006*	-0.035**	0.016
	(0.019)	(0.020)	(0.008)	(0.003)	(0.016)	(0.020)
- Past experience$_{industry}$	0.033	0.072**	0.020	-0.006	0.020	0.063**
	(0.027)	(0.031)	(0.013)	(0.007)	(0.024)	(0.028)
- Past experience$_{SOE}$	0.014	-0.005	0.012	0.003	0.000	-0.014
	(0.021)	(0.024)	(0.010)	(0.004)	(0.019)	(0.022)
- Past experience$_{nonSOE}$	0.008	0.043	0.032***	-0.004	-0.041	0.000
	(0.027)	(0.029)	(0.012)	(0.006)	(0.025)	(0.028)
- Own land	-0.014	-0.071***	0.004	-0.004	-0.011	-0.066***
	(0.022)	(0.022)	(0.011)	(0.003)	(0.020)	(0.021)
N	2,283					

Notes: This table reports marginal effects of a full set of binary covariates on the probability of using formal and/or informal finance. Constants and continuous variables (firm age, size, shares of skilled labour) are all included in probit estimations but not reported for marginal effects. DiD estimators are already provided in Table 4.3. *p <0.10, ** p <0.05, *** p <0.01. Standard errors in parentheses are clustered at the firm level. Source: Authors' calculations.

Table A4.3: Triple differences estimations on local governance quality: All firms, young versus old firms

	$FormalFinance$	$InformalFinance$	$Sole\text{-}funding_{Formal}$	$Sole\text{-}funding_{Informal}$
	(1)	(2)	(3)	(4)
Panel A:	0.115*	-0.086	0.167***	-0.048
All firms	(0.067)	(0.074)	(0.059)	(0.073)
N	3,703			
Panel B:	0.326***	-0.168	0.366***	-0.149
Young firms	(0.117)	(0.117)	(0.092)	(0.116)
N	1,420			
Panel C:	0.003	-0.048	0.061	0.007
Old firms	(0.078)	(0.094)	(0.071)	(0.091)
N	2,283			

Notes: This table reports the triple differences estimations to verify the estimations in in Table 4.4 that the degrees of local governance quality matters. Instead of running separate regressions for subsamples of firms located in provinces with weak and strong local governance, I conduct the DDD estimations by employing triple interaction terms between ReformxFormalisedxHighPCI where HighPCI takes the value of 1 if firms located in provinces under stronger local governance quality. The DDD estimations enable me to keep the sample size and degrees of freedom as many as possible and to technically test the differential impacts across different firm groups. All other variables as in Eq. 4.1 are included. The results are robust to the estimations in Table 4.4 to some extent. The triple interaction terms are positive and statistically significant in columns 1 and 3 of Panels A and B, suggesting that there is reform-induced change in propensity to use formal finance, particularly in the form of formal finance only, for Vietnamese firms operating under stronger local governance. These effects appear to be mostly driven by young, registered firms with strongly positive and statistically significant coefficients (see Panel B) at 1 percent significant level. *p <0.10, ** p <0.05, *** p <0.01. Standard errors in parentheses are clustered at the firm level. Source: Authors' calculations.

Table A4.4: Balancing test for propensity score matching

	All firms		Young firms		Old firms	
	$F-stat$	$p-value$	$F-stat$	$p-value$	$F-stat$	$p-value$
Firm age	1.58	0.161				
Firm age^2	1.55	0.171				
Firm size	3.02	0.010	5.36	0.000	1.19	0.311
Start up constrained$_{no}$	2.43	0.032	0.41	0.839	2.13	0.059
Start up constrained$_{moderate}$	1.43	0.211	0.30	0.914	1.38	0.227
Start up constrained$_{severe}$	2.35	0.038	0.34	0.891	2.30	0.042
Skilled labour (%)	1.06	0.383	0.94	0.457	0.62	0.688
Innovation$_{improveproduct}$	0.03	0.999	0.64	0.672	0.62	0.684
Innovation$_{newproduct}$	1.14	0.337	1.59	0.159	1.98	0.078
Owners' characteristics						
- Education	1.77	0.116	1.46	0.201	1.68	0.136
- Past experience$_{industry}$	0.31	0.905	1.36	0.238	0.89	0.487
- Past experience$_{SOE}$	0.52	0.762	0.14	0.982	0.59	0.709
- Past experience$_{nonSOE}$	2.04	0.070	3.08	0.009	2.04	0.070
- Own land	4.73	0.000	2.02	0.073	3.82	0.002
No.obs	3,703		1,420		2,283	

Notes: This table reports test statistics for the balancing test on the differences of covariates included in the propensity score matching, using the regression approach as suggested by Arnold & Javorcik (2009), Smith & Todd (2005). See the model, hypothesis and other details of the test on the section of propensity score matching. Source: Authors' calculations.

Chapter 5

Conclusion

5.1 Concluding remarks and policy implications

Limited access to external finance has long been considered as one of major determinants for poor firm performance and this relationship exists not only in advanced economies but also in developing countries in which firms become vulnerable due to imperfect financial markets and subject to a high degree of information asymmetries. A distinct feature of most developing and emerging economies is the dominance of informal firms that are viewed as unwelcome imposition for formal institution environment. Thus, it is crucial to contextualising the finance-firm performance along the formality dimension and to better understanding the financial behaviour of these informal firms. The thesis therefore builds on agency costs of debt theory with empirical focus on heterogeneity of firms through lenses of both informal and formal institutional settings. Each essay of the thesis—although seemingly unrelated—is linked altogether, collectively contributing to advance understanding of formal and informal business environment in Vietnam from financial perspectives. The set of essays is studied in sequence: the first essay provides a full picture of the finance-firm performance relation for a broad sample of micro, small and medium-sized firms; as is the second essay yet along an additional dimension of formality status to better gain a contextualised understanding; the remaining essay shifts the focus onto the subsample of informal firms to assess the real-side implications of the reform-induced use of external finance.

The first essay provides a full picture of finance-productivity relation, regardless of the firm's formality status. In this one, the emphasis is on the distributional effects of financial constraints that firms are binding to on their productivity levels. A main finding is the nonmonotonic distributional effects: financially constrained firms at the upper quantiles have the higher productivity than their unconstrained counterparts, while performers at bottom quantiles absorb negative effects of financial constraints. I also find the crucial role of internal resources in mediating the implied finance-productivity relation. I believe that this study is as markedly important as a starting point for the design of policy initiatives towards factors that impede access to external financing, especially for firms at lower quantiles of productivity distribution. Identifying these firms could be conducive

to reduce the weight of the bottom tail of productivity distribution, thereby serving the ultimate goal of impelling the productivity of Vietnam to converge to that of neighbouring countries.

The second essay studies the finance-efficiency relation with an added dimension of formality. By pointing to firm size and formality status, I find that smaller firms within informal sector exhibit stronger positive impacts of leverage than corresponding larger firms, and that heterogeneous effects of leverage are less pronounced for firms operating formally. Also, other economic factors matter with varying degrees upon their formality: property-purchased benefits efficiencies of larger informal firms; property leasing and cash holdings do so for larger formal firms. More importantly, the heterogeneous effects of leverage by firm size are largely engineered through formal—as opposed to informal—financial channels. This in turn helps policy-markers drive a concreted push for the provision of property rights to the private sector with close attention to firm-size differences in the formal and informal sector, for regional efficiency differences and for ways to facilitate efficient capital allocation from formal financial markets to real sector.

The third essay studies the real-side implications of the registration reform on different forms of external finance—co-funding and sole-funding of formal/informal finance. The difference-in-differences estimations identify the heterogeneity of the associated impact by firm age. The main finding is that the reform led to increased use of informal finance in young formalised firms, especially those solely funded by informal finance. Old registered firms, in contrast, experienced an increase in different forms of employing formal financing and a reduced use of informal financial source. Additionally, the local governance quality supported higher access to formal finance for young firms. These findings describe whether formalised firms are doubly welcome to both real and financial sectors after the registration reform is introduced and further explore the ways in which dual financial systems are functioning.

As my studies are primarily confined to firms in a developing country Vietnam, the above set of issues are deemed relevant to developing or emerging countries in which there are dominant patterns of informality settings within both real and financial sectors. The contextualised understandings of (in)formality have several real-side implications: higher efficiency from increased leverage for smaller firms that operate informally and mostly from formal finance—as in the second essay; an increase in access to informal finance following the formalisation reform for young formalised firms—as in the third essay. These are important implications for policy-markers in continued effort to impel the overall business performance and to support the formality—as opposed to informality—settings within both financial and real sectors. Rather than introducing policies that ensure a uniform application across firms, there necessitates a concreted need to point to firm heterogeneity, particularly firm size and age. The thesis therefore highlights the importance of upholding access to formal finance for small or newly formalised firms to scale up their performance to the next level; otherwise, the continued use of informal finance with no end in sight even following the formalisation reform by no means rules out the possibility of alleviating the marked dominance of informal firms in real sector in the long run. In the quest for reproducing the contours of informal firms within the real sector remains combined effort from formal financial markets that need to be more malleable.

5.2 Limitations

Within the scope of the thesis, these essays nonetheless have some limitations that question the validity of the estimates due to limited data availability as in much empirical work. The first set of limitations comes from the Vietnamese survey data available. First, the survey-based dataset has short panels with surveys conducted at two-year intervals, leaving the duration of firms' different engagements to become questionable. For example, the duration of firms engaging in productivity-enhancing activities, or duration of financial constraints that firms are binding to, or changes in access to finance. The available sample at two-year intervals, although not ruling out fundamental assumption of no correlation between transient errors in panel data Wintoki et al. (2012), may cause some confusion over legislation with specific years applicable. Also, the short panels challenge the third essay on before-and-after policy intervention, leaving quite limited evidence on post-reform periods. Second, the surveys have a good list of questionnaires but there are a lot of missing responses to interesting questions over costs of capital (i.e., monthly interest rates to be paid), gender of managers, among others. Third, the stratification strategy cover ten key economic regions in the country; however, a more extensive coverage can help to have a more representative sample, especially when it comes to essays on informality to better understand the size of informal sector across regions and informal financial channels in other rural areas. Fourth, the surveys do not have information on reasons that a firm draw on to make decision of registration, which have been detailed as the first part in the section "Limitations and avenues for future research" of the last empirical work on business registration reform.

The second set of limitations is from methods employed for certain analyses. First, there could have been an analysis on triple interaction terms of formal leverage, firm size, and property rights for the subsample of formal firms to support the power of purchasing property rights or using property rights formally on technical efficiency. However, this analysis cannot perform due to the lack of convergence aroused with poorly fitting observations, which is a major drawback of the maximum likelihood function in stochastic frontier analysis estimations. Lastly, neither has the thesis been able to make comparison analysis with formalisation-induced financing of firms that start registered prior to the reform year 2010 in different-in-different estimations in the last empirical chapter (See second part in the section "Limitations and avenues for future research" of the chapter for details).

5.3 Avenues for future research

Overall, this thesis has many promising avenues for analyses that focus on finance, formality, and small-firm research. First, there can be more investigations of leverage or financial constraints on different types of firm performance, such as firm growth in sales or employment, firm profitability, other than focusing on productivity and efficiency. These

aspects may have been widely studied, one can explore the formality dimension. Based on the premise that some informal firms can outperform small, newly registered firms in real and/or financial sectors, further understanding how smallest firms in size distribution react to such competition can be of interest. Second, the efficiency studies in the second empirical chapter can extend in many other aspects, for example, investment efficiency, or innovative efficiency. The use of external finance, especially formal finance, performs a disciplinary function, is worth some investigations of leverage and innovative or investment efficiency with primary focus on informal sector. Lastly, based on the limitations of the registration reform analysis conducted in this thesis, there are some suggestions as follows. A cross-countries study of other developing countries that did not implement the reform in similar year could be interesting to find out the involvement of dual financial systems between countries with and without the reform implementation. Also, there should be attempts in conducting surveys or interviews to find the reasons that firms decided to register and whether access to formal finance is one of the reasons. Exploring the social network that informal firms have in pre-reform periods would be able to show how firms obtain the information of the reform. A connection with a formal agent (i.e., customers, suppliers, lenders) can be a great contributor to the decision of formalisation.

Research on formality, small firms, finance and firm performance is increasingly evolving and equally challenging. Small firms are likely binding to financial constraints, but some can find ways to preserve capital and improve performance. There is always heterogeneity of firms in differential financial behaviour. The challenge remains for informal sector that is less observable.

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