FINANCIAL DEVELOPMENT AND INNOVATION-LED GROWTH

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ABSTRACT

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Abstract

The purpose of this master's thesis is to study the effects of financial development on economic growth and investigate whether the impact differs between advanced and emerging economies. In addition, the study explores whether it matters for growth if the financial system is bank-based or market-based. As the main theoretical framework, the thesis introduces a simple Schumpeterian multisector growth model with credit constraints. The model explains why further development of different financial systems can enhance innovation-led growth, and also why a country's distance to the technological frontier can affect its growth rate and how financial development is related to it.

The results of the empirical study show that financial development is positively and significantly related to economic growth, but the relationship appears to be bell-shaped; financial development affects growth positively at low levels, but after a certain threshold the impact is vanishing or even turns negative. The results are in line with earlier literature. The study also suggests that to facilitate growth in advanced economies, it is beneficial to develop financial markets, whereas emerging economies benefit most from the overall financial development. The development of financial institutions might have a negative impact on growth in advanced economies. The results confirm earlier findings of the convergence effect; financial deepening can help a country converge to the growth rate of the frontier, but it does not affect steady-state growth.

Keywords
Financial development, financial institutions, financial markets, economic growth, innovations, convergence, technological frontier, productivity

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Tiivistelmä

Tämän pro gradu -tutkielman tarkoituksena on tutkia, millaisia vaikutuksia rahoitusmarkkinoiden kehittyneisyydellä on talouskasvuun ja tarkastella, eroavatko kyseiset vaikutukset kehittyneiden ja kehittyvien talouksien välillä. Lisäksi tutkielman tarkoituksena on selvittää vaikuttaako kasvuun se, onko rahoitusjärjestelmä pankki- vai markkinakeskeinen. Pääasiallisena teoriamallina tutkielmassa esitetään yksinkertainen, monisektorinen Schumpeteriläinen kasvumalli, johon on lisätty luottorajoitukset. Mallin avulla pystytään selittämään, miksi eri rahoitusjärjestelmiä kehittämällä voidaan lisätä innovaatioperusteista kasvua sekä, miksi maan etäisyys teknologisesta eturintamasta vaikuttaa sen talouskasvuun ja millainen rooli rahoitusmarkkinoiden kehittyneisyydellä on tässä.

Empiirisen tutkimuksen mukaan rahoitusmarkkinoiden kehittyneisyys korreloi positiivisesti ja tilastollisesti merkitsevästi talouskasvun kanssa, mutta muuttujien välinen riippuvuus on kirkonkellon muotoinen; rahoitusmarkkinoiden kehittäminen vaikuttaa talouskasvuun positiivisesti silloin, kun kehitysaste on alhainen, mutta tietyn kynnyksen jälkeen vaikutus vähenee tai muuttuu jopa negatiiviseksi. Tulokset ovat yhdenmukaisia aikaisemman kirjallisuuden kanssa. Lisäksi tutkimuksen mukaan kehittyneissä talouksissa on talouskasvun kannalta hyödyllistä kehittää finanssimarkkinoita, kun taas kehittyvät taloudet hyötyvät eniten kokonaisvaltaisesta rahoitusmarkkinoiden kehittämisestä. Finanssi-instituutioiden kehittämisellä voi olla negatiivisia vaikutuksia talouskasvuun kehittyneissä talouksissa. Tulokset vahvistavat aiempia löytöjä konvergoitumisvaikutuksesta; rahoitusmarkkinoiden kehittäminen voi auttaa maata konvergoitumaan eturintaman kasvunopeuteen, mutta sillä ei ole vaikutusta tasapainokasvuun.

Asiasanat
Rahoitusmarkkinoiden kehittyneisyys, rahoitusinstituutiot, rahoitusmarkkinat, talouskasvu, innovaatiot, konvergoituminen, teknologinen eturintama, tuottavuus

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1 INTRODUCTION

The relationship between finance and growth is an issue that has been widely studied empirically. King and Levine (1993) were one of the first authors to form a cross-country study on finance-growth nexus, and later many authors have used their research context as a basis for further studies. Furthermore, the focus of the studies varies - many studies have examined the role of financial systems in economic growth, poverty, and income inequality. This master's thesis concentrates on investigating the relationship between finance and growth, and leaves poverty and income inequality out of the scope. The purpose is to study the impacts that financial development has on economic growth and investigate whether the effects differ between advanced and emerging economies. In addition, the study explores whether it matters for growth if the financial system is bank-based or market-based, and whether a country's distance to the technological frontier (technology leader) affects its growth rate.

The potential output growth in OECD economies has declined over the past decades (Adalet McGowan, Andrews & Millot, 2017a; Gouveia & Osterhold, 2018), and authors have tried to find reasons behind it. According to Andrews and Petroulakis (2019), before the financial crisis, the growth was mainly slowed by a declined multifactor productivity (MFP) growth, whereas after the crisis, the main explanation was a weakness in capital deepening (Andrews & Petroulakis, 2019, 6). Ineffective financial system seems to have a role in this. The absence of well-functioning financial system can lead for example to a prevalence of zombie firms, which refer to non-viable firms (Gouveia & Osterhold, 2018, 2) or "firms that would typically exit or be forced to restructure in a competitive market" (Adalet McGowan et al., 2017b, 3). The capital sunk in zombie firms tends to limit the growth of healthy, high productivity firms, thereby creating a capital and labour misallocation. Also, Rousseau and Wachtel (2011) state that financial deepening that happens too fast or is excessive in a country, might weaken the banking system and increase inflation, which in turn, might lead to financial crisis.

There are two classes of growth theories; the first class believes that growth is grounded on capital accumulation, while the second class relies on endogenous innovation (Aghion & Festré, 2017, 27). As the main theoretical framework, the thesis introduces a simple Schumpeterian multisector growth model with credit constraints. The model explains that the main purpose of financial markets, institutions, and intermediaries is to reduce costs and frictions related to productive reallocation of resources, and thereby further financial development can enhance innovation-led growth. In addition, the model introduces creative destruction, which is an important factor for aggregate productivity growth. Well-functioning exit of unsuccessful firms opens the market for new, more productive entrants and new varieties of products, making the process productivity-enhancing. (Adalet McGowan, Andrews & Millot,

2017b, 8-11.) Schumpeterian growth theory also explains why a country's distance to the technological frontier can affect its growth rate and how financial development is related to it. A country's distance to frontier can be measured for example by dividing a country's GDP per capita with the technological frontier's GDP per capita (e.g. Acemoglu et al., 2006).

This thesis relates to the literature on finance and growth. In one of the first cross-country studies on finance and growth, King and Levine (1993) discovered that the correlation between financial development and growth is positive and strong. Rajan and Zingales (1996) verified in their study, that the previously noted, positive correlation between financial development and growth is causal, relying on the fact that the costs of external finance are diminished with financial development. Hence, financial development is most beneficial for industries depending on external finance (Rajan & Zingales, 1996). Later on, Rajan and Zingales (1998) examined the role of financial systems on growth, and concluded that relationship-based (bank-based) systems are most beneficial for economies with poor legal and contract system, whereas arm's length (market-based) system works well with competition and good contract environment (Rajan & Zingales, 1998). The issue has been further studied by many authors, such as Levine, Loayza, and Beck (2000), who examined the impact of financial intermediary development on growth, Rousseau and Wachtel (2000), who studied the role of equity markets on growth, and Demirgüc-Kunt and Maksimovic (1998), who explored finance and firm growth.

Also, this thesis is related to the literature on convergence and growth. Many studies report evidence of the great divergence, referring to the growing gap between rich and poor countries. However, other studies show that there has been convergence toward similar growth rate in some countries. For instance, Mankiw, Romer, and Weil (1992) used the neoclassical Solow growth model to explain cross-country differences in income per capita, whereas Barro and Sala-i-Martin (1992) constructed a neoclassical growth model to provide evidence on convergence. Howitt (2000), on the other hand, combined both Solow-Swan model and the model by Aghion and Howitt (1992), to construct a Schumpeterian model of club convergence. Later on, the model has been developed by Acemoglu, Aghion and Zilipotti (2006), Aghion et al. (2005), and Aghion and Howitt (2009), to name a few. Aghion et al. (2005) state that the effect of financial development on convergence occurs via productivity growth, and not so much via capital accumulation (Aghion et al., 2005, 178).

The literature review examined in this thesis suggests that there is a strong, positive relationship between financial development and growth (Levine, 2002; Rousseau & Wachtel, 2011), and financial development increases the probability of convergence to the frontier (Aghion et al., 2005). However, the positive finance-growth relationship seems to weaken, or even turn negative after a certain threshold (Aghion et al., 2005; Arcand et al., 2015; Rousseau & Wachtel, 2011; Sahay et al., 2015). The dampening effect might appear at high levels of financial depth (Aghion et al., 2005; Arcand et al., 2015; Sahay et al., 2015), or it can be related to bank and financial crises (Rousseau &

Wachtel, 2011). On the other hand, below a certain level of financial development, the growth rate will be lower than that of the technology frontier (Aghion et al., 2005). Levine (2002) found no evidence for the bank-based or market-based views. However, Demirgüc-Kunt, Feyen, and Levine (2012) suggest that the relative importance of banks and decentralized markets vary at different stages of economic development. According to this view, financial systems become more market-based when countries develop economically (Demirgüc-Kunt et al., 2012). Sahay et al. (2015) conclude that financial development should be accompanied with good institutional and regulatory frameworks, and that there is no "one-size-fits-all" –strategy. However, institutions become relatively more beneficial than markets as economies develop. (Sahay et al., 2015.)

The results of the empirical study verify that financial development is positively and significantly related to economic growth, but the relationship appears to be bell-shaped, which is in line with earlier literature. The study also suggests that to facilitate growth in advanced economies, it is beneficial to develop financial markets, whereas emerging economies benefit most from the overall financial development. The development of financial institutions might have a negative impact on growth in advanced economies. The results follow earlier literature, suggesting that the convergence effect is stronger in emerging economies compared to advanced economies, while there is no clear evidence that financial development increases the likelihood of convergence in frontier economies. Financial deepening can help a country converge to the growth rate of the frontier, but it does not affect steady-state growth.

This thesis contains five main parts. The second chapter presents different growth models and focuses on the Schumpeterian growth theory in detail. The third part contains the literature review related to finance-growth nexus, convergence and different financial systems. In the fourth chapter, the empirical model and methodology are introduced. Finally, the thesis presents and analyzes the results of the empirical research and draws conclusions.

2 THEORETICAL FRAMEWORK

2.1 Paradigms of growth theory

Researchers have tried to determine the main components of economic growth and long-term income differences for decades, and two classes of growth models have been developed. The first class believes that growth is grounded on capital accumulation, while the second class relies on endogenous innovation. (Aghion & Festré, 2017, 27.) The growth models based on capital accumulation include the neoclassical growth model and the AK model, and the innovation-based growth models include the product-variety model and the Schumpeterian model (Aghion & Howitt, 2009, 12-15). This thesis examines economic growth using the Schumpeterian growth theory because it can explain many details better than other theories.

The neoclassical model, which was first developed by Solow (1956) and Swan (1956), suggests that economic growth can be fostered by savings. Nevertheless, the increase of growth by savings will eventually stop (principle of diminishing marginal productivity) and the growth rate will adjust to the rate of technological progress (steady state). Technological change is seen as exogenous and is determined by noneconomic forces. Thus, the neoclassical theory does not provide explanation on why the rate of technological progress varies between countries and therefore cannot explain the cross-country differences in growth or the reason for long-run growth. (Aghion & Howitt, 2009, 21, 39, 47.) Compared to exogenous growth theories, the endogenous growth theories suggest that technological change is relative to economic decisions such as innovations, investments, and accrual of human capital, and is therefore an endogenous variable (Aghion & Howitt, 2009, 47-48). The first developers of endogenous growth models, the AK models, were Harrod (1939), Domar (1946), Frankel (1962), and Romer (1986), to name a few (Aghion & Howitt, 2009, 67). The AK models assume perfect competition and use the basic assumptions of neoclassical model but add knowledge externalities among firms who accumulate physical capital. The knowledge externalities can compensate the decreasing returns to individual capital accumulation, and the long-run growth can be positive depending on the savings rate. The AK models have been criticized for not explaining convergence. In addition, the models highlight the role of physical capital and underrate the significance of human capital. (Aghion & Festré, 2017, 28.)

The growth models were further developed by Romer (1990) and Aghion and Howitt (1992), who explained growth with firm's innovative investments. These models are referred to as "the idea-based" (Aghion & Festré, 2017, 28) or "innovation-based" models (Aghion & Howitt, 2009, 69) of endogenous growth. Romer's (1990) so called product-variety model argues that innovation is the key ingredient for productivity growth, and productivity growth is a result of

two components – expanding variety of specialized intermediate products and research spillovers. The model introduces imperfect competition and monopoly rents from new products, making innovations attractive. Nevertheless, the new products might not be improved in quality, hence the model does not show the importance of exit in the growth process. (Aghion & Howitt, 2009, 69-70, 80-81.) Aghion and Howitt (1992) introduced the Schumpeterian growth paradigm that highlights the role of creative destruction - new, quality-improved innovations displace old innovations, technologies, and skills in the growth process (Aghion & Festré, 2017, 29).

2.2 Schumpeterian growth model

"*Creative destruction is a key feature of well-functioning economies*."

- OECD (2018)

The Schumpeterian paradigm was developed by Aghion and Howitt (1992 & 1998), based on the ideas of Schumpeter at "Theory of Economic Development" (1934)[1] and "Capitalism, Socialism and Democracy" (1942)[2]. There are three key ideas behind the Schumpeterian growth theory. The first idea describes that innovations create long-run growth. These innovations can be either process, product, or organizational innovations. The second key idea is that innovations yield from investments, and investments are made by companies seeking monopoly rents. Thirdly, the Schumpeterian paradigm introduces creative destruction; the old becomes obsolete because of new innovations, which creates a dilemma "between the old and the new". From the political perspective, the difficulty is to find a way to protect monopoly rents without hindering innovation and entry. (Aghion & Festré, 2017, 29.)

2.2.1 Innovation-led growth without credit constraints

Aghion, Howitt, and Levine (2018) form a Schumpeterian model of multiple economies to examine the role of finance and innovation-led growth, based on the work by Aghion and Howitt (2009). First, next section introduces a simple Schumpeterian multisector growth model without credit constraints, and then adds credit constraints to the model. If firms lack internal finance for innovations, they need external financing. Credit constraints appear as costs that restrain firms from borrowing, and the main purpose of financial markets, institutions, and intermediaries is to reduce those costs and other frictions related to productive reallocation of resources. The model is included in this thesis, be-

[1] Schumpeter, J. 1934. The Theory of Economic Development: An Inquiry into Profits, Capital, Credit, Interest, and the Business Cycles. Harvard University Press, Cambridge.
[2] Schumpeter, J. 1942. Capitalism, Socialism and Democracy. Harper, New York.

cause it explains how financial development can enhance innovation-led growth by reducing credit constraints. Competition and property rights system are taken as given in the following models. (Aghion et al., 2018, 6-7.)

The following represents the basic multisector Schumpeterian model with two periods. Individuals are considered to be risk-neutral, and they can offer one unit of labor service in the period one, but none during period two. The final good can be used as an input for new intermediate products, or as an input to research and development (R&D). Under perfect competition, the final good is produced by

$$Y_t = L^{1-\alpha} \int_0^1 A_{it}^{1-\alpha} x_{it}^{\alpha} di, \qquad 0 < \alpha < 1 \tag{1}$$

which is the Cobb-Douglas production function specification. In equation (1), L refers to a fixed population, A_{it} is the productivity variable (quality related to x_{it}), and x_{it} refers to the input (of the latest version of intermediate product i), i is the intermediate sector and t is time. (Aghion et al., 2018, 6-7; Aghion & Howitt, 2009, 130-131).

The model includes the assumption that the average productivity across all sectors during earlier period, $A_{t-1} = \int_0^1 A_{i,t-1} di$, is the new, starting technology in all sectors. The productivity parameter for a successful innovator will be $A_{it} = \gamma A_t$, where $\gamma > 1$ refers to the size of innovations, whereas for a non-innovator the productivity will be $A_{it} = A_{t-1}$. Firms try to reach the productivity level $A_t^* = \gamma A_{t-1}$. In order to achieve it, firms must pay the R&D cost of innovation:

$$R_t = A_t^* \delta \mu^2 / 2 \tag{2}$$

where R_t is the expenditure on R&D, δ is the cost of innovation (the inefficiency of transforming cost into productive innovation), and μ refers to the probability to innovate, which is diminishing in terms of δ and A_t^*. (Aghion et al., 2018, 7; Aghion & Howitt, 2009, 131-132.)

The maximization problem needs to be examined in order to figure out the equilibrium growth rate. A successful innovator, the monopolist, will set the price according to $p_{it}(x_{it}) = \alpha A_{it}^{1-\alpha} x_{it}^{\alpha-1}$. As seen in the equation, the price is the marginal product of the intermediate good. With the price set, the equilibrium profit can be counted as $\Pi_{it} = max_{x_{it}}\{p_{it}(x_{it})x_{it} - x_{it}\}$, and the equilibrium quantity is $x_{it} = \alpha^{\frac{2}{1-\alpha}} A_{it}$. As a result, $p_{it}(x_{it}) = \frac{1}{\alpha}$, which will lead to the equilibrium profit being $\Pi_{it} = \pi A_{it}$, where π is the profitability of innovation, $\pi \equiv (\frac{1}{\alpha} - 1)\alpha^{\frac{2}{1-\alpha}}$. Hence, the gross output of the final good is the following:

$$Y_t = \alpha^{\frac{2\alpha}{1-\alpha}} A_t \tag{3}$$

According to the equation, the gross output, or GDP, grows proportionally to A_t, which means that the economic growth rate is equal to productivity growth rate g. (Aghion et al., 2018, 7-8; Aghion & Howitt, 2009, 93, 131-132.)

A firm tries to maximize its expected payoff and chooses R_t accordingly, which, at the same time, corresponds to determining μ, the innovation probability. The firm chooses μ, that will maximize $\mu\pi A_t^* - A_t^*\delta\mu^2/2$. The equilibrium probability of innovation is therefore $\mu = \pi/\delta$. Subsequently, the productivity for the successful, innovator sectors (μ) will be γA_{t-1}, whereas for non-innovator sectors $(1-\mu)$ the productivity will be A_{t-1}. Thus, the average productivity over all sectors is $A_t = \mu\gamma A_{t-1} + (1-\mu)A_{t-1}$.

Using the average productivity over all sectors, the growth rate of average productivity can be discovered:

(4) $$g = \frac{A_t - A_{t-1}}{A_{t-1}} = \mu(\gamma - 1)$$

Combining the equation (4) and $\mu = \pi/\delta$, will show the equilibrium growth rate, which is:

(5) $$g = (\pi/\delta)(\gamma - 1)$$

The equation indicates that the growth rate (g) correlates positively with the profitability of innovation (π), and the size of innovations (γ). (Aghion et al., 2018, 8; Aghion & Howitt, 2009, 93, 131-132.)

2.2.2 Innovation-led growth with credit constraints

When firms apply for a loan, the role of financial system is to screen the applications and choose the most productive projects. After admitting the loan, the financial system needs to monitor the firms' performance in order to avoid fraud and make it costly to default. This section examines the monitoring of loans. A firm borrows $L = R_t - \omega_{t-1}$, where ω refers to wealth at time t. If a firm innovates successfully, it can hide the result and avoid repaying the loan by paying a "hiding" cost hR_t, where $0 < h < 1$. The cost variable h describes how effectively the financial system monitors the loan, and also how effectively legal institutions protect creditors' rights; well-functioning systems and institutions make it expensive for firms to default. The following equation examines the constraint for a firm:

(6) $$hR_t \geq \mu_t(R_t)\Gamma(R_t - \omega_{t-1})$$

where Γ refers to the interest of the loan, and $\mu_t(R_t)\Gamma(R_t - \omega_{t-1})$ describes the expected amount of saving if a firm decides to behave dishonestly. If the equation holds, a firm decides to be honest.

A firm lends only if the expected repayment is equivalent to the amount of the loan (must equal one), $\mu_t(R_t)\Gamma = 1$. Therefore, a firm will invest up to:

(7) $$R_t \leq \frac{1}{1-h}\omega_{t-1} = \nu\omega_{t-1} = \hat{R}_t$$

where ν is the credit multiplier, which has a positive relationship with financial development. The higher the hiding cost h, the larger the credit multiplier v. (Aghion et al., 2018, 8-9; Aghion & Howitt, 2009, 134-135.)

The credit constraint is restrictive if $\hat{R}_t < R_t$. In the equation, the R&D expenditure R_t (and hence the innovation probability μ) are chosen in the absence of financial constraints. As stated previously, $R_t = A_t^*\delta\mu^2/2$ and $\mu = \pi/\delta$, which will give $\nu\omega_{t-1} < \gamma A_{t-1}\pi^2/(2\delta)$. The equilibrium wage is equivalent to $(1-\alpha)$ times the final output Y_{t-1}. Since $Y_t = \alpha^{\frac{2\alpha}{1-\alpha}}A_t$, the equilibrium wage is $\omega_{t-1} = \omega A_{t-1}$, where $\omega = (1-\alpha)\alpha^{\frac{2\alpha}{1-\alpha}}$.

The inequation above can be written in terms of the credit multiplier:

(8) $$\nu < \gamma\pi^2/(2\delta\omega)$$

where the credit multiplier ν represents financial development. A higher financial development (ν) or higher wealth (ω) lessens the probability of firms to face a credit constraint; with higher ν, the creditors are inclined to lend more (because of higher cost to defraud), and higher ω makes firms financially more self-sufficient.

Two different cases can be viewed using the inequation (8). In a case where the inequation holds, the equilibrium growth rate is:

Case 1: $$g^h = (\gamma - 1) = \sqrt{2\nu\omega/\delta\gamma}$$

In this case, the equilibrium growth rate g^h increases monotonically with financial development and wealth. However, it is not influenced by the productivity-adjusted profit π, because a higher profit does not give lenders incentive to finance any more research (it does not affect the incentive compatibility constraint). Therefore, higher profit fosters growth only if the credit constraint is not binding.

In the second case, the inequation (8) does not hold. This means that the equilibrium growth rate equals the growth rate without credit constraints, which is:

Case 2: $$g = \mu^*(\gamma - 1) = (\pi/\delta)(\gamma - 1)$$

The equation shows that the equilibrium growth rate g is positively dependent on the profitability of innovation (π), and the size of innovations (γ), but it does not depend on financial development and wealth. (Aghion et al., 2018, 9-10; Aghion & Howitt, 2009, 135-136.)

2.2.3 Convergence and financial development

Howitt (2000) presented a Schumpeterian convergence and divergence model based on the creative destruction model by Aghion and Howitt (1992). The purpose was to explain why some countries converge to the same growth rate, while others stagnate. Howitt introduced *technology transfer* from more advanced countries to less advanced counties, and stated, that converge requires positive R&D levels. Howitt's model also showed that the cross-country differences in per-capita income could be explained not only by divergence in capital, but also in productivity. (Howitt, 2000, 837, 842). As many authors, Andrews et al. (2017b, 8-10) state that the productivity gap between frontier and "laggard" firms (non-frontier firms) has been growing in OECD countries, as seen in figure 1. Next, this chapter explains in more detail the reasons why other countries or firms converge while others stagnate.

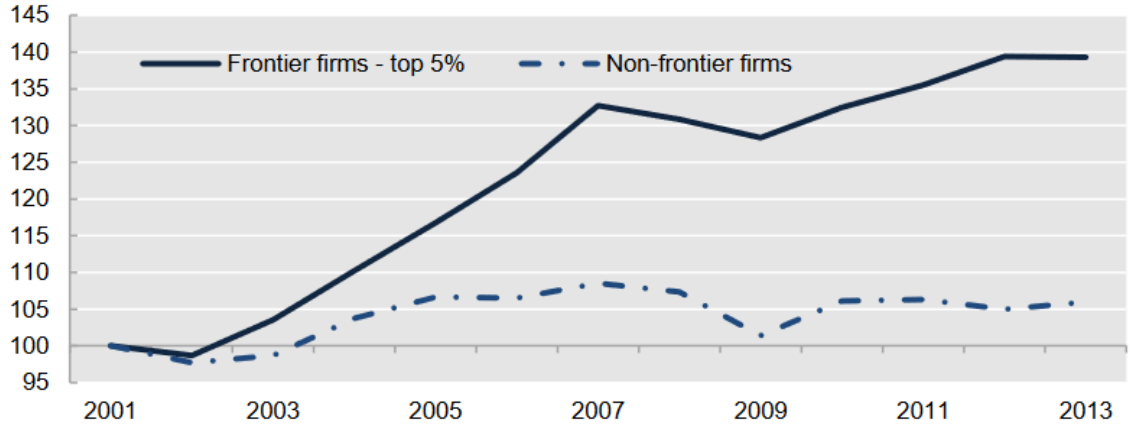

FIGURE 1 Increasing productivity gap between frontier and laggard firms in OECD countries

NOTES: Frontier firms refer to the 5% globally most productive firms in each two-digit industry according to average labor productivity (value added per worker), whereas laggard firms refer to all the other firms in data sample but frontier firms. The dataset includes 24 countries and covers manufacturing and business services (excluding the financial sector), including firms with at least 20 employees. The authors have controlled for differences in capital intensity and mark-up behavior. Source: Andrews et al. (2017b).

The concept of *appropriate institutions* is presented by Aghion and Festre (2017), who refer to the work of Acemoglu et al. (2006). The idea describes that the same institutions and policies that are appropriate for countries close to the technology frontier are not inevitably beneficial to non-frontier countries. (Aghion & Festré, 2017, 30.) Non-frontier countries can utilize *the advantage of backwardness,* which means that they can adopt and imitate existing technologies already developed in more advanced economies (Aghion et al., 2008, 151). By this, Aghion et al. (2008) refer to Gerschenkron's (1962)[3] idea, that the bigger the

[3] Gerschenkron, A. 1962. Economic backwardness in historical perspective: A book of essays. Cambridge, MA, Belknap Press of Harvard University Press.

distance to the frontier, the larger the improvement can be, or in other words, the "bigger" the innovation is (Aghion et al., 2008, 18). According to Acemoglu et al. (2006), countries at early stages of development use a strategy that is *investment-based*; they undertake large investments, create long-term relationships with firms and entrepreneurs. On the downside, the great investments and protection of insiders create market rigidities, less competitive environment, and lack of selection of skilled entrepreneurs. When an economy approaches technology frontier, investment is typically replaced with selection and an *innovation-based* strategy is selected. The typical features of innovation-based strategy include less investment, short-term relationships, younger firms, and skilled entrepreneurs as unsuccessful entrepreneurs are replaced. (Acemoglu et al., 2006, 37-39.)

The difficulty is to determine the right timing to switch from investment-based strategy to innovation-based strategy. According to Acemoglu et al. (2006), some economies switch from investment-based strategy too early, even if it would be beneficial for welfare or growth to continue using the strategy. The reason for this is the *appropriability effect;* monopolists pay large investments in full but can only appropriate part of the monopoly rents, which makes the investment-based strategy unattractive. In this scenario, it might be beneficial for the economy to encourage the investment-based strategy for example with anticompetitive policies or investment subsidies. On the other hand, there is a chance that the economy gets trapped in the investment-based strategy, which might have long-run costs. The monopoly rents might create "a shield" against new innovations and surpass the appropriability effect. This is known as the *rent-shield effect*. One drawback is that it reduces growth because of lack of innovations. Also, failing to change to invest-based strategy before a certain "threshold" (distance to frontier) can lead the economy into a *non-convergence trap*; a failure to converge to the technology frontier. Moreover, Acemoglu et al., (2006) introduce a theory of *leapfrogging*, which explains that the non-convergence trap might cause the initially fast-growing countries getting "leapfrogged by the initial laggards". (Acemoglu et al., 2006, 37, 39.)

Next, this thesis introduces a Schumpeterian model of convergence, as described in Aghion et al. (2018), based on the work by Aghion et al. (2005) and Aghion and Howitt (2009). In the model, technological spillovers from innovations by advanced economies are assumed.

A firm that innovates successfully, is able to implement a technology with a productivity variable that equals level $\bar{A}$. The innovation technology with a productivity variable parameter A_{it} can be described as:

$$A_{it} = \begin{cases} \bar{A}_t & \text{with probability} \quad \mu_{it} \\ A_{i,t-1} & \text{with probability } 1 - \mu_{it} \end{cases}$$

where $\bar{A}_t$ is the technology frontier. If an incumbent firm wants to reach the technology frontier $\bar{A}_t$, it must pay the R&D cost of $c(\mu)\bar{A}_t$ units of the final good.

The frontier productivity growth is $\bar{A}_t = (1+g)A_{t-1}$[4]. Because the average productivity variable across all sectors is $A_t = \int_0^1 A_{it}di$, and the probability of innovation in equilibrium is the same across all sectors $\mu_{it} = \mu^*$, the average productivity can be developed into:

$$A_t = \mu^* \bar{A}_t + (1 - \mu^*)A_{t-1} \tag{9}$$

(Aghion et al., 2018, 13-14; Aghion & Howitt, 2009, 154-155).

2.2.4 Convergence model without credit constraints and distance to frontier

The distance, or proximity to technology frontier can be discovered by the ratio of a productivity in sector i to the productivity of the frontier, described as:

$$a_{i,t} = A_{it} \,/\, \bar{A}_t$$

The average distance to the frontier domestically is measured by:

$$a_t = \int_0^1 a_{it}\, di = A_t/\bar{A}_t$$

which is described as the technology gap, since it is inversely related to the country's distance to the technological frontier.

Dividing the productivity variable $A_t = \mu^* \bar{A}_t + (1 - \mu^*)A_{t-1}$ by $\bar{A}_t$ will lead to:

$$a_t = \mu^* + \frac{(1-\mu^*)}{1+g} a_{t-1} \tag{10}$$

Combining $a_t = a_{t+1}$ to the equation will describe the long-run convergence to the steady-state value a^*, which is:

$$a^* = \frac{(1+g)\mu^*}{g+\mu^*} \tag{11}$$

(Aghion et al., 2018, 15; Aghion & Howitt, 2009, 155-156).

A successful innovator earns π_{it}, whereas a non-innovator earns nothing. The equilibrium profit for an innovator is $\pi\bar{A}_t$, meaning that the equilibrium innovation rate μ^* can be discovered by finding the value of μ that maximizes the expected net payoff $\mu\pi\bar{A}_t - c(\mu)\bar{A}_t$. As stated earlier, a firm pays the R&D cost of $c(\mu)\bar{A}_t$ units of the final good, where $c(\mu) = \eta\mu + \delta\mu^2/2$, and η is a positive parameter. The equilibrium innovation rate μ^* depends on the relative size of innovation reward compared to the cost. If the profit is large enough ($\pi > \eta$), it

[4] Constant at rate g and exogenous.

will lead to innovating at a positive rate, and the equilibrium innovation rate μ^* is $\mu^* = \pi - \eta/\delta > 0$[5]. All these countries will converge to the same growth rate because of technology transfer. The larger a country's distance to the frontier, the higher its growth rate, because the average size of innovations is bigger. In the long run, however, $A_t \simeq a^* \bar{A}_t$, meaning that the productivity growth rate of a country (A_t) equals the frontier growth rate g. On the other hand, if the profit is not sufficiently large ($\pi \leq \eta$), there will be no innovation done, and the equilibrium innovation rate $\mu^* = 0$. These countries will stagnate in the long run and cannot utilize technology transfer. Because $\mu^* = 0$, also $a^* = 0$, applying that the proximity to frontier is reaching infinity, a_t^{-1}. However, in some cases, countries with a positive growth rate fail to converge to the growth rate of the frontier. These cases are examined on the next section with credit constraints. (Aghion et al., 2018, 15-16.)

2.2.5 The convergence model with credit contraints

This section introduces a model, in which credit constraints work as a source of divergence between countries. The model is described in Aghion et al. (2018), based on the work by Aghion et al. (2005). The idea of *disadvantage of backwardness* is presented, describing that the further a country is from the frontier, the harder it is to catch up and keep up with the innovating rate, which requires investments on R&D (Aghion et al., 2005, 176). The lower the cost of defraud (and the lower financial development), the greater the effect of disadvantage of backwardness (Aghion et al., 2018, 17). Next, the impact of credit constraints on convergence are described in more detail.

A firm is able to invest a certain amount of its wealth in innovation, $v\omega_t$[6], which is confined by credit constraints. With innovation probability μ and the cost of innovating $c(\mu)\bar{A}_t$, it will be $c(\mu_{t+1})\bar{A}_{t+1} = v\omega_t$. Wealth ω_t is proportional to A_t, so that $\omega_t = \theta A_t$. It is also known that $\bar{A}_t$ grows at rate g. Knowing these facts and dividing the equation with $\bar{A}_{t+1}$, will give the same equation in perspective of the proximity variable, which is $c(\mu_{t+1}) = \kappa a_t$, where $\kappa = \frac{v\theta}{1+g}$. It is seen from the equation, that μ_{t+1} grows in terms of a_t (the distance to the frontier). In a case of using the same R&D technology (as in previous section), $c(\mu_t) = \eta\mu_t + \delta\mu_t^2/2$.

Therefore, μ_{t+1} can be determined as:

$$\mu_{t+1} = \tilde{\mu}(\kappa a_t) = \frac{\sqrt{\eta^2 + 2\delta\kappa a_t} - \eta}{\delta} \quad (12)$$

which shows that μ_{t+1} grows with a_t, whereas it turns zero if $\kappa = 0$ or $a_t = 0$.

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[5] Maximizing the equation $\mu\pi\bar{A}_t - c(\mu)\bar{A}_t$ will lead to c'(μ)=δ.

[6] As in Aghion, P., Banerjee, A. & Piketty, T. 1999. Dualism and macroeconomic volatility. The Quarterly Journal of Economics, 114(4), pp. 1359–1397.

If $\tilde{\mu}(\kappa a_t) < \mu^*$, the credit constraint is restrictive concerning the investment on R&D. In this case, μ^* represents the optimal probability without constraints on credit, and it is assumed that $\mu^* = (\pi - \eta)/\delta > 0$. Then, the convergence can be expressed as:

$$a_{t+1} = \tilde{\mu}(\kappa a_t) + \frac{(1-\tilde{\mu}(\kappa a_t))}{1+g} a_t \equiv F_2(a_t) \quad (13)$$

The convergence is nonlinear in a_t, meaning that a country far from frontier (very low a_t) will have a lower convergence rate than a country closer to frontier (higher a_t). However, if a country with credit constraints have a small enough wealth ω, it will lead to $a_{t+1} < a_t$, and a divergence from the frontier. (Aghion et al., 2018, 16-18; Aghion & Howitt, 2009, 159.)

2.2.6 A growth regression model: evidence on the effect of financial development on convergence

Aghion, Howitt, and Mayer-Foulkes (2005) formed a cross-country growth regression model to prove that financial development has impact on convergence. The data, estimation methods, and conditioning sets follow the study by Levine, et al. (2000). The most significant difference is that Aghion et al. (2005) included an interaction term ($F_i \times (y_i - y_1)$) in the model to allow convergence to depend on financial development. The regression model is of the following:

$$g_i - g_1 = \beta_0 + \beta_f F_i + \beta_y \times (y_i - y_1) + \beta_{fy} \times F_i \times (y_i - y_1) + \beta_x X_i + \varepsilon_i \quad (14)$$

where g refers to the average growth rate of GDP per-capita during the sample period, F is the average level of financial development, y denotes the initial log of GDP per-capita, X represents the control variables, and ε is the error term. Country i refers to the examined country, whereas country 1 is the leader in the technological frontier.

Because it is assumed that $\beta_y + \beta_{fy} F_i \neq 0$, the above equation (1.14) can be reformulated in the following form $g_i - g_1 = \lambda_i \times (\hat{y}_i - \hat{y}_i^*)$, where $\hat{y}_i$ ($\equiv y_i - y_1$) is the initial relative GDP per-capita of a country i and $\hat{y}_i^*$ is the steady-state value. Using the above equations, the steady-state value $\hat{y}_i^*$ and a country-spesific convergence variable λ_i can be determined by:

$$\hat{y}_t^* = -\frac{\beta_0 + \beta_f F_i + \beta_x X_i + \varepsilon_i}{\beta_y + \beta_{fy} F_i} \quad (15)$$

$$\lambda_i = \beta_y + \beta_{fy} F_i \quad (16)$$

This verifies that the convergence variable λ_i is dependent on financial development. The convergence will happen if the convergence variable λ_i is negative, meaning that the growth rate (relative per capita GDP) of a country is negatively dependent on the initial value $\hat{y}_i$ (relative per-capita GDP). Therefore, finan-

cial development increases the probability of convergence only if $\beta_{fy} < 0$. (Aghion et al., 2005, 191-192; Aghion & Howitt, 2009, 161-163, 454-455.)

3 LITERATURE REVIEW ON EMPIRICAL STUDIES

This section focuses on the earlier literature on finance and growth. The first chapter presents studies that examine the effects of financial development on growth and the convergence of countries to the technological frontier. The second chapter introduces research that focus on different financial systems and ponders whether it matters for growth if the financial system is bank-based or market-based. The final chapter in this section concludes and analyses the results.

3.1 Financial development and growth

Financial deepening seems to play a role in fostering economic growth. Well-functioning financial institutions, markets, and intermediaries enhance growth (Levine, 2018), because financial systems can foster innovation, reallocate resources, ease credit constraints (Aghion, Howitt & Levine, 2018), reduce costs related to financial contracts (Arcand, Berkes & Panizza, 2015), and exercise corporate governance and risk management (Levine, 2002). Financial development is especially beneficial for firms and industries that are dependent on external finance (Rajan & Zingales, 1996). King and Levine (1993) were among the first authors to form a cross-country study on finance-growth nexus, and their research context[7] has served as a basis for further studies. Later on, studies have utilized different datasets, ranging from cross-industry and cross-region to cross-firm datasets. Studies differ based on the method, measure of financial development, and the control variables used. Next, this thesis presents studies that investigate the relationship between finance and growth. The following studies concentrate on examining whether financial development affects growth, and whether countries can converge to the frontier growth rate.

Aghion, Howitt and Mayer-Foulkes (2005) studied the effect of financial development on cross-country convergence. They constructed a cross-country growth regression model with data on 71 countries during 1960 – 1995[8]. They used both instrumental variables (IV) and ordinary least squares (OLS) estimation techniques and included an interaction term between a country's initial relative output and financial development. As a dependent variable, the authors used the log of per-capita GDP growth, and as a measure of financial develop-

[7] King and Levine (1993) constructed a simple growth regression model based on Barro growth regression. A simple model of a cross-country growth regression is of the form:
$g_i = \beta_0 + \beta_1 F_i + \beta_2 X_i + u_i$,
where g_i indicates the average growth rate in country i over the sample period, F_i is the level of financial development, X_i refers to the control variables and u_i is an error term.

[8] The data was taken from Levine, R., Loayza, N. & Beck, T. 2000. Financial Intermediation and Growth: Causality and Causes. Journal of Monetary Economics, LXVI, 31–77.

ment, they used private credit, or more specifically "the value of credits by financial intermediaries to the private sector, divided by GDP". The authors also utilized three alternative measures of financial development; the bank assets (the ratio of credits by banks over GDP), the liquid liabilities (currency plus demand and interest bearing liabilities of banks and nonbank financial intermediaries divided by GDP), and the commercial-central bank asset ratio (the commercial bank assets divided by the sum of commercial plus central bank assets). In the study, a large variety of control variables were used, including controls for legal origin [9], schooling, openness to trade, inflation, government size, black market premium, and the additional conditioning set included controls for ethnic diversity, revolutions and coups, and political assassinations. The study confirmed their assumption that financial development increases the probability of convergence. Below a certain level of financial development, the growth rate will be lower than that of the technology frontier. When an economy has reached a certain level of financial development (the level of private credit exceeds a critical value), it will converge to the same growth rate of the frontier. However, the positive effect of financial development is vanishing, once an economy has merged to the growth rate of the frontier (vanishing steady-state effect). The authors estimated that the critical value of private credit equals to 25 percent. (Aghion et al., 2005, 173-175, 188-190, 193-195, 198, 214.)

Rousseau and Wachtel (2011) explored how financial deepening affects growth. In their study, they constructed growth regression models with pure cross-sectional and cross-country panel data of 84 countries between 1960 and 2004. They used three estimation techniques, including OLS growth regressions (cross section data), dynamic system GMM and two-stage least squares estimations (panels of 5-year averages). As a measure for financial development, they used the private sector credit (the ratio of credit allocated to the private sector to GDP) the liquid liabilities (ratio of M3 to GDP), and liquid liabilities less narrow money (the ratio of M3 less M1 to GDP). The study comprehended controls for the log of initial real per capita GDP, trade (the ratio of imports plus exports to GDP), school (the log of the initial secondary school enrollment rate), and government consumption (the ratio of government final consumption to GDP). The research affirmed the positive relationship between finance and growth but suggested that the positive effect has dampened from the period of 1960-1989. They tested for different reasons for the discovered time effects and found that increased incidence of banking and financial crises contributed to the vanishing effect of financial deepening. In other words, the relationship between financial deepening and growth is strong, unless a country fails to avoid financial crisis. Financial crisis is often related to financial deepening that happens too fast after an increase of nonperforming loans, credit standard deterioration, and banking crisis. On the contrary, a growth enhancing financial deepening can result from an increase of financial intermediary activity. The results also indicated that the impact of financial deepening is not dampened by liberalization (measured by international equity market opening), or the absence of equity markets in the

[9] Dummy variables for British, French, German, and Scandinavian legal origins.

model. Rousseau and Wachtel (2011) concluded, that the role of financial development on growth is complicated, and appropriate policies, such as regulation and financial sector reform, should be performed when conducting financial deepening in a country. (Rousseau & Wachtel, 2011, 276-287.)

Arcand, Berkes, and Panizza (2015) studied the relationship between financial depth and economic growth. More specifically, they wanted to investigate whether there exists a certain level of financial depth at which more finance starts having a negative impact on growth. Different data sets and empirical approaches were used. The data covered the period 1960-2010 and included both country-level and industry-level data. Empirical approaches included cross-sectional and panel regressions, and also semi-parametric models. As a measure of financial depth, they used the credit to the private sector over GDP, even though they consider it as an imperfect measure of financial development, but the best available one. The control variables depended on the model being used, but included for example controls for initial gdp per capita, education, trade openness, inflation, the initial stock of human capital, and government expenditures. The results showed that there existed a concave and non-monotonic relationship between finance and economic growth in countries with small and intermediate financial sectors; low financial depth had a positive and statistically significant effect on growth, whereas high levels of financial depth affected growth negatively. The authors confirmed that there is indeed a threshold level of financial depth, and after crossing that level, more credit no longer has a positive effect on growth. The authors suggested that the threshold occurs when credit to the private sector gets to 80-120% of GDP. Therefore, the results confirmed the *vanishing effect* of financial depth, which was first described by Rousseau and Wachtel (2011). However, the authors agreed that if financial sectors are large, financial depth does not have a positive effect on growth, or the effect might be negative. Arcand et al. (2015) agree with Aghion et al. (2005) in that financial depth can help a country converge to the same growth rate of the frontier, but it does not influence steady-state growth. (Arcand et al., 2015, 105-108, 110-115, 119, 129, 139, 141-142.)

A study constructed by Aghion, Bergeaud, Cette, Lecat, and Maghin (2018) examined the relationship between credit access and productivity growth. They formed both panel analysis and OLS regression models, and used sectoral and firm-level datasets. The empirical model using firm-level data included a cotation[10] variable to describe the access to credit and which "rates firms according to their financial strength and capacity to meet their financial commitments". The sectoral dataset included 22 manufacturing sectors during 2004-2016 and included a spread variable to describe credit constraints. The spread is "the difference between the average rate of new loans to the sector and a reference rate, which is the average yearly value of the Euro Over Night Index Average (EONIA)". The results prevailed that the relationship between productivity growth and credit constraints is an inverted-U shaped. Easier access to credit is related to productivity growth since it promotes innovation. At the same time,

[10] Commonly used by banks, such as European Central Bank.

better credit access reduces creative destruction; it enables the less productive firms to stay on the market hindering the entry of more productive innovators and leading to ineffective allocation of resources. (Aghion, Bergeaud, Cette, Lecat & Maghin, 2018, 1-5, 14-15, 20-21, 30-31.)

3.2 Bank-based versus market-based financial system and growth

King and Levine (1993) refer to Schumpeter (1911)[11], when they state, "Financial intermediaries make possible technological innovation and economic development". However, different financial systems play a different role in economies. This chapter examines whether it matters for growth if the economy is bank-based or market-based.

According to Levine (2002), banks are effective at collecting savings and finding good investment targets, controlling liquidity risk, and preventing moral hazard related to lending. Compared to markets, bank-based systems have a relative advantage at operating corporate control, especially at early stages of economic development (Levine, 2002) and in weak institutional environments (Levine, 2002; Rajan & Zingales, 1998); powerful banks are more effective at forcing firms to pay their debts (Rajan & Zingales, 1998). However, in a case of large inflows of external capital, bank-based systems might be related to misallocation of capital. (Rajan & Zingales, 1998). Markets, on the other hand, have a relative advantage at capital allocation, risk management tool provision, corporate governance improvement, information revelation, stimulation of innovations, and alleviation of problems related to overly powerful banks. One disadvantage of markets is the exposition to liquidity risk. (Levine 2002). Market-based systems work better in economies that have improved legal systems (Rajan & Zingales, 1998).

Levine (2002) examined the importance of financial development on economic growth, and whether the result differs, if the financial system is bank-based or market-based. The research utilized cross-country data of 48 countries (developing and developed) during 1980-1995, and conducted different cross-country regressions using ordinary least squares (OLS) estimation. The study comprised securities markets, banks, and nonbank financial intermediaries and measured their size, efficiency, and activity using a variety of different indicators. The author also measured the overall financial sector development using the same method. For example, activity indicators included total value traded ratio and private credit ratio, size indicator included market capitalization ratio, and efficiency measured overhead costs, just to name a few. In the study, simple and full conditioning sets were used. The simple set included the logarithm of initial real per capita GDP (in 1980) and schooling, and the full set included the simple set plus controls for inflation, trade, black market premium, gov-

[11] Schumpeter, J. 1911. The Theory of Economic Development. Harvard University Press, Cambridge, MA.

ernment size, and "indicators of civil liberties, revolutions and coups, political assassinations, bureaucratic efficiency, and corruption". The results indicated a strong, positive correlation between overall financial development and long-run growth. However, the results promoted neither banks nor markets in facilitating growth. The author suggested that it is more vital to contribute to sound financial services by creating better-functioning markets and banks and deepening the overall financial development. (Levine, 2002, 1-9, 15-24.)

Demirgüc-Kunt, Feyen and Levine (2012) investigated the role of banks and securities markets as economy develops. Their paper surveyed earlier literature proposing that banks are competent in providing finance on standardized, well-collateralized, short term, and low risk projects, whereas decentralized markets suit better at financing long term, high risk projects related to limited collateral and intangible assets. The relative importance of banks and decentralized markets vary at different stages of economic development; financial systems become more market-based when countries develop economically, suggesting that projects are riskier, relying more on intangible inputs and customized arrangements. Demirgüc-Kunt et al. (2012) constructed both quantile regressions model and ordinary least squares (OLS) regressions model. The data included 72 countries during 1980-2008, with 5-year sub-periods. Dependent variables used in the study included private credit (bank credit to the private sector relative to GDP), stock value traded (value of stock market transactions to GDP), stock market capitalization (value of listed shares on stock exchanges relative to GDP), and securities market capitalization (stock market capitalization and the capitalization of private domestic bond markets relative to GDP). They controlled for initial GDP per capita, openness to trade, average years of schooling, inflation rate, and government size. The results showed that the relationship between financial development (both bank and securities market) and growth is nonlinear and concave. Economic development of a country increases the relative size of securities markets and banks compared to the size of the economy. At the same time, there tends to be a transition to more market-based financial systems, as the services provided by banks become less important. (Demirgüc-Kunt et al., 2012, 1-15, 19-20.)

Sahay, Cihák, N'Diaye, Barajas, Bi, Ayala, Gao, Kyobe, Nguyen, Saborowski, Svirydzenka, and Yousefi (2015) constructed a study, which concentrated on financial development, growth and stability in emerging markets. The authors represented a variety of goals of the study, such as figuring out whether the positive effects of financial development turn negative after a certain threshold, and whether it contributes to stability. The dataset consisted of 176 countries during the period of 1980-2013. The authors constructed panel regression models using a dynamic system generalized method of moments (GMM) estimator over five-year periods. The dependent variable was economic growth (per capita real GDP growth) for the first panel regression, and economic volatility and financial stability for the following regressions. The controls for the first regression included initial income per capita, inflation, education, trade, foreign direct investment, government consumption, and banking crisis (dummy variable). Financial development was examined in terms of depth, access,

and efficiency of financial markets and financial institutions, and an overall financial development index was constructed[12]. One outcome of the study was that the relationship between financial development and growth is positively correlated, and most emerging markets could benefit from further financial development. However, after a certain point (between 0.4 and 0.7 on the financial development index), the effect turned negative, forming a bell-shaped connection between financial development and growth. The negative impact was related to greater financial depth (not access or efficiency), hampering the MFP growth (not capital accumulation). The authors also discovered that financial development should be accompanied with good institutional and regulatory frameworks. Otherwise, too fast-paced financial deepening of financial institutions can decrease stability if high leverage and risk-taking is associated with poor regulation. Furthermore, better financial regulation (quality, rather than amount) can be beneficial for both financial development and stability. The study concluded that it depends on the country, whether financial markets or institutions are better, and there is no "one-size-fits-all" –strategy. However, institutions become relatively more beneficial than markets as economies develop. (Sahay, Cihák, N'Diaye, Barajas, Bi, Ayala, Gao, Kyobe, Nguyen, Saborowski, Svirydzenka & Yousefi, 2015, 5-7, 11-13, 15-17, 30, 34-35, 38-41.)

3.3 Summary and analysis of the literature review

The studies that are included in the literature review are summarized in table 1 below:

TABLE 1 Summary of the literature review

Authors (year)	Sample countries and period	Type of data and methods	Measure of financial development	Findings
Levine (2002)	48 countries (1980-1995)	Different cross-country regressions using OLS estimation	A variety of different indicators. Measures the size, efficiency, and activity of securities markets, banks, nonbank financial intermediaries, and the overall financial sector development.	A strong, positive correlation between overall financial development and long-run growth. No evidence for the bank-based or market based views. Promotes financial services view.
Aghion, Howitt & Mayer-	71 countries, (1960 – 1995)	Cross-country growth regression model, IV and	The private sector credit (the ratio of credits by financial intermediaries to	Financial development increases the probability of convergence. The positive effect of

[12] As in Čihák, M., Demirgüç-Kunt, A., Feyen, E. & Levine, R. 2012. Benchmarking Financial Development Around the World. World Bank Policy Research Working Paper 6175. World Bank. Washington, DC.

Foulkes (2005)		OLS estimations	the private sector to GDP). Alternative measures; the bank assets (the ratio of credits by banks to GDP), the liquid liabilities (currency plus demand and interest bearing liabilities of banks and nonbank financial intermediaries to GDP), and the commercial-central bank (the commercial bank assets divided by the sum of commercial plus central bank assets).	financial development is vanishing, once an economy has merged to the growth rate of the frontier (vanishing steady-state effect). Below a certain level of financial development, the growth rate will be lower than that of the technology frontier.
Rousseau and Wachtel (2011)	84 countries (1960-2004)	Cross-section data with OLS growth regressions, panel data (5-year averages) with dynamic system GMM and two-stage least squares estimations.	The private sector credit (the ratio of credit to the private sector to GDP). The liquid liabilities (ratio of M3 to GDP), and liquid liabilities less narrow money (the ratio of M3 less M1 to GDP).	Positive relationship between financial deepening and growth. Increased incidence of banking and financial crises contribute to the vanishing effect of financial deepening. The role of financial development on growth is complicated, and appropriate policies, such as regulation and financial sector reform, should be performed along with financial deepening in a country.
Demirgüc-Kunt, Feyen and Levine (2012)	72 countries (1980-2008)	Cross-country quantile regressions model and OLS regressions. 5-year subperiods.	Private credit (bank credit to the private sector relative to GDP), stock value traded (value of stock market transactions of GDP) stock market capitalization (value of listed shares on stock exchanges relative to GDP), and securities market capitalization (stock market capitalization and the capitalization of private domestic bond markets relative to GDP).	A nonlinear, concave relationship between financial development (both bank and securities market) and growth. Economic development of a country increases the relative size of securities markets and banks compared to the size of the economy. At the same time, there tends to be a transition to more market-based financial system, as the services provided by banks become less important.
Arcand, Berkes & Panizza (2015)	126 countries (1960-2010)	Country-level and industry-level data. Cross-country, cross-sectional, panel regressions, and semi-parametric models; IV, OLS and system GMM estimations.	The private sector credit (the ratio of credit to the private sector to GDP).	A concave and non-monotonic relationship between finance and growth in countries with small and intermediate financial sectors. There is a threshold level of financial depth (the credit to the private sector gets to 80-120% of GDP), and after crossing that level, more credit no longer has a positive effect on growth (vanishing effect). If financial sectors are large, financial depth does not have a positive effect on growth, or the effect might be negative.
Sahay, Cihák, N'Diaye, Barajas, Bi, Ayala, Gao, Kyobe,	176 countries (1980-2013)	Panel regression models using a dynamic system generalized method of moments (GMM) estimator.	A variety of different indicators. Measures the depth, access, and efficiency of financial markets and financial institutions, and constructs an overall	A bell-shaped connection between financial development and growth, where the negative effect is related to greater financial depth. Financial development should be accom-

Nguyen, Saborowski, Svirydzenka & Yousefi (2015)		Five-year periods	financial development index.	panied with good institutional and regulatory frameworks. There is no "one-size-fits-all" – strategy. However, institutions become relatively more beneficial than markets as economies develop.
Aghion, Bergeaud, Cette, Lecat & Maghin (2018)	22 French manufacturing sectors (2004-2016)	Sectoral and firm-level datasets. Panel analysis and OLS regression models	Two different variables to describe credit access. A cotation (rating) variable (rates firms according to their financial strength and capacity to meet their financial commitments) and a spread variable (the difference between the average rate of new loans to the sector and a reference rate).	The relationship between productivity growth and credit constraints is an inverted-U shaped. Easier access to credit is related to productivity growth since it promotes innovation. At the same time, better credit access reduces creative destruction; it enables the less productive firms to stay on the market hindering the entry of more productive innovators and leading to ineffective allocation of resources.

Studies show that there is a strong, positive relationship between financial development and growth (Levine, 2002; Rousseau & Wachtel, 2011; Levine et al., 2000). According to Aghion et al. (2005), financial development increases the probability of convergence to the technological frontier. However, the positive finance-growth relationship seems to weaken, or even turn negative after a certain threshold (Aghion et al., 2005&2018; Arcand et al., 2015; Rousseau & Wachtel, 2011; Sahay et al., 2015), thus forming a bell-shaped, or in other words, an inverted U-form figure. The dampening effect might appear with high levels of financial depth (Aghion et al., 2005; Arcand et al., 2015; Sahay et al., 2015), or it can be related to bank and financial crises (Rousseau & Wachtel, 2011). Some authors state that high levels of financial depth affect growth mainly via multifactor productivity (MFP) rather than capital accumulation; it leads to ineffective allocation of finances and human capital, but it does not hamper capital accumulation itself (see e.g. Sahay et al., 2015, 16-17). Arcand et al. (2015) argue that large financial sector might be inefficient if it captures human capital from more productive sectors, whereas Aghion et al. (2018) state that credit access can reduce creative destruction, leading to ineffective allocation of resources. Rousseau and Wachtel (2011) concluded on their study, that the role of financial development on growth is complicated, and appropriate policies, such as regulation and financial sector reform, should be performed when conducting financial deepening in a country. Moreover, Levine et al. (2000) have argued in their paper, that legal and accounting reforms are able to foster financial intermediary development and hence, growth.

To examine the relationship between finance and growth, a measure of financial development needs to be defined. Unfortunately, there is no uniformly accepted definition that would be used in all the studies, which makes the comparison of the studies challenging. Most authors concentrate on measuring the financial depth, and the most commonly used measure is *the private sector credit*, which can denote to "the ratio of credit to the private sector to GDP" (Rousseau & Wachtel, 2011; Arcand et al., 2015), "the ratio of credits by financial interme-

diaries to the private sector to GDP" (Aghion et al., 2005), or "the bank credit to the private sector relative to GDP" (Demirgüc-Kunt et al., 2012). Some authors consider the credit to the private sector as an imperfect measure of financial development, but the best available one (Arcand et al., 2015). Other measures of financial depth used in researches include *the stock value traded* (Demirgüc-Kunt et al., 2012), *the stock market capitalization* (Demirgüc-Kunt et al., 2012), and *the liquid liabilities* (Aghion et al., 2005; Rousseau & Wachtel, 2011), just to name a few. However, a few authors have discovered that financial development signifies more than just financial depth and have included a broader view to their study. Levine (2002) used a variety of different indicators of financial development; the study measured the size, efficiency, and activity of securities markets, banks, nonbank financial intermediaries, and the overall financial sector development. Also, Sahay et al. (2015) utilized a variety of different indicators to measure the depth, access, and efficiency of financial markets, financial institutions, and the overall financial development.

It seems like different aspects of financial development have different effect on growth. Law and Singh (2014) state that the depth of financial development affects growth according to its level; at low and high levels of financial depth, the effect is low or insignificant, whereas at intermediate levels the impact is strong and positive (Law & Singh, 2014, 37). According to Sahay et al. (2015), the negative impact of finance is related to greater financial depth, but not to financial access or efficiency. If that is the case, then improvement of financial efficiency and access might be able to enhance growth, at least in emerging markets (Sahay et al., 2015). Aghion et al. (2005) suggested that once an economy has merged to the growth rate of the frontier, the positive effect of financial development is vanishing. So, financial deepening can help a country converge to the frontier faster, but in the end, it does not affect steady-state growth (Aghion et al., 2005; Arcand et al., 2015). According to Rousseau and Wachtel (2011) and Sahay at al. (2015), the speed and size of financial deepening matters. If financial deepening happens too fast or is excessive, it might weaken the banking system and increase inflation, which in turn, might lead to financial crisis. On the contrary, financial deepening can be growth enhancing if it follows from an increase of financial intermediary activity. (Rousseau & Wachtel, 2011.)

There is also a debate on whether bank-based or market-based financial systems are better at facilitating growth. Levine (2002) found no evidence for the bank-based or market-based views. However, Demirgüc-Kunt et al. (2012) suggest that the relative importance of banks and decentralized markets vary at different stages of economic development. According to this view, financial systems become more market-based when countries develop economically, since markets suit better at customized arrangements and high-risk projects, whereas banks provide finance on standardized, well-collateralized, and low risk projects (Demirgüc-Kunt et al., 2012). Levine (2002), on the other hand, wants to highlight the financial services view, suggesting that it is more vital to contribute to sound financial services other than concentrating on the debate between bank and markets. The key is to create better-functioning markets and banks,

and deepening the overall financial development (Levine, 2002). Sahay et al. (2015) conclude that financial development should be accompanied with good institutional and regulatory frameworks, and that there is no "one-size-fits-all" –strategy. However, markets become relatively more beneficial than institutions as economies develop, which is why economies with high income levels should develop markets and low-income economies should concentrate on developing institutions (Sahay et al., 2015). Booth, Junttila, Kallunki, Rahiala, and Sahlström (2006) also investigated the role of financial system - equity financing and bank loan financing - on growth but added research and development (R&D) spending to the equation. The purpose of their research was to examine "whether the nature of the financial environment affects R&D-valuation linkage". They concluded that the more a financial system in an economy is market-based (equity financing) rather than bank-based (bank loan financing), the more the investments in R&D activities increase value at stock market. (Booth, Junttila, Kallunki, Rahiala & Sahlström, 2006, 197, 210). To conclude, if the financial systems become more market-based when countries develop (as the literature suggests), investing in R&D becomes more important. This follows Schumpeterian growth theory in that investing in R&D is especially beneficial to economies close to the frontier, since it gives them a change to succeed in innovation and gain the monopolist profits. (e.g. Aghion et al., 2005.)

4 EMPIRICAL FRAMEWORK

The purpose of the empirical framework is to confirm and add on the results from earlier literature and theories on the topic. Based on the literature review above, there are three research questions that are examined in this empirical study. The research questions are the following: 1) What is the effect of financial development on economic growth, and does the effect differ between advanced and emerging economies? 2) Does it matter for growth, whether the financial system is bank-based or market-based, or in other words, is it more beneficial to develop financial institutions or financial markets? 3) Does financial development increase the likelihood of growth convergence to frontier economies?

This section introduces the empirical framework of this thesis. In the first part of this section, the data set and empirical model are presented, whereas the second part introduces the methodology used in the research. The results and analysis of the research are presented in chapter 5.

4.1 Data and empirical model

The data utilized in the empirical study is obtained from the World Bank (2020)[13], the OECD Productivity Statistics database (2019), Barro-Lee Educational Attainment Dataset (2013), and IMF Data (2020)[14]. The full panel dataset is comprised of 60 countries (listed in Appendix 1, table 7) covering the period of 1993-2017, and includes both advanced and emerging economies to enable a broad examination of the topic. The data are averaged over non-overlapping, five-year periods (1993-1997, 1998-2002, 2003-2007, 2008-2012, 2013-2017), implying that there are up to five observations for each variable per country and 300 observations in the overall data sample. The panel data applied is strongly balanced. Panel (i.e. longitudinal) data is chosen, because it is a combination of cross-sectional (N) and time-series (T) data and thereby has several advantages (Hsiao 2003, 7). Most importantly, the cross-sectional data allows to observe the effect of financial development on growth across countries, whereas the time aspect describes how the finance-growth relationship has changed in a country during the observed period (Levine et al., 2000). Moreover, panel dataset offers plenty of observations, which decreases collinearity and increments the degrees of freedom (Hsiao 2003, 3).

The empirical model in this thesis is influenced by the models used by Aghion et al. (2005) and Sahay et al. (2015) but adjusted to own purposes and thereby does not follow the models directly. In the empirical model, average GDP per capita growth is regressed against current and past financial devel-

[13] The World Development Indicators (WDI) database.
[14] Financial Development Index Database.

opment, possible interaction terms, control variables and time-fixed effects. The empirical model is the following:

$$(17) \quad y_{i,t} = \alpha_t + \beta_0 FD_{i,t} + \beta_1 (FD_{i,t} \times Interact) + \beta_3 X_{i,t} + \lambda_t + \varepsilon_{i,t}$$

where $y_{i,t}$ is the real GDP per capita growth, $FD_{i,t}$ is the level of financial development (FD or its sub-index), $(FD_{i,t} \times Interact)$ is an interaction term between financial development and frontier economies (FE, a dummy variable) or distance to frontier ($DTF_{i,t}$), X_{it} describes the control variables, λ_t refers to time-fixed effects, ε_{it} represents the error term, $i = 1, \dots, N$ refers to the country and $t = 1, \dots, T$ refers to time. All variables except FD/FI/FM are in logarithmic terms.

As a measure of financial development, this study uses a broad index that follows the matrix of financial system characteristics developed by Čihák, Demirgüç-Kunt, Feyen, and Levine (2012), and the financial development indices that were originally developed by Sahay et al. (2015), and later further developed by Svirydzenka (2016). International Monetary Fund (IMF) Data (2020) provides an updated database of the broad index and its subindices. The *financial development index* (FD) consists of sub-indices that consider the depth, efficiency, and access of both *financial institutions* (FI) and *financial markets* (FM) (see figure 2). With financial institutions, Svirydzenka (2016) refers to banks, pension funds, insurance companies, and mutual funds. Financial markets consider both bond and stock markets. The *depth* of financial development describes the size and liquidity of markets, the *access* refers to easiness that firms and individuals can get a hold of financial services, whereas *efficiency* measures whether institutions provide financial services at low cost and with sustainable revenues, and the level of activity of capital markets. All the indices are normalized so that the range is between 0 and 1, with higher value indicating greater financial development. The dataset that is used to construct the financial development indices contains annual data between 1980-2013 for 183 low-income, emerging, and advanced economies. Several sources are used for the indices, including Financial Access Survey by IMF, the World Bank FinStats 2015, Bank for International Settlement (BIS) debt securities database, and Dealogic corporate debt database (Svirydzenka, 2016, 5, 7). For more information on the construction of the indices, see Appendix 3.

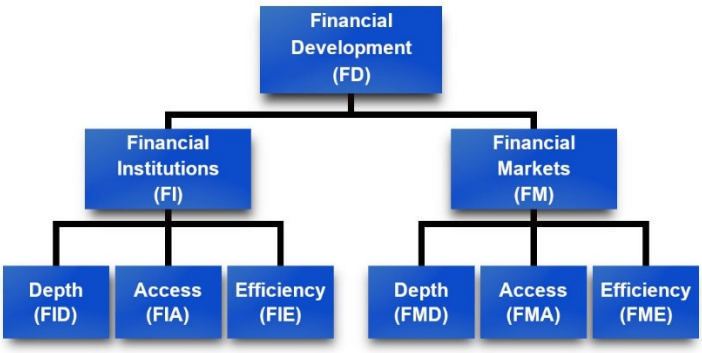

FIGURE 2 Financial Development Index Pyramid

Source: Svirydzenka (2016)

This study utilizes three different measures of financial development developed by Svirydzenka (2016), including the overall financial development index (FD), the financial institutions index (FI), and the financial markets index (FM). The data are obtained from IMF Data (2020), Financial Development Index Database. The countries included in the empirical study are ranked based on the average of their overall financial development index (FD) level during 1993-2017 (the ranking according to financial development can be found in Appendix 2, table 8). The data sample is then divided into two country groups, the advanced and emerging economies, based on the median of the average level of financial development in countries. The median of financial development index (FD) is 0.4637. The above median group is stated as the advanced economies (AE), and the below median group is called the emerging economies (EE). The countries and country groups are listed in Appendix 1, table 7.

Besides the advanced and emerging economies, the empirical research classifies technological frontier economies (FE), which are categorized using *the distance to frontier*. A country's distance to frontier can be measured for example by dividing a country's GDP per capita with the technological frontier's GDP per capita (e.g. Acemoglu et al., 2006). Distance to frontier can also be calculated by using ratios of labor productivity (Adalet McGowan et al., 2017b) or ratios of multifactor productivity (MFP), which is also called total factor productivity (TFP). In some studies, the technology frontier is regarded as the United States (e.g. Acemoglu, Aghion & Zilipotti, 2006), or sometimes as the technology leader in the data sample. According to OECD (2019), labor productivity can be calculated as GDP per hour worked. Labor productivity is commonly used to measure productivity at a country level, but it still has measurement problems between countries, which reduces comparability. Moreover, multifactor productivity refers to "the residual growth that cannot be explained by changes in labor and capital inputs". Sometimes it is referred to as a measure of technical change, as it depicts changes for example in general knowledge, network effects, management practices, brand names, organizational change, spillovers from production factors, adjustment costs, and economies of scale. (OECD, 2019, 11-12). Adalet McGowan et al. (2017b) classify frontier firms as "the 5% globally

most productive firms in each two-digit industry", which are calculated using the average labor productivity (value added per worker). This study uses the MFP option, meaning that a country's proximity to frontier is measured by comparing the level of a country's MFP to the highest level of MFP during the year (the ranking based on distance to frontier can be found in Appendix 2, table 9). With technological frontier, this study refers to the 10 most advanced countries according to their multifactor productivity (MFP) level, more specifically, the 10 countries that have the smallest average distance to frontier. The 10 frontier economies (FE) are also categorized as advanced economies, and are listed in Appendix 1, table 7. The empirical research includes interaction terms between frontier economies (FE) and financial development indices (FD/FI/FM), which measure the joint effects of the variables. The research also includes interaction terms between distance to frontier (DTF) and financial development indices (FD/FI/FM).

Different sets of control variables are used in the study. Almost all regressions (only a few exceptions) include controls for the first lag of GDP per capita (Y_{t-1}), the first lag of financial development ($FD_{t-1}/FI_{t-1}/FM_{t-1}$), the first lag of schooling ($school_{t-1}$) and time-fixed effects (dummy variables for the 5-year periods). Other controls include the first lag of inflation (inf_{t-1})[15], government expenditure (exp_t), and trade ($trade_t$). The data for real GDP per capita, GDP growth, inflation, trade, and government expenditure are obtained from the World Bank, the World Development Indicators (WDI) Database. The government consumption is regarded to describe macroeconomic stance (Sahay et al., 2015). Schooling is assumed to reflect human capital, which presumably affects growth (Levine, 2002; Rousseau & Wachtel, 2011). This study utilizes the average years of total schooling and includes population aged 15 and over. Barro-Lee Educational Attainment Dataset (2013) contains educational data from 1950 to 2010 and uses 5-year intervals. The data of school enrollment covers all the 60 countries but lacks data after 2010. Multifactor productivity data is found for 22 countries [16] utilized in this study, starting from 1993. Initially, the plan was to include six different aspects of governance as control variables from the World Bank (WGI)[17], including control of corruption, regulatory quality, political stability and absence of violence, voice and accountability, rule of law, and government effectiveness. However, none of the governance indicators were statistically significant when included in the regressions and therefore the vari-

[15] When schooling and inflation are added to the model at time t, they cause a serial correlation in the model. Therefore, they are added to the regression in first lag (time t-1) to avoid autocorrelation.

[16] Including Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, the Republic of Korea, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom, and the United States.

[17] Kaufmann, D., Kraay, A. & Mastruzzi, M. 2010. The Worldwide Governance Indicators: A Summary of Methodology, Data and Analytical Issues. World Bank Policy Research Working Paper No. 5430. The governance indicators are stated from the year 1996 on and the governance performance is estimated between -2.5 (weak) to 2.5 (strong).

ables were dropped from the regression. All the variables and their detailed definitions are listed in Appendix 4, table 11.

Descriptive statistics of the data, including the number of observations, the mean, the minimum, the maximum, and standard deviations of the variables, are presented in table 2. The table shows descriptive statistics for all countries, and also for advanced economies (AEs), emerging economies (EEs), and frontier economies (FEs). As expected, the mean values for real GDP per capita, FD, FI, FM, schooling, government expenditure, and trade are higher for AEs compared to EEs, whereas the mean of inflation is higher for EEs. If FEs and AEs are compared, the mean values for real GDP per capita, FI, schooling, government expenditure, and trade are a little higher for FEs, the mean value for FD is the same, and the mean values for FI and inflation are a little smaller for FEs compared to AEs. The mean value for economic growth, however, is highest for EEs and smallest for FEs, which refers to the convergence effect (e.g. Aghion et al., 2005 & 2009; Aghion & Howitt, 2009). Based on the mean values of FI and FM, financial institutions are further developed than financial markets among all countries, and also among AEs, EEs, and FEs. The correlations of the variables used in the empirical study are listed in Appendix 5, table 12. As the correlation table shows, GDP per capita correlates positively with the first lag of GDP per capita, FD index, FI index, FM index, the first lag of schooling, government expenditure, and trade, whereas it correlates negatively with the first lag of inflation.

TABLE 2 Descriptive statistics

Variables	Obs.	Mean	Std.dev.	Min	Max
All countries (60)					
Real GDP per capita	300	21792.55	22647.7	359.36	107326.7
Economic growth	300	2.39	2.27	-4.92	10.86
Financial development index (FD)	300	0.48	0.24	0.05	0.96
Financial institutions index (FI)	300	0.54	0.24	0.09	0.99
Financial markets index (FM)	300	0.41	0.27	0	0.95
Schooling	240	8.79	2.46	2.45	13.18
Inflation	300	1.18	1.10	-2.32	4.45
Government expenditure	300	2.71	0.34	1.57	3.28
Trade	300	4.21	0.59	2.86	6.00
Advanced economies (30)					
Real GDP per capita	150	37959.66	21813.4	1222.46	107326.7
Economic growth	150	2.27	2.16	-2.32	10.86
Financial development index (FD)	150	0.68	0.14	0.36	0.96
Financial institutions index (FI)	150	0.74	0.13	0.36	0.99
Financial markets index (FM)	150	0.60	0.18	0.21	0.95
Schooling	120	10.05	1.69	5.5	13.18
Inflation	150	0.55	0.81	-2.32	2.96
Government expenditure	150	2.87	0.27	2.06	3.28
Trade	150	4.35	0.69	2.86	6.00
Emerging economies (30)					
Real GDP per capita	150	5625.44	5214.94	359.36	21234.11
Economic growth	150	2.52	2.38	-4.92	8.44
Financial development index (FD)	150	0.27	0.13	0.05	0.53
Financial institutions index (FI)	150	0.34	0.12	0.09	0.67

Financial markets index (FM)	150	0.21	0.18	0	0.65
Schooling	120	7.53	2.48	2.45	12.8
Inflation	150	1.81	0.98	-0.76	4.45
Government expenditure	150	2.55	0.33	1.57	3.28
Trade	150	4.07	0.41	3.06	5.12
Frontier economies (10)					
Real GDP per capita	50	47697.08	23958.19	18134.3	107326.7
Economic growth	50	1.54	1.49	-2.32	4.34
Financial development index (FD)	50	0.68	0.11	0.46	0.88
Financial institutions index (FI)	50	0.78	0.11	0.51	0.91
Financial markets index (FM)	50	0.57	0.17	0.24	0.85
Schooling	40	10.09	1.42	6.69	12.32
Inflation	50	0.48	0.59	-1.33	1.40
Government expenditure	50	3.00	0.14	2.75	3.28
Trade	50	4.37	0.53	3.74	5.96

NOTES: The data is presented in 5-year non-overlapping windows, between 1993-2017. Unit-root tests are also applied and are available upon request. Financial development index (FD) refers to depth, efficiency, and access of both financial institutions (FI) and financial markets (FM). FI denotes to depth, efficiency, and access of financial institutions (banks, pension funds, insurance companies, and mutual funds), whereas FM denotes to depth, efficiency, and access of financial markets (bond and stock markets). FD, FI, and FM indices are valued between 0 and 1. Economic growth means the log difference of real GDP per capita (constant 2010 US$). School denotes to the average years of total schooling, inf is the inflation measured by the consumer price index (annual %), exp is the general government final consumption expenditure (% of GDP) and trade is the sum of exports and imports of goods and services trade (% of GDP), all are expressed in logs. The division to advanced and emerging economies is based on the median of average levels of financial development index (FD) in countries. Frontier economies are the 10 most advanced countries according to their multifactor productivity (MFP) level, including: Belgium, Canada, Denmark, France, Italy, Luxembourg, New Zealand, Norway, Portugal, and Spain. Advanced economies are the following: Australia, Austria, Belgium, Brazil, Canada, China, Denmark, Finland, France, Germany, Hong Kong, Ireland, Israel, Italy, Japan, Korea Rep., Luxembourg, Malaysia, Netherlands, New Zealand, Norway, Portugal, Singapore, South Africa, Spain, Sweden, Switzerland, Thailand, UK, and USA. Emerging economies are: Albania, Bangladesh, Bulgaria, Chile, Colombia, Costa Rica, Czech Republic, Ecuador, Egypt, Gambia, Ghana, Hungary, India, Indonesia, Jamaica, Jordan, Kenya, Mexico, Nepal, Pakistan, Peru, Philippines, Poland, Romania, Russia, Saudi Arabia, Tanzania, Turkey, Uganda, and Uruguay.

Figure 3 illustrates how the overall financial development has developed in advanced and emerging economies of the data sample between 1993 and 2017. As seen in the figure, the average level of financial development has been remarkably greater in advanced economies compared to emerging economies. Figure 4 demonstrates the development of the overall level of financial development (FD index), financial institutions (FI index) and financial markets (FM index) in the whole data sample.

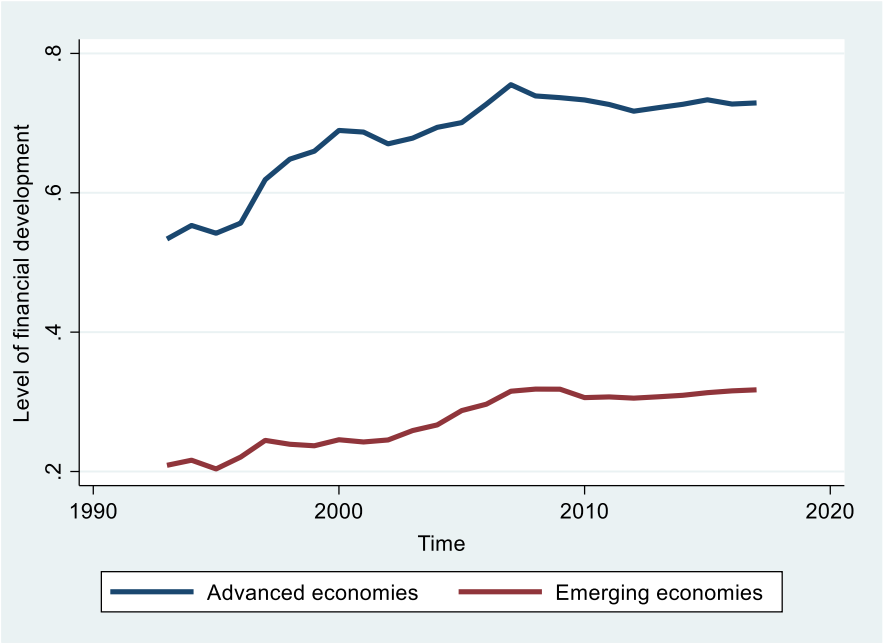

FIGURE 3 Financial development (FD) in advanced and emerging economies, 1993-2017

Notes: The lines represent the yearly, average level of financial development (FD index) in the data sample of advanced economies (30 countries) and emerging economies (30 countries). Source: IMF Data (2020) and own calculations.

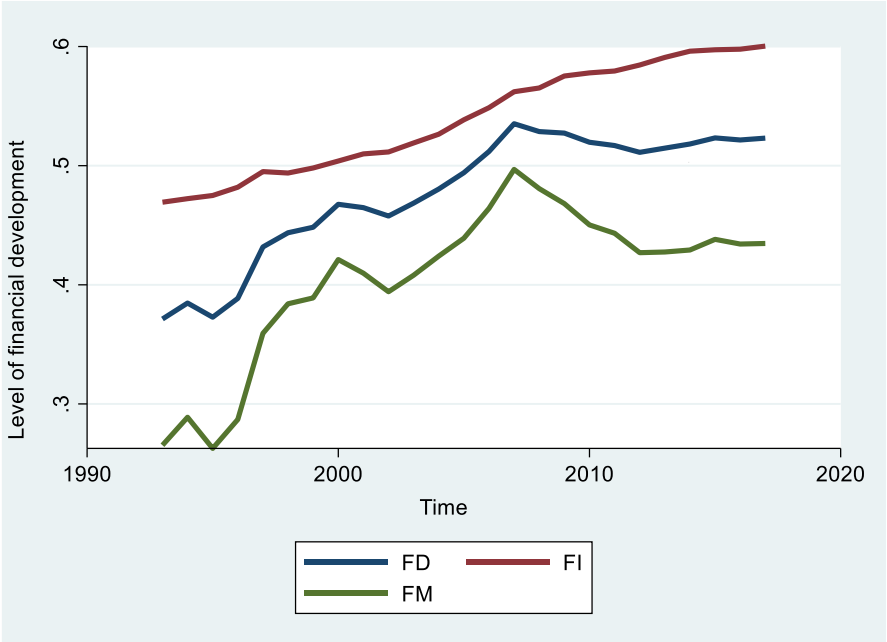

FIGURE 4 Development of FD, FI, and FM indices in the data sample, 1993-2017

Notes: The lines represent the yearly, average development of the overall level of financial development (FD index), financial institutions (FI index) and financial markets (FM index) in the data sample of 60 countries. Source: IMF Data (2020) and own calculations.

4.2 Methodology

In this study, the system generalized method of moments (GMM) dynamic panel estimation technique is used as a preferable option to ordinary least squares (OLS)[18] or instrumental variables (IV)[19]. A dynamic panel method is chosen because economic growth is a dynamic process in nature rather than static. The GMM method addresses endogeneity, omitted variable bias (including unobserved country-specific effects), and simultaneity bias (Levine et al., 2000; Rousseau & Wachtel, 2011; Sahay et al., 2015), which are usual sources of estimation bias when it comes to studying finance and growth empirically. Also, reverse causality can be addressed in panel regressions by using lagged values as instruments (e.g., Levine et al. 2000; Sahay et al., 2015). GMM is specifically designed to address the joint endogeneity problems of the explanatory variables in models with lagged dependent-variable (Levine et al., 2000, 33) and it allows to correct for autocorrelation and heteroscedasticity in the error terms (Law & Singh, 2014). The endogeneity bias can be addressed by instrumenting any endogenous variables with variables that are not correlated with the fixed effects, or to transform the data so that the fixed effects are removed (Roodman, 2009b, 100-103). However, if the data set is too small (cross-sectionally), the GMM method can result in a weakened over-identification test, biased standard errors, and biased estimated parameters (Law & Singh, 2014).

The generalized method of moments (GMM) estimation was initially presented by Hansen (1982). Later on, the method has been updated by many authors, such as HoltzEakin, Newey and Rosen (1988), Arellano and Bond (1991), Arellano and Bover (1995), and Blundell and Bond (1998), who designed difference and system GMM estimators specifically for dynamic panels (Roodman, 2009a, 136). The difference GMM is the first-difference transformation, which removes the fixed effects using lagged variables in levels. System GMM also uses lagged variables in levels as instruments for the first-differenced equation, but it also uses lagged differences as instruments for the level equation (Roodman, 2009a, 138). System GMM has benefits compared to difference GMM. If variables are close to a random walk, system GMM performs better, since past changes predict current levels better than past levels predict current changes (Roodman, 2009b, 114). System GMM also reduces the finite sample bias and it has efficiency gains compared to difference GMM (Baltagi, 2005, 147-148). Difference GMM performs poorly if the panel is unbalanced because it magnifies gaps (Roodman, 2009b, 104).

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[18] Ordinary least squares (OLS) estimator does not control for country fixed effects or address the potential simultaneity bias. (Beck & Levine, 2004). Applying OLS to a dynamic model (which includes lagged dependent variable as regressors) causes "dynamic panel bias", because lagged dependent variable (in this case yt-1) correlates positively with the fixed effects in the error term. (Roodman, 2009b, 100-103).

[19] If heteroskedasticity is present, the GMM is consistent and thereby preferred estimator compared to IV. (Baum, Schaffer & Stillman, 2003, 2).

The difference and system GMM methods are both dynamic panel estimators that can be applied in occasions with the following features: 1) panels with "small T, large N" , where T refers to time periods and N means the cross-sectional individuals; 2) a linear functional relationship; 3) dynamic, dependent variable that is dependent on its own past values; 4) explanatory variables that are either predetermined or endogenous (correlated with past and possibly current values of the error); 5) fixed individual effects; and 6) heteroskedasticity and autocorrelation within, but not between individuals (Roodman, 2009b, 86).

In the empirical study of this thesis, the data is collapsed into five-year periods to satisfy the "small T, large N" condition and validate the use of GMM method. According to Roodman (2009b), the number of instruments increases as T increases, making small T preferred. The use of large N, however, is preferred as it makes the cluster–robust standard errors and the Arellano–Bond autocorrelation test more reliable. (Roodman, 2009b). Other benefits of averaging the data is that it mitigates the impact of missing data, measurement errors, and business cycle effects. Roodman (2009a) warns about the risk of instrument proliferation, referring to a situation where the number of instruments in the model grows large relative to the sample size (N). Instrument proliferation can lead to biased coefficients and also weaken the Hansen test, which is designed to identify endogeneity and invalid instruments (Roodman, 2009a, 139, 143). To limit instrument proliferation, Roodman (2009a; 2009b) suggests collapsing instruments ("*collapse*" option in *xtabond2*), and limiting the lags used in GMM-style instruments (Roodman, 2009a, 148-149; Roodman, 2009b, 87, 129).

This study uses a Stata regression code *xtabond2*, created by Roodman in 2003 (2009b). In this study, one-step system GMM method is used with *collapse, small, robust, and orthogonal* options. Choosing the option *small* indicates that small-sample corrections are made to the covariance matrix estimate, thereby applying an F-test statistic for the overall fit and t-test statistics for the coefficients. *Robust* option calls for "standard errors that are robust to heteroskedasticity and arbitrary patterns of autocorrelation within individuals". Including *orthogonal* means using transform of (forward) orthogonal deviations instead of first differencing. Orthogonal deviations are used to maximize the sample size. (Roodman, 2009b, 122-123.)

Xtabond2 command contains automatic Arellano-Bond test (AR2) and difference-in-Sargan/Hansen testing. AR2 test (1991) was developed to detect autocorrelation, the null being that the errors in the first-difference regression exhibit no second-order serial correlation, which is essential to be checked if lags are used as instruments. The Sargan/Hansen test of overidentifying restrictions and difference-in-Hansen tests checks for the validity of instrument subsets, in other words that the instruments are exogenous, the null stating that the instruments used are not correlated with the residuals. (Roodman, 2009b, 87, 97-98.)

5 RESULTS AND ANALYSIS

In this chapter, the results of the empirical study are presented and analysed. The purpose of the research is to find answers to the research questions presented in chapter 4. The results are analysed to see whether they support the earlier findings of the literature on the topic.

The results of the empirical study are reported in tables 3-6. In all panels, the research method is a one-step system GMM dynamic panel data estimation technique. The data is a 5-year non-overlapping panel data between 1993-2017, and the dependent variable is the GDP per capita growth. The control variables included in the models are standard in the literature. In all models, shortest possible lags are used to limit the number of instruments. However, in some models, longer lags are used in order to obtain proper Hansen and AR(2) statistics. The maximum number of lags is 4. When schooling and inflation are added to the model at time t, they cause a serial correlation in the model. Therefore, they are added to the regression in first lag (time t-1) to avoid auto-correlation, and to obtain proper Hansen and AR(2) statistics. Mainly, the earlier studies use levels (or logs) of the variables at time t, but a few use the first lag (e.g. Arcand et al., 2015).

The panel presented in table 3 explores the effects that the overall financial development has on economic growth and distinguishes the effects separately in advanced and emerging economies, whereas the panel in table 4 concentrates on studying the impacts of financial institutions and the panel in table 5 the impacts of financial markets on growth. In table 6, the joint effects of financial development and frontier economies are explored in more detail.

5.1 Overall financial development and growth

The results in table 3 explores the growth effect of overall financial development in all the countries in the data sample, and separately in advanced and emerging economies.

TABLE 3 One-step system GMM regression results, overall financial development and growth

In all the tables 3-6, one-step system GMM regression results are listed. The data is a 5-year non-overlapping panel data between 1993-2017. The dependent variable is the growth of GDP per capita. Explanatory variables include the financial development index ($FD_{i,t}/FI_{i,t}/FM_{i,t}$), and an interaction term/interaction terms. Control variables include the first lag of GDP per capita ($Y_{i,t-1}$), time-fixed effects (dummy variables for the 5-year periods), the first lag of financial development ($FD_{i,t-1}/FI_{i,t-1}/FM_{i,t-1}$), the first lag of schooling ($school_{i,t-1}$), the first lag of inflation (inf_{t-1}), government expenditure ($exp_{i,t}$), and trade ($trade_{i,t}$). Countries are divided into two groups, advanced and emerging economies, based on their level of financial development (divided by the median of FD, which is 0.4637). FE is a dummy variable and refers to the frontier economies, which are the 10 most advanced countries in the data sample according to their average level of multifactor productivity (MFP). All variables are treated as endogenous except for time-fixed effects, which are treated as exogenous. The results for time dummies are not reported for brevity. P-values are reported in parenthesis. ***, ** and * indicate statistical significance at 1%, 5%, and 10% levels. For more information on the equation and variables, see chapter 4.1.

Overall financial development (FD) and growth	**Full sample**					**Advanced economies (AE)**	**Emerging economies (EE)**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
ln $Y_{i,t-1}$	-0.041***	-0.017***	-0.036***	-0.030***	-0.020**	-0.020***	-0.033***
	(0.001)	(0.004)	(0.000)	(0.000)	(0.029)	(0.007)	(0.000)
$FD_{i,t}$	0.458***	-	0.195***	0.163***	0.097**	0.086	0.166***
	(0.000)		(0.000)	(0.000)	(0.022)	(0.261)	(0.002)
$FD_{i,t-1}$	-0.264***	-	-0.123***	-0.104**	-0.093**	-0.159**	-0.119**
	(0.001)		(0.005)	(0.030)	(0.010)	(0.035)	(0.027)
$FD_{i,t}$ x FE	-	-	-	-	0.013	-	-
					(0.129)		
ln $School_{i,t-1}$	-	0.087***	0.097***	0.102***	0.091***	0.033	0.083***
		(0.000)	(0.000)	(0.000)	(0.001)	(0.565)	(0.000)
ln $Inf_{i,t-1}$	-	-0.007**	-	-0.003	-	-	-
		(0.041)		(0.356)			
ln $Exp_{i,t}$	-	-0.046*	-	-0.032	-0.027	-	-
		(0.061)		(0.100)	(0.172)		
ln $Trade_{i,t}$	-	0.005	-	0.005	-	-	-
		(0.764)		(0.690)			
Constant	0.299***	0.093	0.101***	0.115*	0.081***	0.202*	0.113***
	(0.000)	(0.217)	(0.000)	(0.057)	(0.009)	(0.061)	(0.000)
Countries	60	60	60	60	60	30	30
Observations	240	240	240	240	240	120	120
Instruments	16	29	35	35	33	18	22
Hansen J test[1]	0.251	0.115	0.156	0.120	0.135	0.179	0.159
DiffinHansen tests[2]							
for levels	0.240	0.144	0.168	0.271	0.133	0.443	0.108
for IV	0.134	0.179	0.177	0.130	0.142	0.152	0.149
AR(2) test[3]	0.345	0.129	0.119	0.184	0.106	0.190	0.282

NOTES: The panel includes an interaction term between financial development index and frontier economies (FDi,t x FE). Schooling and inflation are in first lag to avoid autocorrelation. In all (1)-(7) models, the set of instruments include different lags of the variables used in the regression. Model (3) also includes instruments for inflation, government expenditure and trade. The instruments include different lags to control for serial correlation and endogeneity. The lags are not reported for brevity, however, the maximum number of lags is 3. 1 Hansen J test of overidentifying restrictions (p value); 2 Difference-in-Hansen tests of exogeneity of instrument subsets (p value), the null stating that the instruments used are not correlated with the residuals; 3 Arellano-Bond test for AR(2) in first differences (p value), the null being that the errors in the first-difference regression exhibit no second-order serial correlation.

In table 3, the estimates for the coefficients of lagged GDP per capita are negative and statistically significant at 1-5% level in all models (1)-(7), which is consistent with theory and indicates that countries in the data sample are converging to the frontier growth rate. The convergence effect is stronger in EEs compared to AEs. Similarly, the coefficients of lagged financial development are negative and statistically significant, again referring to the convergence effect, but with the level of financial development. The coefficients of financial development are positive in all models and statistically significant in all models but in model (6), which reflects the effects of financial development on growth in AEs. This indicates that financial development has a significantly positive effect on growth in EEs but not in AEs, thus supporting the findings in earlier literature that the relationship between financial development and growth is non-linear and bell-shaped – positive at first, but after a certain threshold the positive effect seems to weaken, or even turn negative (Arcand et al., 2015; Rousseau & Wachtel, 2011; Sahay et al., 2015; Aghion et al., 2018). This also follows the results by Aghion et al. (2005), who state that eventually the convergence effect vanishes as countries reach the steady-state level of the frontier (Aghion et al., 2005). It seems like schooling, which is commonly perceived to reflect human capital, has similar results; schooling has a positive effect on economic growth and the effect is statistically significant at 1% level in all the models except in model (6), which represents the effects in AEs. This finding suggests that schooling has a positive growth effect especially in emerging economies. The coefficients of inflation and government expenditure are negative, while the coefficients of trade are positive. However, their coefficients are not statistically significant when financial development is included in the regression, suggesting that they are insignificant determinants of long-term growth and may have bigger impact on business cycles. The results concerning the control variables follow earlier studies; trade and schooling are positively related to growth, whereas inflation and government expenditure affect growth negatively (e.g. Arcand et al., 2015; Beck & Levine, 2004). However, these studies do not explore the impacts in advanced and emerging economies separately, and thereby the results cannot be fully compared. The estimate for the coefficient on the interaction term between financial development (FD) and frontier economies (FE) is positive but not statistically significant, which is consistent with the earlier statements of the dampening effect of financial development.

5.2 The development of financial institutions and financial markets and growth

As a separate subsample, table 4 investigates the impacts of financial institutions on economic growth in all the countries in data sample, and in advanced and emerging economies.

TABLE 4 One-step system GMM regression results, financial institutions and growth

Development of financial institutions (FI) and growth			Full sample		Advanced economies (AE)	Emerging economies (EE)
	(1)	(2)	(3)	(4)	(5)	(6)
ln $Y_{i,t-1}$	-0.003	-0.047***	-0.019*	-0.023	-0.016	-0.029***
	(0.900)	(0.003)	(0.052)	(0.221)	(0.362)	(0.001)
$FI_{i,t}$	-0.045	-0.112	0.046	-0.267**	-0.331	0.095
	(0.752)	(0.359)	(0.627)	(0.020)	(0.116)	(0.253)
$FI_{i,t-1}$	-0.024	0.172	-0.007	0.259**	0.225	-0.094
	(0.867)	(0.160)	(0.947)	(0.044)	(0.285)	(0.193)
$FI_{i,t}$ x FE	-	-	-	0.013	-	-
				(0.446)		
ln $School_{i,t-1}$	-	0.163***	0.110***	0.127**	0.016	0.081***
		(0.003)	(0.002)	(0.011)	(0.735)	(0.001)
ln $Inf_{i,t-1}$	-0.010**	-	-0.008**	-	-	-
	(0.032)		(0.047)			
ln $Exp_{i,t}$	0.011	-	-0.072***	-0.052	-	-
	(0.851)		(0.004)	(0.142)		
ln $Trade_{i,t}$	0.052*	-	-0.016	-	-	-
	(0.051)		(0.420)			
Constant	-0.145	0.065	0.225**	0.117*	0.232	0.098***
	(0.342)	(0.275)	(0.038)	(0.095)	(0.106)	(0.001)
Countries	60	60	60	60	30	30
Observations	240	240	240	240	120	120
Instruments	21	30	38	21	14	24
Hansen J test[1]	0.114	0.199	0.122	0.174	0.284	0.137
DiffinHansen tests[2]						
for levels	0.303	0.156	0.248	0.181	0.706	0.078
for IV	0.192	0.188	0.126	0.173	0.090	0.133
AR(2) test[3]	0.153	0.111	0.105	0.100	0.103	0.112

NOTES: The panel includes an interaction term between financial institutions index and frontier economies ($FI_{i,t}$ x FE). In all (1)-(6) models, the set of instruments include all variables used in the regression. Model (2) also includes instruments for inflation, government expenditure and trade. The maximum number of lags used in instruments is 4. For additional information, see notes on table 3.

The panel in table 4 investigates how the development of financial institutions (i.e. financial intermediaries or indirect channel of funding) affects growth. As in table 3, the estimates for the coefficient of lagged GDP per capita are negative in all models (1)-(6), referring to convergence, but statistically significant only in models (1)-(3) and (6). However, the coefficients of lagged financial institutions development are both positive and negative, but statistically insignificant in all models except in model (4). The coefficients of financial institutions are negative

in models (1), (2), (4), and (5), positive in models (3) and (6), and statistically significant only in model (4). These empirical results suggest that developing financial institutions further might in fact have a negative impact on growth in all countries, especially in AEs, but the effect is not significant. In EEs, the impact may be positive but insignificant. One reason might be that financial institutions are further developed compared to financial markets in countries. The result is in line with the suggested bell-shaped relationship between financial development and growth, suggesting that the optimal threshold level for financial institutions has been achieved already and there is a dampening, or even negative effect if financial institutions are developed further. When it comes to schooling, the results follow the findings presented in table 3, suggesting that schooling together with financial development has a positive, statistically significant impact on growth in all the countries except in AEs, where the positive effect is not significant. The results with inflation, government expenditure, and trade are similar to table 3 results, except that the impact of inflation is more significant in table 4. The estimate for the coefficient of the interaction term between FI and frontier economies (FE) is positive but not statistically significant, as is the case in table 3 with the interaction term between FD and FE.

Table 5 concentrates on studying the effects that financial markets have on economic growth in all countries, advanced economies and emerging economies of the data sample.

TABLE 5 One-step system GMM regression results, financial markets and growth

Development of financial markets (FM) and growth			**Full sample**		**Advanced economies (AE)**	**Emerging economies (EE)**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
ln $Y_{i,t-1}$	-0.037***	-0.031***	-0.019**	-0.015*	-0.025***	-0.012
	(0.001)	(0.000)	(0.010)	(0.074)	(0.001)	(0.169)
$FM_{i,t}$	0.284***	0.085***	0.063***	0.074***	0.109*	0.027
	(0.000)	(0.000)	(0.003)	(0.001)	(0.089)	(0.342)
$FM_{i,t-1}$	-0.173***	-0.044***	-0.040**	-0.050***	-0.124**	-0.034
	(0.001)	(0.006)	(0.017)	(0.001)	(0.029)	(0.188)
$FM_{i,t}$ x FE	-	-	-	0.007	-	-
				(0.557)		
$lnSchool_{i,t-1}$	-	0.097***	0.077***	0.079***	0.018	0.031
		(0.000)	(0.002)	(0.002)	(0.758)	(0.247)
ln $Inf_{i,t-1}$	-	-	-0.005	-	-	-
			(0.149)			
ln $Exp_{i,t}$	-	-	-0.038**	-0.055**	-	-
			(0.031)	(0.011)		
ln $Trade_{i,t}$	-	-	0.002	-	-	-
			(0.889)			
Constant	0.306***	0.068***	0.108*	0.116***	0.246**	0.058
	(0.000)	(0.000)	(0.063)	(0.002)	(0.029)	(0.126)
Countries	60	60	60	60	30	30
Observations	240	240	240	240	120	120
Instruments	16	43	39	31	21	18
Hansen J test[1]	0.122	0.172	0.185	0.106	0.234	0.181
DiffinHansen tests[2]						

for levels	0.310	0.101	0.158	0.170	0.475	0.220
for IV	0.110	0.150	0.250	0.100	0.221	0.115
AR(2) test[3]	0.783	0.164	0.243	0.201	0.383	0.445

NOTES: The panel includes an interaction term between financial markets index and frontier economies ($FM_{i,t}$ x FE). In all (1)-(6) models, the set of instruments include all variables used in the regression. Model (2) also includes instruments for inflation, government expenditure and trade. The maximum number of lags used in instruments is 3. For additional information, see notes on table 3.

The results in table 5 present the impact that financial market (i.e. direct channel of funding) development has on growth. In the panel, the estimates for the coefficients of lagged GDP per capita and lagged financial markets development are negative in all models (1)-(6), but statistically significant in models (1)-(5). The coefficients of financial markets are positive in all models, and statistically significant in models (1)-(5). Compared to table 4, the empirical results in table 5 suggest that further development of financial markets affects growth positively in all countries. The positive impact is significant in AEs, but insignificant in EEs. The results suggest that with AEs, the threshold for optimal financial market development has not been reached yet, whereas with EEs, the results might signify that the positive effect of financial market development may still be in the beginning. The effect of schooling is positive, but insignificant in both AEs and EEs. The results with inflation, government expenditure, and trade are similar to previous panels, but in this panel the effect of trade is significant. The estimate for the coefficient on the interaction term between FM and FE is positive but not statistically significant.

5.3 Financial development and growth in frontier economies

Table 6 examines the impact of financial development on growth in frontier economies and the possible convergence effect.

TABLE 6 One-step system GMM regression results, financial development and growth in frontier economies

Financial development and growth in frontier economies (FE)	**(1)**	**(2)**	**Full sample** **(3)**	**(4)**	**(5)**	**Advanced economies (AE)** **(6)**	**Sample with MFP data** **(7)**	**(8)**	**(9)**
ln $Y_{i,t-1}$	-0.030*** (0.000)	-0.031*** (0.001)	-0.040*** (0.000)	-0.016 (0.437)	-0.016* (0.087)	0.012 (0.666)	-0.009 (0.645)	-0.005 (0.881)	-0.008 (0.688)
$FD_{i,t}$	0.223*** (0.000)	0.207*** (0.000)	0.214*** (0.000)	-	-	0.027 (0.720)	0.338 (0.586)	-	-
$FD_{i,t-1}$	-0.154*** (0.000)	-0.136*** (0.004)	-0.116*** (0.005)	-	-	-0.156* (0.091)	-	-	-

$FI_{i,t}$	-	-	-	-0.173* (0.098)	-	-	-	0.175 (0.830)	-
$FI_{i,t-1}$	-	-	-	0.155 (0.162)	-	-	-	-	-
$FM_{i,t}$	-	-	-	-	0.088*** (0.005)	-	-	-	0.354 (0.372)
$FM_{i,t-1}$	-	-	-	-	-0.036** (0.034)	-	-	-	-
FE	-0.026 (0.197)	0.008 (0.777)	0.190** (0.023)	0.005 (0.987)	0.183* (0.064)	-0.053 (0.465)	-	-	-
$FD_{i,t}$ x FE	-	-	-0.241** (0.029)	-	-	-	-	-	-
$FI_{i,t}$ x FE	-	-	-	0.011 (0.978)	-	-	-	-	-
$FM_{i,t}$ x FE	-	-	-	-	-0.259* (0.063)	-	-	-	-
DTF	-	-	-	-	-	-	0.290 (0.616)	0.262 (0.724)	0.265 (0.468)
$FD_{i,t}$ x DTF	-	-	-	-	-	-	-0.437 (0.520)	-	-
$FI_{i,t}$ x DTF	-	-	-	-	-	-	-	-0.309 (0.734)	-
$FM_{i,t}$ x DTF	-	-	-	-	-	-	-	-	-0.413 (0.344)
ln $School_{i,t-1}$	0.083*** (0.000)	0.089*** (0.001)	0.096*** (0.000)	0.122** (0.019)	0.057** (0.022)	-0.070 (0.261)	0.007 (0.840)	-0.026 (0.514)	0.012 (0.748)
ln $Inf_{i,t-1}$	-	-0.000 (0.947)	-	-	-	-	-	-	-
ln $Exp_{i,t}$	-	-0.032 (0.103)	-0.018 (0.444)	-0.069* (0.065)	-0.050** (0.044)	-	-	-	-
ln $Trade_{i,t}$	-	0.021** (0.034)	-	-	-	-	-	-	-
Constant	0.081*** (0.003)	0.071 (0.198)	0.171*** (0.000)	0.117 (0.133)	0.150*** (0.005)	0.167 (0.434)	-0.118 (0.807)	-0.014 (0.973)	-0.149 (0.611)
Countries	60	60	60	60	60	30	22	22	22
Observations	240	240	240	240	240	120	88	88	88
Instruments	40	40	38	25	30	18	19	21	19
Hansen J test[1]	0.180	0.138	0.152	0.115	0.109	0.172	0.214	0.421	0.201
DiffinHansen tests[2]									
for levels	0.106	0.147	0.246	0.203	0.174	0.145	0.236	0.351	0.318
for IV	0.240	0.136	0.131	0.112	0.154	0.160	0.263	0.289	0.198
AR(2) test[3]	0.135	0.213	0.242	0.124	0.224	0.188	0.175	0.236	0.207

NOTES: The panel includes interaction terms between frontier economies and financial development index (FDi,t x FE), financial institutions index (FIi,t x FE), and financial markets index (FMi,t x FE). Also a new variable, distance to frontier (DTF), is included in the models (7)-(9) with interaction terms between distance to frontier and financial development index (FDi,t x DTF), financial institutions index (FIi,t x DTF), and financial markets index (FMi,t x DTF). In all (1)-(9) models, the set of instruments include all variables used in the regression. Model (1) also includes instruments for inflation, government expenditure and trade. The maximum number of lags used in instruments is 3. For additional information, see notes on table 3.

Table 6 focuses on financial development and growth in frontier economies. The models (1)-(5) include the full sample, whereas model (6) includes only AEs. Models (7)-(9) contain data of multifactor productivity, including 22 countries. The estimates for the coefficient of lagged GDP per capita are negative in models (1)-(5), and (7)-(9), whereas positive in model (6) that includes AEs, suggesting that there is no convergence effect in AEs. The coefficients of lagged FD are negative and statistically significant at 1-10% level in all the models that includes it, referring to a convergence effect. The coefficients of the interaction term between FD and FE, and between FM and FE are negative and statistically significant, whereas between FI and FE, the coefficient is positive and statistically insignificant. The interaction term FDxFE is significant at 5% level and FMxFE is significant at 10% level. This indicates that in frontier economies, an overall financial development and further development of financial markets can have a negative impact on growth. This is in line with earlier literature, suggesting that after a certain threshold the impact might turn negative (e.g. Aghion et al., 2005 & 2018; Arcand et al., 2015). The coefficient of distance to frontier (DTF) is positive but not statistically significant. In models (7)-(9), the interaction term between financial development (FD/FI/FM) and DTF describes how the distance to frontier alters the impact that financial development has on convergence (Aghion et al., 2009, 455). According to Aghion et al. (2005), a negative coefficient of the interaction term between financial development and distance to frontier indicates that financial development will increase the likelihood of convergence. The coefficients of the interaction terms FDxDTF, FIxDTF, and FMxDTF are negative, but not statistically significant. However, the coefficient of the interaction term FMxDTF is more significant than the coefficient of the interaction term FIxDTF. To conclude, the results show no clear evidence that financial development increases the likelihood of convergence in frontier economies.

5.4 Reliability of the research

The data is from the World Bank (2020), the OECD Productivity Statistics database (2019), Barro-Lee Educational Attainment Dataset (2013), and IMF Data (2020). All four data sources are commonly used in empirical studies and are considered reliable. The dataset is a panel data and considers the time and cross-sectional aspects, which serves well the growth analysis; it allows to observe how the finance-growth relationship has changed during the observed time period across countries. Panel dataset also offers plenty of observations. The panel data applied is strongly balanced. The system GMM dynamic panel estimation technique is commonly used in empirical studies to explore finance-growth nexus. GMM is specifically designed to address the joint endogeneity problems (Levine et al., 2000, 33), it allows to correct for autocorrelation and heteroscedasticity in the error terms (Law & Singh, 2014), which are common problems that surface when exploring the topic.

One new feature of this empirical study is the broad financial development index. Previous literature has commonly used certain variables, such as private sector credit to measure financial development, but many authors have criticized the narrow view of it. This study used the index constructed by Svirydzenka (2016), which enables the inspection of financial markets and financial institutions, and the overall financial development. It also captures various aspects of financial development, including the access, depth, and efficiency. Therefore, the use of a broad index enables a comprehensive exploration of financial development and its relationship to economic growth.

However, the study lacks a proper amount of data concerning multifactor productivity. MFP data is needed for the formulation of distance to frontier and thereby to classify the frontier economies. One suggestion for improvement is to use labor productivity to formulate distance to frontier and frontier economies. The reason is that data availability is better for labor productivity than for MFP. In addition, the measurement of labor productivity is most likely more coherent in countries than the measurement of complex MFP, making the labor productivity data more reliable. However, MFP captures different aspects of productivity compared to labor productivity because it is considered to reflect the technical change that labor productivity does not capture, which is why it was chosen to the research of this thesis.

The use of multifactor productivity data causes another dilemma in addition to the difficulty of getting a proper amount of data. The frontier economies in this thesis include Belgium, Canada, Denmark, France, Italy, Luxembourg, New Zealand, Norway, Portugal, and Spain. However, Adalet McGowan et al. (2017a) revealed that the productivity slowdown has been especially remarkable in Italy and Spain during the period of 2003–2013, which is not in line with the information gained from the data used in this empirical study. This is because Spain and Italy are included in frontier economies, and for example USA is not. Adalet McGowan et al. (2017a) used labor productivity to reflect productivity, which clearly differs from the insights gained from multifactor productivity data in this study. This could be due to different measurement techniques between countries or there might be measurement errors on multifactor productivity. To conclude, even though multifactor productivity reflects technical changes that labor productivity cannot capture, the use of labor productivity would be a preferred option because of reliability.

Several tests are conducted to check the robustness of the results. Roodman suggests that with GMM estimators, good estimates for the coefficient on lagged dependent variable should be placed between the values given by OLS and fixed effects estimators. (Roodman, 2009b, 100-103). To check the robustness of the results, the models presented in table 3 were run by OLS and fixed effects model. All the estimates for the coefficient on lagged dependent variable were placed between the values given by OLS and fixed effects estimators. Robustness is also tested in all the panels by testing the models with and without schooling and different control variables. The results are robust to including additional variables.

According to Roodman (2009b), the p value of a Hansen test should lie somewhere between 0.1-0.25. Lower values should not be trusted, and higher values should be taken as "potential signs of trouble". (Roodman, 2009b, 128-129). A perfect Hansen statistic of 1.000 reflects instrument proliferation and weakens Hansen tests ability to detect the very problem. (Roodman, 2009a, 151). In this study, the Hansen test p values are in most models settled between the wanted 0.1-0.25 range, but in some cases the values are slightly over the preferred values. The lowest value of Hansen p test is 0.106 and highest value is 0.421. Based on rather good Hansen statistics, the problem of endogeneity is addressed properly, and the instruments are valid, which indicates that the results of the study should be reliable.

6 CONCLUSIONS

The results of the empirical study indicate that financial development is positively and significantly related to economic growth, which is in line with earlier literature. However, the relationship between financial development and growth appears to be non-linear, or more specifically bell-shaped, as many authors suggest (Aghion et al. 2005 & 2018; Arcand et al. 2015; Rousseau & Wachtel, 2011; Sahay et al., 2015); financial development affects growth positively at low levels, but after a certain threshold the impact is vanishing or even turns negative. The results also confirm the findings by Demirgüc-Kunt et al. (2012); the relative importance of banks and decentralized markets vary at different stages of economic development and there tends to be a transition from bank-based to more market-based financial system as countries develop. In emerging economies, the overall financial development has a significantly positive effect on economic growth. Also, the development of financial institutions is more beneficial than the development of financial markets. This finding may suggest that financial institutions need to be developed up to a certain threshold before the countries can reap benefits from the development of financial markets. In advanced economies, however, the development of financial markets affects growth positively and is statistically significant, whereas the development of financial institutions might in fact have a negative impact on growth. The results suggest that financial development increases the likelihood of convergence especially in emerging economies but shows no clear evidence of convergence in frontier economies, which follows the earlier findings in literature (e.g. Aghion et al., 2005; Arcand et al., 2015); financial deepening can help a country converge to the growth rate of the frontier faster, but it does not affect steady-state growth.

According to earlier literature, the speed and size of financial deepening matters (Rousseau & Wachtel, 2011; Sahay et al., 2015). If financial deepening happens too fast or is excessive, it might weaken the banking system and increase inflation, whereas it can be growth enhancing if it follows from an increase of financial intermediary activity (Rousseau & Wachtel, 2011). Both Sahay et al. (2015) and Rousseau and Wachtel (2011) suggest that financial development should be accompanied with good institutional and regulatory frameworks.

The model presented in this thesis concentrates on the role that the overall financial development, different financial systems, and a country's distance to the technological frontier have an economic growth. It does not consider how intellectual property rights system or differences in competition affects innovation and hence, economic growth. It also leaves out the influence of firm dynamics, democracy, education, and trade openness. All the mentioned factors affect growth directly or indirectly and could be added to a possible new study. In addition, the role of schooling in finance-growth dilemma should be investigated in more detail. In this empirical study, an interaction term between finan-

cial development (FD/FI/FM) and schooling was added to the regression, but GMM estimation method did not give any reliable results. This implies that further investigation is suggested on the topic with another estimation method, such as VAR analysis. Furthermore, the global financial crisis 2008-2009 most likely alters the results, which is why it would be good to divide the data sample into two data periods to examine the impact of the crisis.

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APPENDIX 1 Countries included in the empirical study

Table 7 lists all the countries included in the empirical study in an alphabetical order. The full data set contains 60 countries. The countries are ranked based on the average of their overall financial development index (FD) level during 1993-2017. The sample is divided into two groups based on the median of the average of their overall financial development index (FD) level. The countries that have their average level of financial development above median (>0.4637) are stated as the advanced economies (AE), and the countries below median (<0.4637) are the emerging economies (EE). In addition, the empirical study categorizes frontier economies (FE), which are the 10 most advanced countries according to their multifactor productivity (MFP) level.

TABLE 7 List of countries used in the empirical study

Advanced economies (30)	Emerging economies (30)	Frontier economies (10)
Australia	Albania	Belgium
Austria	Bangladesh	Canada
Belgium	Bulgaria	Denmark
Brazil	Chile	France
Canada	Colombia	Italy
China	Costa Rica	Luxembourg
Denmark	Czech Republic	New Zealand
Finland	Ecuador	Norway
France	Egypt	Portugal
Germany	Gambia	Spain
Hong Kong	Ghana	
Ireland	Hungary	
Israel	India	
Italy	Indonesia	
Japan	Jamaica	
Korea, Rep.	Jordan	
Luxembourg	Kenya	
Malaysia	Mexico	
Netherlands	Nepal	
New Zealand	Pakistan	
Norway	Peru	
Portugal	Philippines	
Singapore	Poland	
South Africa	Romania	
Spain	Russian Federation	
Sweden	Saudi Arabia	
Switzerland	Tanzania	
Thailand	Turkey	
United Kingdom	Uganda	
United States	Uruguay	

APPENDIX 2 Country ranking

Table 8 lists the country ranking based on their average level of financial development index. As a comparison, the table also shows the average values of financial markets index (FM) and financial institutions index (FI) for all countries. The median of average values of financial development index (FD) is 0.4637, the median of financial institutions index (FI) is 0.5513, and the median of financial markets index (FM) is 0.4177. Higher value indicates greater financial development. Table 9 includes a country ranking according to their average distance to frontier (DTF). Higher value indicates closer proximity to frontier.

TABLE 8 Country ranking based on the average level of financial development

Country	FD	Country	FI	Country	FM
Switzerland	0.9193	Switzerland	0.9442	Switzerland	0.8747
USA	0.8398	UK	0.8932	USA	0.8590
Australia	0.8266	Australia	0.8930	Korea, Rep.	0.7546
UK	0.8257	Luxembourg	0.8730	Australia	0.7424
Spain	0.7991	Japan	0.8725	UK	0.7405
Canada	0.7846	Canada	0.8654	Spain	0.7332
Korea, Rep.	0.7641	Denmark	0.8501	Singapore	0.7064
Japan	0.7552	Spain	0.8478	Norway	0.7027
Luxembourg	0.7436	Ireland	0.8456	Hong Kong	0.7002
Netherlands	0.7430	Portugal	0.8214	Canada	0.6870
Germany	0.7284	France	0.8195	Germany	0.6853
Hong Kong	0.7223	USA	0.8026	Sweden	0.6720
Ireland	0.7159	Netherlands	0.8018	Netherlands	0.6684
Italy	0.7097	Korea, Rep.	0.7573	Italy	0.6548
France	0.7014	Germany	0.7558	Japan	0.6217
Singapore	0.6982	Italy	0.7494	Luxembourg	0.5982
Sweden	0.6947	Austria	0.7334	Ireland	0.5708
Denmark	0.6600	Hong Kong	0.7290	France	0.5684
Portugal	0.6454	New Zealand	0.7052	Finland	0.5672
Norway	0.6454	Sweden	0.7025	Thailand	0.5515
Austria	0.6386	Singapore	0.6751	Austria	0.5302
Finland	0.5887	Belgium	0.6706	Malaysia	0.5213
Malaysia	0.5857	Israel	0.6676	Turkey	0.5117
New Zealand	0.5640	Malaysia	0.6376	China	0.4971
Thailand	0.5558	South Africa	0.6144	Denmark	0.4557
Belgium	0.5468	Finland	0.5977	Portugal	0.4557
Israel	0.5276	Norway	0.5743	Saudi Arabia	0.4555
South Africa	0.5020	Brazil	0.5642	India	0.4479
Brazil	0.4995	Bulgaria	0.5560	Hungary	0.4411
China	0.4766	Chile	0.5544	Brazil	0.4241
Chile	0.4508	Thailand	0.5482	Belgium	0.4112
Hungary	0.4412	Czech Rep.	0.4944	New Zealand	0.4107

Jordan	0.4282	Jordan	0.4818	Philippines	0.3794
Turkey	0.4244	Poland	0.4731	South Africa	0.3789
Poland	0.4128	China	0.4459	Israel	0.3762
Saudi Arabia	0.4008	Hungary	0.4320	Jordan	0.3654
India	0.3843	Russia	0.3882	Russian Fed.	0.3640
Russia	0.3802	Costa Rica	0.3820	Poland	0.3438
Czech Rep.	0.3616	Mexico	0.3675	Chile	0.3375
Philippines	0.3567	Romania	0.3584	Mexico	0.3344
Mexico	0.3547	Saudi Arabia	0.3375	Indonesia	0.3183
Bulgaria	0.3375	Colombia	0.3316	Egypt	0.2702
Indonesia	0.3242	Jamaica	0.3310	Peru	0.2591
Egypt	0.2873	Turkey	0.3281	Pakistan	0.2466
Colombia	0.2863	Philippines	0.3265	Colombia	0.2349
Peru	0.2677	Albania	0.3233	Czech Rep.	0.2211
Pakistan	0.2658	Indonesia	0.3233	Jamaica	0.1319
Jamaica	0.2340	India	0.3125	Bulgaria	0.1118
Costa Rica	0.2137	Uruguay	0.3091	Bangladesh	0.0635
Romania	0.2129	Nepal	0.3082	Romania	0.0628
Uruguay	0.1735	Egypt	0.2983	Kenya	0.0620
Nepal	0.1723	Ecuador	0.2860	Ghana	0.0421
Albania	0.1665	Pakistan	0.2794	Costa Rica	0.0408
Bangladesh	0.1650	Peru	0.2706	Uruguay	0.0342
Ecuador	0.1616	Bangladesh	0.2629	Ecuador	0.0337
Kenya	0.1528	Kenya	0.2404	Nepal	0.0327
Tanzania	0.1053	Tanzania	0.1940	Uganda	0.0176
Ghana	0.1051	Gambia	0.1932	Tanzania	0.0144
Gambia	0.0976	Ghana	0.1658	Albania	0.0062
Uganda	0.0904	Uganda	0.1613	Gambia	0.0000

TABLE 9 Country ranking based on average distance to frontier

Country	DTF	Country	DTF
Italy	0.9654	Australia	0.9272
Norway	0.9637	Japan	0.9252
Spain	0.9536	Netherlands	0.9178
Denmark	0.9505	Austria	0.9171
Portugal	0.9428	Switzerland	0.9165
Luxembourg	0.9423	Sweden	0.9057
New Zealand	0.9391	UK	0.9020
Canada	0.9353	Finland	0.8929
Belgium	0.9329	USA	0.8840
France	0.9328	Ireland	0.8582
Germany	0.9320	Korea, Rep.	0.7996

APPENDIX 3 Construction of financial development index

The financial development index (FD) and its sub-indices are constructed using a variety of data sources. The table 10 below describes the different indicators that the indices are comprised of.

TABLE 10 Construction and sources of financial development index

Financial institutions (FI)		
Category	**Indicator**	**Source**
Depth (FID)	1. Private-sector credit (% of GDP)	FinStats 2015
	2. Pension fund assets (% of GDP)	FinStats 2015
	3. Mutual fund assets (% of GDP)	FinStats 2015
	4. Insurance premiums, life and non-life (% of GDP)	FinStats 2015
Access (FIA)	1. Bank branches per 100 000 adults	FinStats 2015
	2. ATMs per 100 000 adults	IMF Financial Access Survey
Efficiency (FIE)	1. Net interest margin	FinStats 2015
	2. Lending-deposits spread	FinStats 2015
	3. Non-interest income (% of total income)	FinStats 2015
	4. Overhead costs (% of total assets)	FinStats 2015
	5. Return on assets	FinStats 2015
	6. Return on equity	FinStats 2015
Financial Markets (FM)		
Category	**Indicator**	**Source**
Depth (FMD)	1. Stock market capitalization (% of GDP)	FinStats 2015
	2. Stocks traded (% of GDP)	FinStats 2015
	3. International debt securities of government (% of GDP)	BIS debt securities database
	4. Total debt securities of financial corporations (% of GDP)	Dealogic corporate debt database
	5. Total debt securities of nonfinancial corporations (% of GDP)	Dealogic corporate debt database
Access (FMA)	1. Percent of market capitalization outside of top 10 largest companies	FinStats 2015
	2. Total number of issuers of debt (domestic and external, nonfinancial and financial corporations) per 100 000 adults	FinStats 2015
Efficiency (FME)	1. Stock market turnover ratio (stock value traded to stock market capitalization)	FinStats 2015

Source: Svirydzenka (2016)

Svirydzenka (2016) compiles the broad data into one index following a three-step approach, which is the following: 1) min-max normalization of the indicators; 2) aggregation of the indicators into six sub-indices (FID, FIA, FIE, FMD, FMA, FME); and 3) aggregation of the six sub-indices into an overall financial development index.

The first step includes a winsorization of the indicators with the 5th and 95th percentiles set at the cutoff levels (cutoff levels are determined according to global distribution across time and countries), and a normalization of the indicators between 0 and 1. The normalization is applied using min-max procedure so that indicators with different measurement units can be aggregated into an identical range [0, 1]. The min-max normalization includes the following procedures:

(18) $$I_x = \frac{x - x_{min}}{x_{max} - x_{min}}$$

(19) $$I_x = 1 - \frac{x - x_{min}}{x_{max} - x_{min}}$$

, where x is the raw data and I_x refers to the indicator with 0-1 values. As in equation (18), the normalization is done by first subtracting the minimum value and then dividing by the range between the global minimum and maximum across all countries and years. With some indicators, a higher value indicates worse performance. The equation (19) is used to rescale these indicators to match the other indicators so that a higher value indicates greater financial development.

The second step includes an aggregation of the indicators into six sub-indices. The six sub-indices are formulated as weighted averages of the underlying series. Principal component analysis (PCA) is applied to obtain the weights, which are squared factor loadings (so that their sum adds up to 1). The weights are shown in figure 5 below:

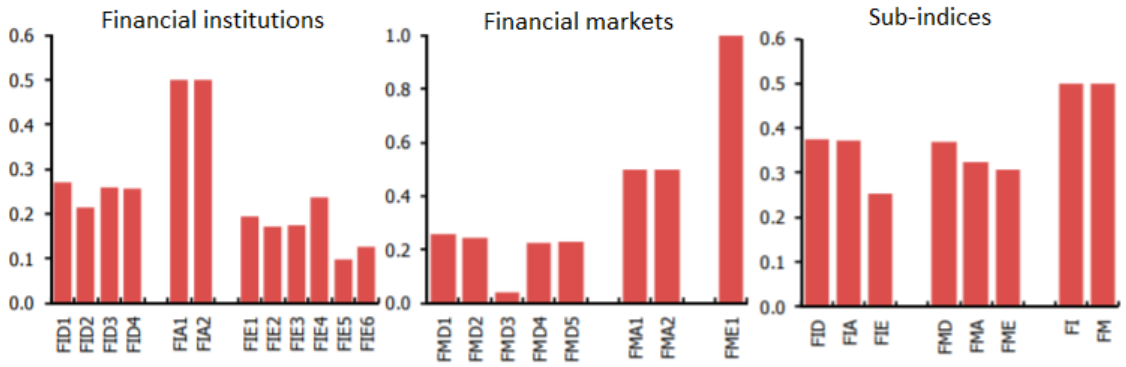

FIGURE 5 Principal component analysis: Normalized weights

The equations to obtain the sub-indices are:

(20) $$FI_j = \sum_{i=1}^{n} w_i I_i$$

(21) $$FM_j = \sum_{i=1}^{n} w_i I_i$$

, where FI_j refers to financial institutions depth (FID), access (FIA), and efficiency (FIE), and FM_j denotes to financial markets depth (FMD), access (FMA), and efficiency (FME). After the formulation, the sub-indices are re-normalized with min-max procedure (equation 18) to obtain the range 0-1.

In the third step, the six sub-indices are first aggregated into FI and FM indices, which are then aggregated into the final FD index. The third step also includes a re-normalization of FI, FM, and FD indices into the range between 0 and 1. The equations applied are the following:

(22) $$FI = \sum_{j=1}^{n} w_j FI_j$$

(23) $$FM = \sum_{j=1}^{n} w_j FM_j$$

(24) $$FD = w_{FI} FI + w_{FM} FM$$

, where FI and FM are the higher-level indices of financial institutions and financial markets, and FD is the overall index of financial development (Svirydzenka, 2016, 6-10, 15-20). For further details on how the index was constructed, e.g. the treatment of missing data, see Svirydzenka (2016).

APPENDIX 4 Variables included in the empirical study

The table 11 below lists all the variables used in the empirical research, including the dependent, explanatory and control variables.

TABLE 11 Summary of data variables

Category	Indicator	Definition	Source
Dependent variable	Real GDP per capita growth	Log difference of real GDP per capita (constant 2010 US$)	The World Bank: WDI (2020)
Explanatory variables	Financial development index (FD)	The depth, efficiency, and access of both financial institutions (FI) and financial markets (FM). Described in more detail in chapter 4.1.	IMF Data (2020)
	Financial institutions index (FI)	The depth, efficiency, and access of financial institutions (banks, pension funds, insurance companies, and mutual funds)	IMF Data (2020)
	Financial markets index (FM)	The depth, efficiency, and access of financial markets (bond and stock markets)	IMF Data (2020)
	Frontier economies (FE)	FE (dummy) refers to the 10 most advanced countries in the data sample according to their average of multifactor productivity (MFP) level	Own calculations based on the data from the OECD Productivity Statistics database (2019)
	Distance to frontier (DTF)	Multifactor productivity (MFP) of a country / MFP of a frontier country (during the year). Multifactor productivity index, 2010=100	Own calculations based on the data from the OECD Productivity Statistics database (2019)
	Interaction term: Financial development (FD/FI/FM) x Frontier economies (FE)	FD/FI/FM index x FE (dummy)	Own calculations based on the data from IMF Data (2020), and the OECD Productivity Statistics database (2019)
	Interaction term: Financial development (FD/FI/FM) x distance to frontier (DTF)	FD/FI/FM index x MFP of a country/MFP of a frontier country	Own calculations based on the data from IMF Data (2020), and the OECD Productivity Statistics database (2019)

Control variables	First lag of real GDP per capita	Log of first lag of real GDP per capita	The World Bank: WDI (2020)
	First lag of financial development	First lag of FD/FI/FM index	IMF Data (2020)
	First lag of schooling	Log of first lag of average years of total schooling, 5-year averages, population aged 15 and over	Barro-Lee Educational Attainment Dataset (2013)
	First lag of inflation	Log of first lag of inflation measured by the consumer price index (annual %)	The World Bank: WDI (2020)
	Government expenditure	Log of general government final consumption expenditure (% of GDP)	The World Bank: WDI (2020)
	Trade	Log of the sum of exports and imports of goods and services (% of GDP)	The World Bank: WDI (2020)

APPENDIX 5 Correlations of the variables in the data sample

Correlations of the variables in the data sample are described in table 12. Figure 6 visualizes the correlation between GDP per capita and financial development index (FD), whereas figure 7 illustrates the correlation between GDP per capita and financial institutions index (FI), and figure 8 the correlation between GDP per capita and financial markets index (FM). Also, figure 9 shows the correlation between GDP per capita and distance to frontier. The correlations are based on a yearly data.

TABLE 12 Correlations matrix

	Y_t	Y_{t-1}	FD_t	FI_t	FM_t	School $_{t-1}$	Inf_{t-1}	Exp_t	$Trade_t$
Y_t	1								
Y_{t-1}	0.9982	1							
FD_t	0.8524	0.849	1						
FI_t	0.8616	0.8592	0.9425	1					
FM_t	0.7648	0.7608	0.9567	0.8044	1				
$School_{t-1}$	0.8131	0.8035	0.6508	0.6902	0.5557	1			
Inf_{t-1}	-0.5592	-0.5567	-0.6461	-0.6439	-0.5876	-0.381	1		
Exp_t	0.6557	0.6626	0.5143	0.5535	0.4321	0.5984	-0.3396	1	
$Trade_t$	0.3847	0.3788	0.29	0.3174	0.2391	0.382	-0.266	0.1262	1

Notes: Y_t is the real GDP per capita (constant 2010 US$) at time t, whereas Y_{t-1} refers to the real GDP per capita at time t-1, FD is to the financial development index, FM refers to the financial markets index, FI is the financial institutions index, school denotes to the average years of total schooling, inf_t is the inflation measured by the consumer price index (annual %), exp_t is the general government final consumption expenditure (% of GDP) and $trade_t$ is the sum of exports and imports of goods and services trade (% of GDP). All variables are in logarithmic forms, except for FD_t, FM_t, and FI_t.

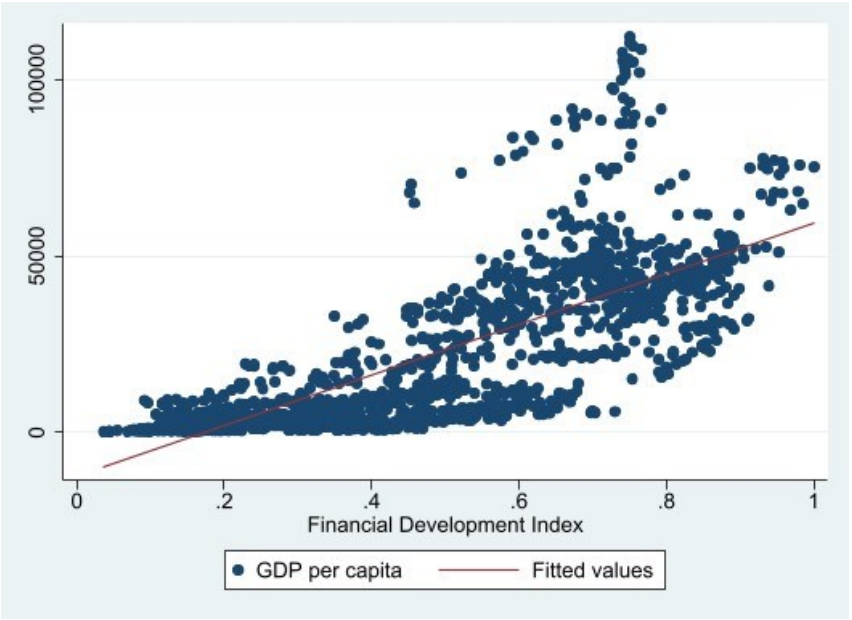

FIGURE 6 Correlation between GDP per capita and Financial Development Index (FD)

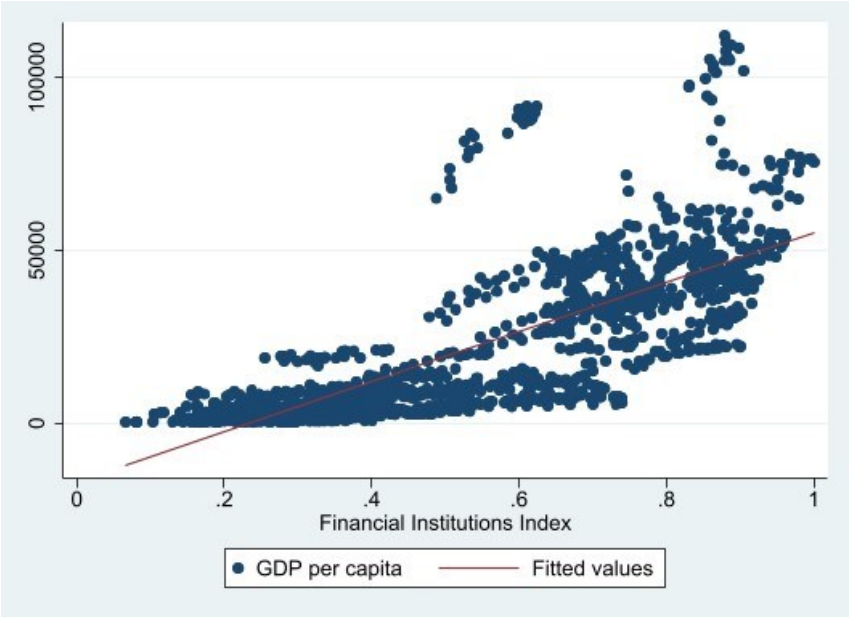

FIGURE 7 Correlation between GDP per capita and Financial Institutions Index (FI)

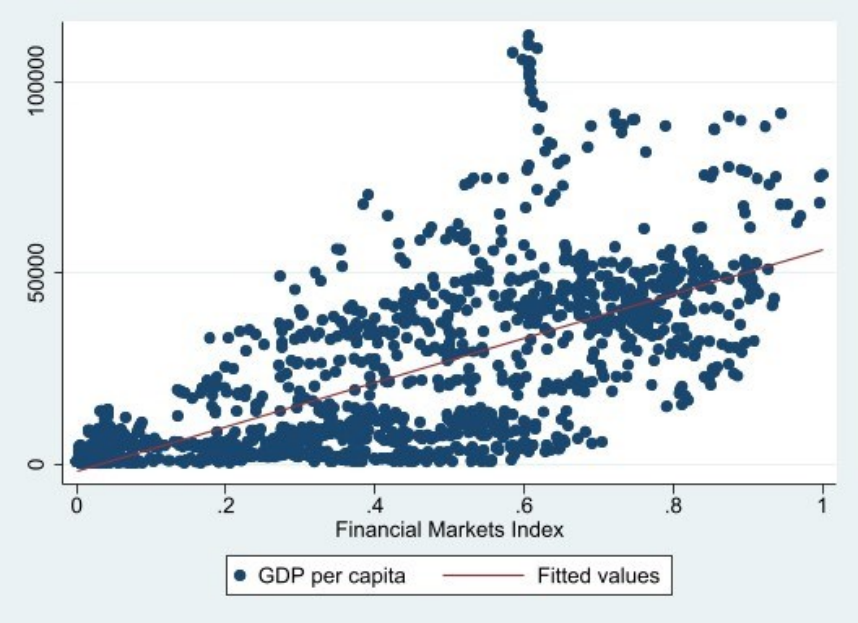

FIGURE 8 Correlation between GDP per capita and Financial Markets Index (FM)

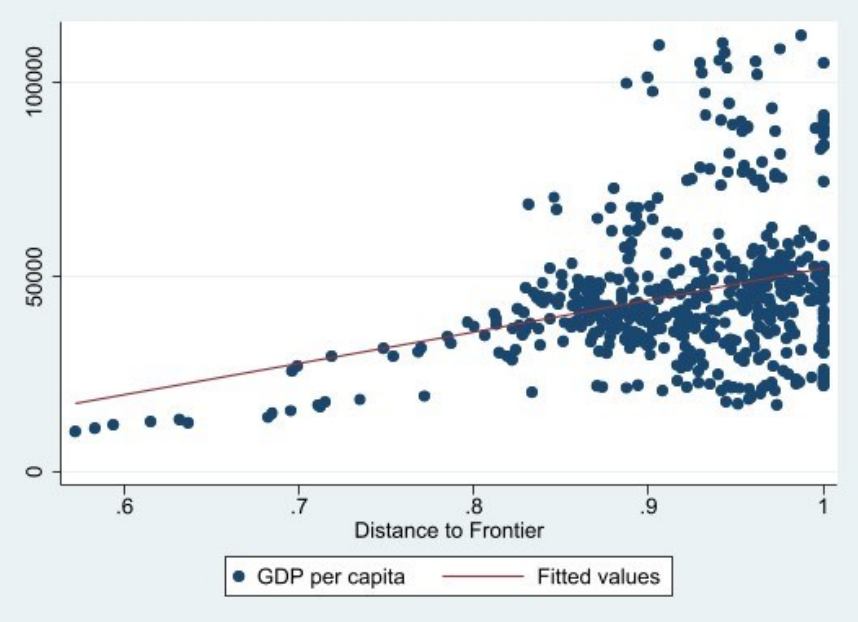

FIGURE 9 Correlation between GDP per capita and Distance to Frontier (DTF)