FINANCIAL DEVELOPMENT AND PRODUCTIVITY
A PANEL DATA APPROACH

A Master's Thesis

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ABSTRACT

FINANCIAL DEVELOPMENT AND PRODUCTIVITY
A PANEL DATA APPROACH

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Much ink has been spilled over the relation of financial market development and economic growth. Productivity growth is one of the main sources of economic growth. In this study we empirically examine the role of financial sector development in enhancing productivity growth, in a group of industrial and developing countries using panel data from 1965 to 1990. The productivity is measured by Malmquist index, introduced by Fare et al. (1994). This measure of productivity change index computes the productivity change from one year to another and furthermore it is possible to decompose the productivity change into efficiency change (diffusion) and technical change (innovation) components. Generalized Method of Moments techniques are applied where the results indicate that there is a significant effect of some financial development not only on Malmquist index but also on its components.

Keywords: Financial Development, Productivity

ÖZET

FİNANSAL GELİŞME VE VERİMLİLİK
PANEL VERİ ANALİZİ

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Finansal gelişme ve büyüme ilişkisi literatürde sıkça incelenen bir konudur. Büyümenin temel kaynaklarından birinin verimlilik artışları olması sebebiyle bu çalışmada finansal gelişmenin verimliliğe olan katkısı araştırılmaktadır. Gelişmiş ve gelişmekte olan ülkelerin verileri 1965 ve 1990 yılları arası panel analiz yapılarak incelenmiştir. Verimlilik artışları, Fare ve öbürleri (1994) tarafından tanımlanan Malmquist verimlilik değişimi indeksi ile ölçülmüştür. Birbirini izleyen iki yıl arasındaki verimliliği ölçen bu indeks etkinlik değişimi indeksi ve teknolojik değişim indeksi olarak iki bileşene ayrılabilir. Genelleştirilmiş Momentler Yöntemi teknikleri kullanılarak statik ve dinamik analizler çerçevesinde bulunan sonuçlar finansal gelişmenin hem Malmquist verimlilik değişimi indeksi üzerinde hem de bileşenlerinde olumlu bir etkisi olduğunu göstermektedir.

Anahtar Kelimeler: Finansal gelişme, Verimlilik

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CHAPTER 1

INTRODUCTION

Dating as back as to 18th century there begins a huge debate on the link between financial development and economic growth. The purpose of this paper is look at the financial development growth relationship with an alternative productivity measure. We analyze the effect of financial development on Malmquist productivity index which shows the improvement of a country's productivity relative to the world frontier.

Past literature have opposing views regarding the role of finance on growth. According to some authors, finance is one of the boosting factors for long-run growth, whereas some disagree with the stimulating effect of financial development.
Many economists, such as Hamilton (1781), Bagehot (1873), Gurley and Shaw (1955), Hicks (1969), McKinnon (1974) and Schumpeter (1912), claim that financial markets spur economic growth. Hamilton (1781: 36), discusses that 'banks were the happiest engines that ever were invented' for stimulating growth. To illustrate, both Bagehot (1873) and Hicks (1969) emphasize that financial system enhanced England's industrialization process by making capital mobile for ''immense works''. Besides, Gurley and Shaw (1955) stress that, in an economy where only self finance and direct finance are accessible, i.e. financial intermediaries are not involved,

economic development will be impeded as intermediaries promote the credit supply process. In addition, McKinnon (1974) claims that in less developed countries the dependence on self finance is higher. Also, he argues that liberalization will bring about easier and cheaper access to capital to entrepreneurs evolving in high quality projects that will result in economic growth and development. In addition, Schumpeter (1912) highlights the role of banks in promoting innovation. He believes that banks identify and support the enterprises that will be more successful at implementing the innovations.

On the other hand, there are some economists such as, Robinson (1952), Adams (1819) and Lucas (1988), who disagree with the supporting role of financial activity. To begin with, Robinson (1952: 86) questions the spurring effect of finance by asserting that ‘‘where enterprise leads finance follows’’. He mentions that economic growth demands its particular financial arrangements and financial system supplies. Hence, according to him growth gives rise to financial development, not the opposite. Adams (1819: 36) declares that banks harm the "morality, tranquility, and even wealth" of nations. Moreover, Lucas (1988: 6) contends that finance economic development relationship is "badly over-stressed".

In view of the papers stated above, this study investigates the link between financial development and economic growth. However, this paper differs from the existing literature in the sense that Malmquist Productivity index measures are used to measure economic performance instead of traditional measures such as per capita GDP growth or per capita capital stock growth. One of the main advantages of this index is that it can be further decomposed into two component measures, efficiency change (diffusion) and technical change (innovation). Therefore, this technique will help us to identify the diffusion effect which McKinnon (1974) emphasized and innovation effect that Schumpeter (1912) pointed out. We calculated productivity series using data envelopment analysis and solving 4088 linear programming problems in GAMS. This is a worthwhile analysis as this methodology helps us to analyze the effects of financial development on efficiency and technical change separately and thus examine the *source* of productivity change. The empirical analysis is conducted on a group of countries, which includes both industrial and developing countries.

In the analysis of empirical relationship between productivity and financial development we conducted two groups of estimations:

Firstly, in addition to the fixed effects Ordinary Least Squares (OLS) estimators, the efficient Generalized Method of Moments (GMM) fixed effects estimators and GMM dynamic panel estimators is utilized to expose the relationship between the productivity and efficiency measures and the indicators of financial development. The presence of unit effects leads us to use the fixed effects model whereas the dynamic nature of the problems brings about the GMM dynamic panel estimation proposed by Arellano and Bond (1981).

Considering the unit heterogeneity effects we start with a fixed effects panel data model. We collect a panel data set of 48 countries where the data is averaged over 5-year intervals from 1965-1990. The dependent variables are Malmquist productivity index, efficiency change index and technical change index. The explanatory variables are comprised of indicators of financial development and conditioning variables. In order to deal with endogeneity problem firstly we regress productivity measures on the lagged values of the explanatory variables as we believe that the lagged values of the explanatory variables are correlated with the regressors but not correlated with our dependent variables.

On the other hand, in the literature instrumental variables techniques are widely used to address this issue. As the explanatory variables are endogenous in most of the growth regressions, instrumental variables (IV) are used since they allow parameters to be estimated consistently. However, in the presence of heteroskedasticity the IV estimators are not only inconsistent but also inefficient (Baum and Schaffer, 2003). Although the use of heteroskedasticity consistent standard errors i.e. robust standard errors may solve the consistency problem, the efficiency problem needs to be addressed. As Baum and Schaffer (2003) points out GMM estimation brings efficiency in the presence of unknown heteroskedasticity. Therefore, we analyze the same model with fixed effects in a GMM framework where utilize the efficient Generalized Method of Moments (GMM) fixed effects estimators.

As many economic relationships are dynamic in nature, we question financial development productivity relationship in a dynamic panel data model. As Baltagi (2001) notes, there are two sources of persistence in this setup: the autocorrelation effect owing to the lagged dependent variable and the unit heterogeneity effects. In this context, we will utilize a GMM procedure proposed by Arellano and Bond (1991) in order to address the issue of omitted variables, unobserved country specific effects and simultaneity bias. Again, the variables are averaged for five year intervals in order to get rid of business cycle effects. The empirical analysis is conducted on a panel data set of 48 countries for the period 1965-1990. We firstly, difference the regression equation to eliminate country specific effects and then we instrument the explanatory variables in the differenced equation with their lagged level values.

On the other hand, due to the simultaneity bias we instrument financial development by legal origin where we employ cross sectional GMM estimator, panel data pooled GMM estimator and GMM dynamic panel estimator. Following La Porta, Lopez-de-Silanes, Schleifer and Vishny (1998), legal origin is considered to be an appropriate instrument as it is not correlated with economic growth due to the fact that countries obtained their legal origin through colonization or occupation. On the other hand, legal origin is an appropriate instrument as it is correlated with financial development owing to the evidence that country's legal origin affects the development of creditor rights and the enforcement of contracts in that country which is linked with financial environment or investment climate.

Besides, we utilize three econometric techniques where we instrument financial development by legal origin. Firstly, we use a cross sectional GMM estimator with a cross sectional data for 46 countries are averaged over 1965-1990. However, we believe that in this case we could not address the issue of possible endogeneity arising from the remaining right hand side variables. In addition, although the data proves the presence of unit effects as legal origin variable has no time dimension, we estimate the model by common intercept GMM estimator. Finally, we expand our dynamic panel data model by additional legal origin instruments.

We find that there is a robust positive relationship between financial development and productivity. The dynamic models suggest that this effect comes through efficiency change channel whereas the static models suggest that this effect comes through technical change.

The plan of the paper is as follows: Chapter 2 gives a review of existing theoretical and empirical literature on finance and growth. Chapter 3 describes the calculation of Malmquist productivity index measures, and gives details of the data. Chapter 4 discusses the methodology and reports the empirical results and Chapter 5 concludes.

CHAPTER 2

LITERATURE REVIEW

It is undeniable that there is both theoretical and empirical literature that suggests a positive relationship between financial development and economic growth. Many authors even claim that financial development is a necessary condition and a good predictor for long-run economic growth.

In the Section 2.2 we will start with the theoretical literature and in Section 2.3 we will continue with summarizing the empirical literature.

2.1 Theoretical Review

In this section, we will try to explain the theoretical literature regarding the role of financial markets and institutions on economic growth. Having looked at the initial opposing views in this literature, we will firstly explain why financial markets evolved and then mention what kind of functions they serve in promoting economic growth.

Likewise many things in the history of humankind, financial intermediaries did not happen to exist instantly or without any reason. On the contrary, as Levine (1997) points out, the costs of market frictions lead to the emergence of financial markets and intermediaries. In fact, a huge literature on economic theory states that, financial instruments, markets and institutions reduce the frictions caused by information and transaction costs such as costs of acquiring information, enforcing contracts and exchanging goods and financial claims.

When considering how well the mitigating effect of financial system is working, special attention could be given to the functions that financial system provides. In Levine (1997), these functions are defined to be facilitating risk amelioration, acquiring information about investment and allocating resources, monitoring managers and exerting corporate control, mobilizing savings and easing the trading of goods, services and financial contracts.

The functions mentioned above, i.e. the ones that financial system serves; affect economic growth through two main channels which are capital accumulation and technological change (Levine, 1997). Financial system affects capital accumulation through the modification of savings rate or re-allocation of savings (Levine, 1997). On the other hand, financial system influences technological innovation through inventions and their implementations.

It is also mentioned in Gurley and Shaw (1955), Goldsmith (1969), McKinnon (1974) and Levine (1997) that across time and countries there exists no difference between the existences of the above functions instead the difference lies in the quality of them. This quality differences will convey the relationship between finance and economic development.

In order to have a better understanding of the impact of finance on growth, one should better focus on the functions that financial intermediaries provide. One of the functions that financial markets and institutions serve is to ameliorate risks and simplify any kind of risk management, such as liquidity risk or risks associated with projects, industries, regions, etc.

Especially, financial markets provide liquidity and hence diminish the liquidity risk[1]. Focusing on the effect of more liquidity on economic growth there are two aspects to be discussed. By supplying liquidity, firstly financial system can increase returns on investment and secondly can decrease the uncertainty in the economic environment (Levine, 1997).

Starting with the first aspect, one could observe that higher return projects necessitate longer term commitments of capital. However, savers are not willing to invest on long term and hence illiquid projects. At this point, financial system comes into the picture. Financial system augments liquidity of long term investments and by this way it provides funds for long term projects. As a result, it increases the demand for long term-higher return projects. Higher returns not only results in the usage of

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[1] Before moving to the consequences of the elimination of liquidity risk on growth, we will shortly examine what is meant by liquidity risk and how it takes place. The instabilities inherent in the process of converting assets into a monetary tool give rise to liquidity risk. On account of the information asymmetries and transaction costs, liquidity risk arises since it is expensive to trade and there is uncertainty about the trading time and settlements. Hence, the need for liquidity brings about financial markets and institutions that provide liquidity (Levine1997).

capital its best allocation i.e. effective investment in the economy, but also attracts more investment in the economy, which will both bring in economic growth (Levine, 1997). To illustrate, Hicks (1969) claims the main engine of industrialization process was not the technological innovation as many of the products had been invented before the industrialization. He argues the important engine was the mobilization of capital markets which eased making investments. He continues that this was the case since for inventions to be made, large and long term investments were necessitated. On the other hand, as capital markets became more liquid, savers started investing on liquid assets which can easily be converted to a medium of exchange. Capital markets played a crucial role where by using short term investments of the savers they supplemented large funds for longer term projects which are illiquid. If the capital market was not that liquid this investment demand could not be fulfilled and industrial revolution will not take place. That's why Bencivenga et al. (1966: 243) conclude that ''the industrial revolution had to wait for the financial revolution…''.

One of the financial intermediaries which lessens liquidity risk and yields higher returns on investment is stock markets where people can issue and trade securities. Stock markets help diminishing liquidity risk by assisting trade. The mechanism pursues as follows: under the umbrella of stock markets transaction costs decreases, the investments in illiquid, higher return, long term projects will rise as the individuals feel more comfortable at selling the assets whenever they want. As a result the economy will enjoy growth owing to the increase in higher return investments (Levine, 1997).

Not only stock markets but also banks may provide liquidity and bring about higher returns in investments. Bencivenga and Smith (1991), explains how banks create liquidity and mitigate its need. They enlighten the activities that banks serve which are keeping and lending deposits of many people, holding huge liquid reserves in case of any withdrawal, issuing liabilities that are more liquid then their primary assets and providing a service for self-financing of investments. Also they emphasize that "an intermediation industry permits an economy to reduce the fraction of its savings in the form of unproductive liquid assets and to prevent misallocations of invested capital due to liquidity needs" (Bencivenga and Smith, 1991: 196). In addition, Levine (1997) explains the role of banks as follows. Under normal circumstances it is impossible or too costly to observe shocks to individuals and write state-contingent insurance contracts. Instead of dealing with this complicated issue individuals may use the demand deposits or any liquid deposits offered by the banks to savers. Banks arrange these deposits to be composed of low return liquid assets and high return illiquid ones. By providing these deposits banks not only grant savers liquidity risk insurance but also increase the investments in long-run projects and hence through capital accumulation channel it boosts growth[2].

Finally, before completing the effect of the elimination of liquidity risk on growth through higher returns in investment, it should be noted that higher returns may have an ambiguous effect on savings due to income and substitution effects. Other than yielding higher investment returns, financial intermediaries through reducing liquidity risk, lowers uncertainty which will in turn promote long run

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[2] Besides, Jacklin (1987) points out that banks will not be able to reduce liquidity risk if equity markets are available as savers will substitute equity markets to banks. However, Gorton and Pennachi (1990) notes that this liquidity creation process will work if there are enough obstacles in the equity market.

economic growth. However, its effect on saving rates is uncertain (Levhari and Srinivasan, 1969)[3]. There may be a decrease in savings rates which will cause a deceleration in growth (Levine, 1997).

In addition to the liquidity risk control, financial markets and institutions such as banks, mutual funds, and security markets facilitate risk management in idiosyncratic risks. Growth may be influenced by risk diversification through capital accumulation and technological innovation (Levine, 1997).

Looking at the former, as Levine (1997) explains, the amelioration of risk may bring about an increase in high return investments. Seeing that higher return projects are more risky than lower return ones savers have an incentive for not to invest on high return projects. Obstfeld (1994), mention the role of higher risk diversification in shifting investors from low-risk lower return projects to high risk higher return ones (Saint-Paul, 1992; Devereux and Smith, 1994 and Levine, 1997). This portfolio shift may bring about capital accumulation which would end up with economic growth. However, as discussed above, the impact of higher returns on saving rates is uncertain. Higher returns may result in a decrease in saving rates leading to a fall in long-run growth.

On the other hand, amelioration of risk has growth implications through technological innovation. Since there is no guarantee for making successful innovations, or no exact timing of them or exact amount of money needed for them,

[3] The confidence bred by a stable environment may lead to a decrease in savings rate due to the relaxation of savers. Also, the savings rate may increase owing to the environment which is very suitable to make an investment.

innovations are risky. Nonetheless, a successful innovation not only brings in profits to corresponding agent that implemented it but also generates technological change. At that point, financial systems, offer diversified portfolio's including investments in risky innovative projects. By this way, financial system helps investors to diversify risk and at the same time promote innovations which would speed up technological change, and result in economic growth (King and Levine, 1993c; Levine, 1997).

The second function that financial markets serve is acquiring information and improving the allocation of capital. As Carosso (1970) states gathering information about firms, their managers and market conditions are not an easy and costless job due to the fact that this process needs not only time but also capacity. Therefore, if there is high information costs, investors either will not be able to monitor projects or will have scarce information. As a result, investors simply won't invest on the projects that they would with enough information. Hence, resources will not be allocated efficiently in the presence of high information costs (Levine, 1997). In fact, Greenwood and Jovanovich (1990) illustrates that financial agents can economize on the cost of gathering information. By the help of financial intermediaries, information acquisition costs fall which leads to a situation where investments are made to the projects having the highest value use, in other words savings will be allocated more efficiently (Levine, 1997).

Stock markets are one of the financial intermediaries that serve to provide information. By just looking at the published prices, the investors can acquire free information reflecting the company's run of business. Investors won't waste their resources for information which will lead to a reduction in information costs. As there are limited resources, this will bring about better resource allocation and spur growth[4] (Levine, 1997).

The effect of this function on growth, works through both capital accumulation and technological innovation channels. If a country's financial system is good at selecting most promising firms and managers, there will be a more efficient resource allocation. As a result, the economy will enjoy growth through capital accumulation channel (Greenwood and Jovanovic, 1990). For instance, in mid-1800s, England's financial system was so organized that capital was flowing to its highest value use definitely and quickly (Bagehot, 1873). England's financial system's organization, which is good at spotting the best production technologies and sponsoring them, is the reason behind England's greater economic development compared to the other countries at that time (Levine, 1997).

Next, financial system also leads to innovation by decreasing information acquisition costs. Together with, identifying best production technologies as mentioned, financial intermediaries identify firms that would be best at starting the production of new goods and production processes (King and Levine, 1993c; Levine, 1997). The mechanism pursue as follows. After spotting the firms which have the

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[4] The capacity and degree of liquidness of stock markets alters the ability of stock markets in acquiring information about investments. Firstly, in the presence of larger stock markets, the participants will be more motivated to gather information due to the possibility of higher returns (Grossman and Stiglitz, 1980). Similarly, in the presence of the more liquid the stock markets the participants will be more motivated to gather information due to the possibility of higher returns owing to the fact that in the presence of liquid stock markets transactions can be made without facing any frictions. (Kyle, 1984; Holmstrom and Tirole, 1993). As a result, with larger and liquid stock markets resources will be allocated more efficiently, which will bring about an enhancement in growth.

best chances of successful innovations, financial intermediaries provide these firms capital or loans for investing on innovations which leads to long run growth through technological innovations.

Up to now, the information costs before the investment decisions were made, was considered. However, as Levine (1997) declares there also exist costs after financing the activity such as information acquisition and enforcement of monitoring firm managers and exerting corporate control.

As a third function, financial systems gather information, monitor managers and exert corporate control after the projects are funded (Levine, 1997). In the absence of corporate control, there would be impediments to mobilization of savings, which avoid capital flowing to its highest value use. On the other hand, with well functioning financial systems monitoring and enforcement costs will lessen. This reduction in costs will bring about reductions in obstacles in efficient investment (Thadden, 1995; Levine, 1997). Therefore, through efficient investment there will be better resource allocation.

An example for this is given in Levine (1997), which is ‘delegated monitor arrangement’ property of financial intermediaries. Suppose there is a borrower who needs funds from outside creditors. Yet, instead of all savers trying to monitor the borrower financial intermediaries monitors and lends which will decrease monitoring costs of savers (Diamond, 1984). In other words, growth comes through better resource allocation.

Now, capital accumulation channel works through the following mechanism. Financial arrangements exert corporate control that improves the allocation of capital and hence results in higher capital accumulation (Bencivenga and Smith, 1993; Khan, 1994 and Levine, 1997).

There exists no consensus on whether stock markets exert corporate control or not. Jensen and Meckling (1976) argue in the favor of stock markets and claim that stock market performance of a firm's shares will reveal information about the success of managers. By associating stock performance to managerial administration savers will fulfill their concern about their investment's goings-on (Verrecchia, 1982; Jensen and Murphy, 1990).

In contrast, others question whether stocks markets exert corporate control. Myers and Majluf (1984) declare that insider outsider information asymmetries may reduce the effect of stock market takeovers on promoting corporate control. As Levine (1997) also mentions, during the takeover process outsiders will be less informed comparatively. Thus, outsiders may demand a premium for the purchase of the company.

Besides Stiglitz et al. (1988) and Morck et al. (1990) disagree with the promoting role of stock markets on corporate governance (Levine, 1997). They assert that liquid stock markets worsen resource allocation due to the takeover effects. They reason their argument as follows: After the takeover, the new shareholders will relocate the capital from the stakeholders to themselves so as to gain profit. However, this new profit mechanism will hurt efficiency of resource allocation. In addition, Shleifer and Vishny (1986) and also Bhide (1993) stresses liquid stock markets lessen the exit costs which will in turn reduce the motivation for keeping an eye on managers and firm’s on goings.

Mobilization of savings is another function of financial systems which will yield in economic growth through both capital accumulation and technological innovation channel (Levine, 1997).

By pooling distinct savers’ capital, financial systems lead to economic growth through capital accumulation channel. Firstly, by mobilization of savings financial systems solve the scale inefficiency problem (Sirri and Tufano, 1995). By pooling savings financial intermediaries can provide necessary capital to production processes which may not be able to start by individual financing due to scale inefficiency. Next, mobilization of savings brings new financial instruments. By using these instruments agents can hold diversified portfolios or more liquid assets and they can invest in efficient scale firms. To summarize, mobilization leads to better resource allocation by increasing the scale of the firms, enhancing risk diversification and providing liquid assets (Sirri and Tufano, 1995; Levine, 1997).

As a final function financial system facilitates exchange. The link between this function and growth depends on specialization. Financial intermediaries, by facilitating exchange function, reduce the cost of transactions and hence promote specialization which has a positive effect on economic development (Levine, 1997).

2.2 Empirical Literature

As mentioned in the previous section, financial development might be a very important factor in spurring growth. After having emphasized the theoretical ties in the previous section, now, we will focus on the empirical literature.

Among the body of literature in this area, we will follow an econometric approach which goes from general to specific. Therefore, we will include a wide spectrum of empirical papers with different techniques, ranging from cross section to panel data.

Cross country growth regressions aggregate economic growth over time and analyze the link between growth and financial indicators. To begin with, King and Levine (1993b) develop the cross sectional study of Goldsmith (1969) in such a way that they increase not only the cross sectional dimension but also time dimension and the number of control variables. Apart from Goldsmith's analysis they investigate the effect of financial development on productivity and capital accumulation. Using a large cross section of 80 countries, King and Levine (1993b) analyze the relationship between financial development and growth performance from year 1960 to 1989. They examine whether the level of financial development affects current and future rates of the sources of the growth and growth. The level of financial development is measured by four indicators which are: the ratio of financial intermediary system to nominal output i.e. the ratio of liquid liabilities to GDP; the ratio of bank credit to bank credit plus central bank's domestic assets; the ratio of credit issued to the private firms to total domestic credit and the ratio of credit issued to the private firms to GDP. On the other hand, they use three growth indicators which are: real per capita GDP growth, real per capita capital growth and productivity growth which is measured as Solow residual[5]. Employing linear regression and controlling for possible determinants of growth such as initial income, educational attainment, inflation, black market exchange rate premia, government expenditure, openness to trade and political instability, King and Levine (1993b) find a strong and robust correlation between growth and channels of growth. In addition, they show that financial development predicts long run growth. However, the results do not formally imply causality.

Since we are mentioning the studies linking financial development and growth, the natural question follows as whether stock markets and/or banks lead to economic growth.

While some authors believe that especially stock market development triggered economic growth, and others stress the role of banks. On the other hand, Levine and Zervos (1998) simultaneously investigate the effects of stock markets and banking sector development on growth. In addition, they analyze whether stock markets and banks provide different services. In their study, they use a sample of 47 countries from 1976 through 1993. They examine whether measures of stock market size, stock market liquidity, volatility, integration with world capital markets and banking development influences current and future rates of growth and sources of growth. The size of stock market is evaluated by the value of listed domestic shares on domestic exchanges divided by GDP. In order to measure stock market liquidity

[5] Solow residual is defined as real per capita GDP growth minus the product of production function parameter and real per capita physical capital stock growth.

they used two different indicators which are stocks turnover ratio, i.e. value of trades of domestic shares on domestic exchanges divided by the value of listed domestic shares, and value traded ratio, i.e. the value of trades of domestic shares on domestic exchanges divided by the GDP. Furthermore, they use bank credit to the private sector as a share of GDP to measure banking sector progress. Besides, real per capita capital growth, productivity growth, private savings and real per capita GDP growth are used to measure sources of growth and growth. In their cross county study, in addition to the linear regression, they employ instrumental variables techniques while they control for possible determinants of growth. Levine and Zervos (1998) find a strong positive and robust correlation between current and future rates of ‘growth of output, capital accumulation and productivity’ and stock market liquidity and banking sector progress. However, they empirically find that there is no correlation between financial indicators and savings rate. Additionally, they show that banks and stock markets provide different functions in spurring growth as they jointly enter to the regressions with significant positive coefficients.

On the other hand, simultaneity bias is one of the concerns of financial development versus growth literature. As there was both evidence on finance following growth and growth being triggered by finance, there was a need for techniques taking simultaneity bias into account. One of the appropriate techniques is using an instrumental variable which is not correlated with the dependent variable, i.e. growth indicator, but highly correlated with the independent variable which leads to endogeneity, i.e. financial development indicator.

Following La Porta et al. (1998), many authors used legal origin as an instrument for financial development[6]. Legal origin is an appropriate instrument as it is not correlated with economic growth due to the fact that countries obtained their legal origin through colonization or occupation. On the other hand, legal origin is an appropriate instrument as it is correlated with financial development owing to the evidence that country's legal origin affects the development of creditor rights and the enforcement of contracts in that country which is linked with financial environment or investment climate.

To start with, Levine (1999) studies not only whether legal and regulatory environment determine level of financial intermediary development but also the causality issue between financial development and growth. Firstly, he measures financial development by the indicators used in King and Levine (1993b). In addition, he uses the national legal origin measure from La Porta et al. (1998). Using dataset consisting of a cross section of 49 countries between the years 1980-1989 and applying OLS techniques between indicators of creditor rights and financial development he finds that there exists a strong relation between creditor rights and financial development. He controls for simultaneity bias by instrumenting financial development with legal origin; however, even stronger evidence is found leading the same conclusion that there is a strong relation between creditor rights and financial development. When he looks at the efficiency of legal system in enforcing contracts with the same procedure, he finds the efficiency of legal system in enforcing contracts spurs financial development. On the other hand, as the quality of

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[6] LaPorta et al. (1998) collect the data on legal system for 49 countries and show that legal origin—British, French, German, or Scandinavian law—characters the laws regarding creditor rights laws and the efficiency of the enforcement of these laws in that country.

accounting standards plays a critical role in constructing financial contracts, he checks the effect of them on financial growth by using an index of comprehensiveness of company reports. Again with the same procedure, the results indicate that accounting standards positively affect financial intermediary development while this results are not that strong compared to the other legal and regulatory environment measures. In order to handle whether exogenous component of financial intermediary development triggers growth, he extends the study of King and Levine (1993b). Using the data of 45 countries from year 1960 to 1989, he instruments financial development indicators with both creditor rights, accounting and legal origin indicators while he uses Generalized Method of Moments (GMM) framework[7]. In addition, he controls for other factors such as initial per capita GDP, initial secondary school enrollment, the degree of ethnic diversity, government consumption to GDP, inflation rate, ratio of exports plus imports to GDP. He finds that the exogenous component of financial development leads to economic growth where the result is not driven by simultaneity bias.

Next, Levine (1998) investigates the sources of the cross country differences in banking sector development. In fact, he examines whether legal rights of creditors, the efficiency of contract enforcement and the legal origin determine the level of banking sector development in that country. Moreover, in his paper he assesses whether the exogenous component of banking sector development is linked with growth, capital stock accumulation and productivity growth. He uses data on 49 countries over the period 1976-1993, where he measures banking sector development by credit allocated by the commercial and other deposit taking banks to the private

[7] He conducts two-stage least squares methods for robustness checks.

sector divided by GDP. In order to assess creditor rights he defines a creditor index indicating the rights written in law books. In addition, he constructs an enforcement index which is the average of two indexes constructed by International Country Risk Guide (ICRG). On the other hand, he takes the legal systems' origin measure from La Porta et al. (1998). Firstly, by using OLS with averaging the data over 1976-1993 periods, he concludes that rights of creditors and the efficiency of contract enforcement positively affects banking sector development. Also, by adding dummy variables for legal origin he finds that legal origin also explains the cross country differences in banking sector development. Next, by using GMM instrumental variable estimators and controlling for several factors, he shows that the exogenous component of banking development enhances growth, capital stock accumulation and productivity no matter it is instrumented by creditor rights, efficiency of contract enforcement or legal origin.

Next we discuss the panel data techniques. Note that one of the advantages of using panel data is the addition of time dimension. Levine et al. (2000) improve past work on finance growth literature by introducing recent panel data techniques developed by Arellano and Bond (1991) and Arellano and Bover (1995), confronting the potential biases caused by simultaneity, unobserved country specific effects and omitted variables. On the one hand, they control for unobserved specific effects, unlike cross sectional studies they are not considered as a part of the error term. On the other hand, they control for simultaneity bias in a GMM panel data framework developed by Arellano and Bond (1991) and Arellano and Bover (1995). The cross sectional studies can not always consider instruments for all of the regressors whereas the panel studies can, as they use instruments based on the past realizations of explanatory variables (Levine, 2000). However, panel studies consider a weal type of exogeneity. Levine et al. evaluate the effect of exogenous component of financial development on economic growth and whether the differences in legal and accounting systems affects the level of financial development. They use real per capita GDP growth in order to assess economic growth and use three measures of financial intermediation which are: liquid liabilities of the financial system divided by the GDP, the ratio of commercial bank assets divided by commercial bank plus central bank assets and the value of credits by financial intermediaries to the private sector divided by GDP. They collect data on 74 countries from 1960 to 1995. They employ both panel data GMM estimators and cross sectional instrumental variable estimators. They average the panel data set over five year intervals for the GMM techniques for 74 countries whereas they average all the data such that there is one observation per country, for the cross section for 71 countries. The results show that the exogenous component of financial intermediary development triggers economic growth. Also, this paper finds that legal and accounting environment helps to explain cross country differences in financial development where the countries that put much emphasis on creditor rights, contract enforcement and accounting standards positively influence the functioning of financial system. The methodology that we used in this thesis gets the motivation from this paper.

Beck et al. (2000), investigate the link between financial intermediary development and sources of growth. They use almost the same dataset and econometric techniques with Levine et al. (2000) but they differ in the sense that in addition to economic growth they evaluate the link between finance and sources of growth which are total factor productivity (TFP), physical capital accumulation and private savings rates. Their results suggest that better financial intermediation will bring about higher economic growth and TFP. However, taking physical capital accumulation and private savings rates into account, the paper finds no robust relationship between financial development and physical capital accumulation or private savings.

Rousseau and Wachtel (2000), empirically assess the relationship between growth and both banks and stock markets. They contribute to the literature in the sense that they analyze the effect of banking and stock market development on growth with recent panel data techniques. They use difference panel estimator to control for the potential biases caused by simultaneity, unobserved country specific effects and omitted variables. Using liquid liabilities to GDP as an indicator of banks performance and using measures of stock market size and liquidity (Measures of Levine and Zervos, 1998) with annual panel data, they find that not only banking sector but also stock market development enhances economic growth.

Beck and Levine (2002) develops Rousseau and Wachtel (2000)'s analysis while issuing the same hypothesis. They differ in two areas. While Rousseau and Wachtel (2000) uses annual data Beck and Levine (2002) takes the averages of the data for five year intervals. They improve former analysis by getting rid of business cycle effects. In addition they improve Rousseau and Wachtel (2000) in the sense that they run their regressions with more advanced GMM estimator called GMM system estimator. They use the same measures with Levine and Zervos (1998) with slight differences in deflating procedures. They use a data set of 40 countries for the period 1976-1998 where they use real per capita GDP growth to evaluate economic growth. Both OLS and GMM techniques support the conclusion that stock markets and banks jointly and positively affect long run economic growth. In the light of studies above we will examine the relationship of financial development and economic growth where we use Fare et al. (1994)'s productivity measures.

CHAPTER 3

MALMQUIST PRODUCTIVITY CHANGE INDEX AND DATA

In this chapter we will first describe the Malmquist Productivity Index measures then we will describe our data. The objective of the paper is to address the question of economic growth and financial development from a different perspective. Traditionally, growth has been analyzed with the following variables: real per capita GDP growth, real per capita capital stock growth rate or total factor productivity. This paper examines the productivity component of growth and replaces economic growth with a specific productivity measure, Malmquist index introduced by Fare et al. (1994). The Malmquist productivity index is further decomposed into two component measures, efficiency change (diffusion) and technical change (innovation).

3.1 Measuring Productivity: Malmquist Productivity Index Approach

In this study, we use a Malmquist index approach whose idea was first originated from Malmquist (1953), then introduced by Caves et al. (1982) and further developed by Fare et al. (1994), who calculated the index by the relationship between distance functions and Farrell efficiency measures. We calculated the index so as to analyze the productivity growth among a panel data of developed and developing countries.

The calculation of the index is done by data envelopment analysis, a non-parametric mathematical programming approach to frontier estimation, which enables us to calculate efficiencies relative to a non-parametric piecewise surface in other words frontier (Coelli, 1996). The advantages of Malmquist productivity index could be stated as follows: It neither requires price information in the calculations nor imposes a functional form. In addition, it does not assume that all decision making units are fully efficient. Finally, the main advantage of this index is that it allows for technical change and technical efficiency change decomposition.

Although there are too many definitions of productivity used in the literature, what productivity basically refers to is the relationship between the quantity of outputs of goods and services produced and the quantity of resources employed in production process (Fabricant, 1969; Kendrick, 1977). Having this simple definition in mind, we will start with a case where total factor productivity is calculated before directly moving to the explanation of Malmquist index.

Suppose there is an economy producing a single output, represented by vector y, using a single input, represented by vector x, in its production process which holds in two periods, t and t+1. So, in the first period, we have input-output mix (x_t, y_t) and in the following period we have (x_{t+1}, y_{t+1}). As total factor productivity is measured by the quantity of output divided by the amount of all inputs used in production, the total factor productivity growth from year t to t+1 becomes:

$$TFP = \frac{y^{t+1} / x^{t+1}}{y^{t} / x^{t}}$$

However, things get more complicated if we introduce many inputs and/or outputs. At this point, we need to introduce input and output distance functions which are the reciprocals of the technical efficiency measures[8].

As defined in Fare et al. (1994), the production technology S^t is the technology set which is comprised of feasible input output vector combinations. It is defined formally at time t as: $S_t = \left\{ (x_t, y_t) : x^t \ can \quad produce \quad y^t \right\}$.

Following Shepard (1970) or Fare (1988), Fare et al. (1994), defined the Output distance function at time t as:

$$D_o^t(x^t, y^t) = \inf\left\{\theta : (x^t, y^t/\theta) \in S^t\right\} = (\sup\left\{\theta : (x^t, y^t/\theta) \in S^t\right\})^{-1}.$$

This distance function measures the maximal proportional expansion of output vector y^t given inputs vector x^t in relation to the technology at time t. Note that, $D_0^t(x_t, y_t) \le 1$ if and only if $(x^t, y^t) \in S_t$. Moreover, output distance function

8 In Appendix A, more detailed discussion of input and output oriented productivity measures is presented.

is equal to one if and only if (x^t, y^t) is on the on the best practice frontier. In terms of Farrell's technical efficiency terminology, input output vectors (x^t, y^t), with the property $D_0^t(x_t, y_t) = 1$ corresponds to be the technically efficient allocations.

To have a better understanding, look at the Figure1. There are two different reference technologies: period t and t+1. In addition, there is only one DMU, producing a single output using a single input, is operating at $(x^t, y^t) \in S_t$ at period t and $(x^{t+1}, y^{t+1}) \in S_{t+1}$ at period t+1. It can be observed that technical advance has occurred between the year t and t+1, i.e. $S_t \subset S_{t+1}$. In the figure, since the observed production at t (x^t, y^t) is interior to the boundary of technology at t, (x^t, y^t) is not technically efficient. Given x^t, maximum feasible production is at (y^t / θ^*). In other words, there is still room fro expanding output. The technical efficiency measure with respect to t[th] period's technology, which is value of the distance function $D_0^t(x^t, y^t)$, is O*a*/O*b*, which is less than 1.

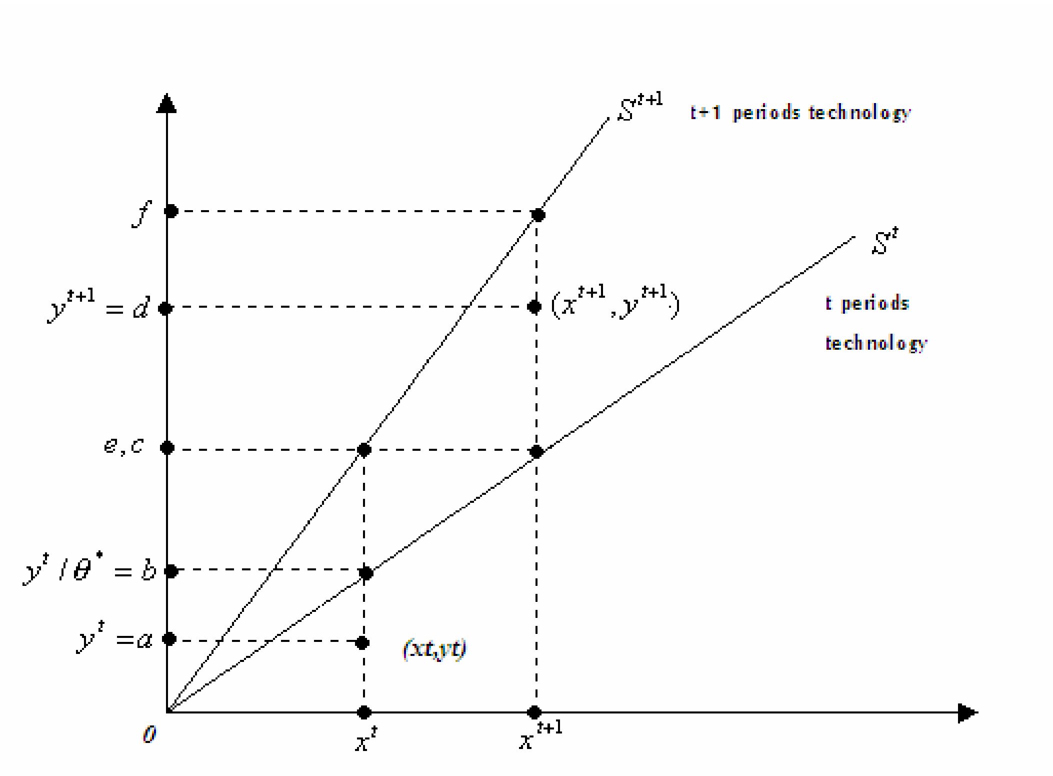

Figure 1. The Malmquist Output-Based Index of Total Factor Productivity

On the other hand, in order to improve and introduce the Malmquist index, Fare et al (1994) defined output functions relative to different time periods. To illustrate, the output distance function at time t can be defined as: $D_0^t(x^{t+1}, y^{t+1}) = \inf\{\theta : (x^{t+1}, y^{t+1}/\theta) \in S^t\}$. This distance function measures the maximal proportional change in outputs required to make (x^{t+1}, y^{t+1}) feasible in relation to the technology at t, whereas distance function $D_0^{t+1}(x^t, y^t) = \inf\{\theta : (x^t, y^t/\theta) \in S^{t+1}\}$ measures the maximal proportional change in outputs required to make (x^t, y^t) feasible in relation to the technology at t+1. If we again look at the figure, (x^{t+1}, y^{t+1}) is no more feasible according to the reference technology at time t. Moreover, the value of distance function, at (x^{t+1}, y^{t+1}) with respect to reference technology at time t is 'Od/Oe', which is greater than 1. Besides, the value of distance function, at (x^t, y^t) with respect to reference technology at time t+1 is 'Oa/Oc', which is less than 1.

In order to get the intuition behind the construction of Malmquist index, following Fare and Grosskopf (2000) we will start simple where we will not use time subscripts. Also, suppose that the Decision Making Units (DMU's) are operating under constant returns to scale (CRS) and strong disposability of inputs assumptions. Observe that, $D_o(x, y) = \frac{y}{x} D_o(1,1)$ using the general 'homogeneity of degree 1 in y' property of output functions and 'homogeneity of degree -1 in x' property which holds only in CRS assumption (Fare and Grosskopf, 2000)[9].

Now, combining above observation with the total factor productivity definition, by simply substituting the input and output combinations with their time indexes, one would get:

$$TFP = \frac{y^{t+1} / x^{t+1}}{y^t / x^t} = \frac{D_o(x^{t+1}, y^{t+1}) / D_o(1,1)}{D_o(x^t, y^t) / D_o(1,1)} = \frac{D_o(x^{t+1}, y^{t+1})}{D_o(x^t, y^t)}$$

, where $D_o^t(.)$ is the output distance function relative to the reference technology from period t (Fare and Grosskopf, 2000).

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9 $D_o(x, \theta y) = \theta D_o(x, y), \forall \theta > 0$ and $D_o(\theta x, y) = (1/\theta) D_o(x, y), \forall \theta > 0$

Depending on the benchmark technology period chosen, the Malmquist Productivity Index is a total factor productivity index, and it is defined to be $M^t = \frac{D_0^t(x^{t+1}, y^{t+1})}{D_0^t(x^t, y^t)}$ *or* $M^{t+1} = \frac{D_0^{t+1}(x^{t+1}, y^{t+1})}{D_0^{t+1}(x^t, y^t)}$ if period t or period t+1 are taken to be the reference technology respectively (Caves et al., 1982; Fare et al., 1994). In any case, a value greater than one indicates that there has been an improvement in productivity between period t and t+1 relative to the benchmark technology.

So as to avoid choosing arbitrary benchmarks, following Fischer (1922)[10], Fare et al. (1994) introduced the Malmquist index to be the geometric mean of the t and t+1 Malmquist Indexes:

$$M_0^t(x^{t+1}, y^{t+1}, x^t, y^t) = \left[\frac{D_0^t(x^{t+1}, y^{t+1})}{D_0^t(x^t, y^t)} \frac{D_0^{t+1}(x^{t+1}, y^{t+1})}{D_0^{t+1}(x^t, y^t)} \right]^{1/2}.$$

This expression could be rewritten as (Fare et al. ,1989, Fare et al. 1992, Fare et al. 1994):

$$M_0(x^{t+1}, y^{t+1}, x^t, y^t) = \frac{D_0^{t+1}(x^{t+1}, y^{t+1})}{D_0^t(x^t, y^t)} \times \left[\frac{D_0^t(x^{t+1}, y^{t+1})}{D_0^{t+1}(x^{t+1}, y^{t+1})} \frac{D_0^t(x^t, y^t)}{D_0^{t+1}(x^t, y^t)} \right]^{1/2}$$

On the one hand, the ratio outside the brackets measures the change in relative efficiency between years t and t+1. What is meant by relative efficiency is that how the DMU performs relative to the benchmark technology with given set of

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[10] Fare and Grosskopf notes that they used the idea of the construction of Fischer Ideal Index. In the sense that Fisher constructed this index by using the geometric mean of upper and lower bound of the index. In fact, Fischer ideal index is the geometric mean of Paasche index and Laspeyres index.

inputs. In other words, relative efficiency assesses how far the actual production to the benchmark production in that year is.

Efficiency change component of productivity change: $\dfrac{D_0^{t+1}(x^{t+1}, y^{t+1})}{D_0^t(x^t, y^t)}$

On the other hand, the geometric mean of the two ratios inside the brackets captures the shift in technology, in other words shift in best practice frontier between the two periods evaluated at x^t and x^{t+1}. As (Fare and Grosskopf, 2000) explains it is the geometric mean of shifts measured at x^t and x^{t+1}.

Technical change: $\left[\dfrac{D_0^t(x^{t+1}, y^{t+1})}{D_0^{t+1}(x^{t+1}, y^{t+1})} \dfrac{D_0^t(x^t, y^t)}{D_0^{t+1}(x^t, y^t)}\right]^{1/2}$

Suppose $x^t = x^{t+1}$ and $y^t = y^{t+1}$ then Malmquist productivity index is equal to one which implies no change[11]. For values greater than one, efficiency change component will indicate that the country has improved its relative technical efficiency during the period considered and experienced diffusion of technology.

The above Malmquist Index and its decomposition to the efficiency change and technical change component measures can be graphically represented in Figure1 with the following distances.

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[11] This does not imply that Technical Change component and Efficiency change component is equal to 1.

$$M_0(x^{t+1}, y^{t+1}, x^t, y^t) = \left(\frac{0d}{0f}\right)\left(\frac{0b}{0a}\right)\left[\left(\frac{0d/0e}{0d/0f}\right)\left(\frac{0a/0b}{0a/0c}\right)\right]^{1/2}$$

$$= \left(\frac{0d}{0f}\right)\left(\frac{0b}{0a}\right)\left[\left(\frac{0f}{0e}\right)\left(\frac{0c}{0b}\right)\right]^{1/2}$$

It can be seen inside the brackets of the last expression that technical change component measures the shift in frontier between two periods. It is the geometric mean of shifts from period t to t+1. The expression outside the brackets, gives the relative efficiency at t and t+1 which evaluates the actual production relative to the benchmark production. The Malmquist index, which displays the changes in the productivity, is the product of these measures. Values greater than one show improvement in the productivity index over time and values smaller than one indicate deterioration in performance. Note that, the components do not have to move in same directions, on the contrary, they could move in opposite directions. In conclusion, Fare et al. (1994) defined a productivity growth index which can be further decomposed into the product of two indexes: efficiency change and technical change. While efficiency change accounts for catching up the frontier, the technical change accounts for innovation.

In our study, we are interested in estimating productivity changes along a wide set of countries. Therefore, Malmquist productivity index is calculated by non-linear programming techniques. As we mentioned before, the index will be used to investigate the productivity growth among countries.

In our model, we assume that there are k=1,2…K countries using n=1,2…N inputs $x_n^{k,t}$ at each time period t=1,2…T in order to produce m=1,2,…M outputs $y_m^{k,t}$. In the model, capital and labor are assumed to be the input variables and the GDP of each country is assumed to be the output value.

The reference technology in period t is constructed as:

$$S^t = \left\{ \begin{array}{l} (x^t, y^t) : y_m^t \leq \sum_{k=1}^{K} z^{k,t} y^{k,t} \quad m = 1,...M \\ \sum_{k=1}^{K} z^{k,t} x_n^{k,t} \quad n = 1,...N \\ z^{k,t} \geq 0 \quad k = 1,...K \end{array} \right\}$$

where constant returns to scale is assumed.

The following four distance functions are calculated for each pair of years t to compute the Malmquist Productivity Index and its components.

1) $D_0^t(x^t, y^t)$, 2) $D_0^{t+1}(x^{t+1}, y^{t+1})$, 3) $D_0^t(x^{t+1}, y^{t+1})$, 4) $D_0^{t+1}(x^t, y^t)$. So for each k′=1…K these four linear programming problem can be defined as:

1)

$$\begin{aligned} &\left(D_0^t\left(x^{k',t} y^{k',t}\right)\right)^{-1} = \max \theta^{k'} \\ &subject \quad to \\ &\theta^{k'} y_m^{k',t} \leq \sum_{k=1}^{K} z^{k,t} y_m^{k,t} \qquad m = 1,..., M \\ &\sum_{k=1}^{K} z^{k,t} x_n^{k,t} \leq x_n^{k',t} \qquad n = 1,..., N \\ &z^{k,t} \geq 0 \qquad k = 1,..., K \end{aligned}$$

2)

$$\left(D_0^{t+1}\left(x^{k',t+1} y^{k',t+1}\right)\right)^{-1} = \max \theta^{k'}$$
$$subject \quad to$$
$$\theta^{k'} y_m^{k',t+1} \le \sum_{k=1}^{K} z^{k,t+1} y_m^{k,t+1} \qquad m = 1,\ldots, M$$
$$\sum_{k=1}^{K} z^{k,t+1} x_n^{k,t+1} \le x_n^{k',t+1} \qquad n = 1,\ldots, N$$
$$z^{k,t+1} \ge 0 \qquad k = 1,\ldots, K$$

3)

$$\left(D_0^{t}\left(x^{k',t+1} y^{k',t+1}\right)\right)^{-1} = \max \theta^{k'}$$
$$subject \quad to$$
$$\theta^{k'} y_m^{k',t+1} \le \sum_{k=1}^{K} z^{k,t} y_m^{k,t} \qquad m = 1,\ldots, M$$
$$\sum_{k=1}^{K} z^{k,t} x_n^{k,t} \le x_n^{k',t+1} \qquad n = 1,\ldots, N$$
$$z^{k,t} \ge 0 \qquad k = 1,\ldots, K$$

4)

$$\left(D_0^{t+1}\left(x^{k',t} y^{k',t}\right)\right)^{-1} = \max \theta^{k'}$$
$$subject \quad to$$
$$\theta^{k'} y_m^{k',t} \le \sum_{k=1}^{K} z^{k,t+1} y_m^{k,t+1} \qquad m = 1,\ldots, M$$
$$\sum_{k=1}^{K} z^{k,t+1} x_n^{k,t+1} \le x_n^{k',t} \qquad n = 1,\ldots, N$$
$$z^{k,t+1} \ge 0 \qquad k = 1,\ldots, K$$

In order to find out the Malmquist productivity index, we need to solve the above equations.

3.2 Data

In this section we will describe the data that we used in our estimations. First, we will start with the definitions and sources of our productivity measures, and then we will explain our selected financial variables. Finally, we will describe our conditioning sets and details of our conditioning variables.

3.2.1 Growth Indicators

As stated before, the objective of this paper is to revisit the link between financial development and growth. However, this paper examines the productivity component of growth and replaces economic growth with a specific productivity measure, Malmquist index introduced by Fare et al (1994). The purpose of this paper is specifically evaluating the effect of financial development on productivity and the sources of productivity after controlling for simultaneity bias and unobserved country specific effects.

Analysis is conducted initially on a panel dataset of 56 countries which includes industrial and developing countries see the Appendix B for the list. This set of countries also consists of lower income, lower middle income, upper middle income and upper income countries. For the above countries and for each year in the sample Malmquist productivity index and its components, efficiency change index and technical change index are calculated. The application of the above methodology provides for each country, the Malmquist productivity index (Malm) and its components, efficiency change index (Eff) and technical change index (Tech). In this methodology, a world frontier is constructed at every period and each countries performance is evaluated according to the frontiers. Regarding all the indices, a value equal to one indicates, that the country is operating on the world frontier whereas a value greater than one indicates an average annual improvement in the performance of the country relative to the world frontier and a value less than one shows deterioration in performance.

In order to calculate the productivity indices, the equations (1) to (4) stated above are solved by using GAMS (General Algebraic Modeling System) for every time period between 1965 and 1990 where capital and labor are taken to be the inputs and GDP is taken to be the output for each country. The data on capital stock and employment are taken from Penn World Tables 5.6[12].

For a single country we need to solve four linear programming problems in order to calculate the distance functions (1) to (4). If one more period is added one has to calculate three more distance functions. So for each country, we need to solve (3T-2) linear programming problems. Thus for the whole sample, we need to solve N*(3T-2) problems where N denotes number of countries and T denotes time period. To sum up, growth indicators are measured with the Malmquist Productivity Index and its two components for 25 periods and 56 countries, a total of 56*73=4088 linear programming problems are solved.

[12] Employment data is retrieved from real GDP per worker series with 1985 international prices. Capital stock data is retrieved from Nonresidential Capital Stock per worker series with 1985 international prices.

3.2.2 Financial Development Indicators

In order to measure financial development we used mainly the private credit by deposit money banks and other financial institutions to GDP (denoted by **Finvar1**). The data is taken from Beck et al. (1997)[13]. This measure stresses claims on private sector. In fact, it focuses on the credit issued by private sector and distinguishes the central bank's part. As stated by Beck et al. (2000), this variable measures the activity of financial intermediaries.

The second variable used is the deposit money bank assets to GDP (denoted by **Finvar2)**. The data is taken from Beck et al. (1997)[14]. As noticed in Beck et al. (2000), this variable measures the size of financial intermediaries relative to GDP.

3.2.3 Conditioning Variable Set

The aim of this paper is to examine the relationship between financial development and productivity indicators. In addition to financial variables there are other factors that contribute to growth (or productivity changes). Our regressions include a set of conditioning variables to capture these effects. The simple conditioning variable set consists of the logarithm of initial real per capita GDP and

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[13] Private credit by deposit money banks and other financial institutions to GDP, calculated using the following deflation method: $\{(0.5)*[F_t/P\_e_t + F_{t-1}/P\_e_{t-1}]\}/[GDP_t/P\_a_t]$ where F is credit to the private sector, P_e is end-of period CPI, and P_a is average annual CPI. For the details of the deflation method see Beck et al. (2000).

[14] Claims on domestic real nonfinancial sector by deposit money banks as a share of GDP, calculated using the following deflation method: $\{(0.5)*[F_t/P\_e_t + F_{t-1}/P\_e_{t-1}]\}/[GDP_t/P\_a_t]$ where F is deposit money bank claims, P_e is end-of period CPI, and P_a is average annual CPI. For the details of the deflation method see Beck et al. (2000).

secondary school enrollment. The initial income is utilized to capture catching up process whereas secondary school enrollment indicates the investment in human capital. The data of initial income is taken from Levine et al. (2000) where the initial source of the data is World Development Indicators (WDI) and the secondary source is Loayza et al. (1998). In addition, average years of secondary schooling in total population over 15 are taken from Barro and Lee (1996).

Moreover, in order to control the macroeconomic environment and economic policy in which economic activity takes place we use additional conditioning variables which are indicators of government size defined as government consumption expenditure as a share of GDP, Inflation, the log difference of GDP deflators. The former is used to control for fiscal policy while the latter accounts for monetary policy. In order to control for trade effects on productivity, openness, the sum of exports plus imports as a share of GDP, and foreign direct investment, foreign direct investment net inflows as a share of GDP are used. The government size is taken from Penn World Tables 5.6 whereas the remaining variables are taken from (WDI).

In order to assess sensitivity of the results we construct seven conditioning sets. Firstly, we control only for initial income and secondary school enrollment. Then to this group we add macroeconomic policy indicators and trade indicators individually one by one. That is firstly we add government size indicator. After dropping it and adding inflation we construct our third conditioning set. Similarly we add the openness and construct our fourth conditioning set. Next, after dropping openness and adding foreign direct investment we get our fifth conditioning set.

Finally, the sixth and seventh conditioning information sets, include the simple conditioning set plus measures of macroeconomic environment plus one of the measures of trade effects.

CHAPTER 4

METHODOLOGY AND EMPIRICAL RESULTS

In this chapter we will firstly present our estimation techniques and their empirical results where our main objective is to control for simultaneity bias. To begin with, we will present the results of computation of Malmquist productivity index for each country and for each year in the sample. In the light of the purpose of examining the role of financial development on the growth process i.e. on productivity changes, an empirical analysis is conducted with a set of econometric estimations where productivity change indexes are explained. The following section provides a summary of productivity change indexes and other components which are used as growth indicators. After this section, the regression equations, estimation techniques and robustness checks are presented. There is clear evidence that there exists a positive relationship between financial development and productivity.

4.1 Malmquist Productivity Change Index and Its Component Measures

Malmquist Productivity Change Index and its components computed for each country and pair of year within the sample indicates whether a country moved towards the frontier-efficiency change index and best frontier expanded- technical change index. For each index, a value greater than one indicates an improvement in the performance of the country and a value less than one shows a deterioration in the performance. In Appendix C, in Table 1 all countries and the average of the sample period Malmquist index and its component indices are reported. According to this table, the largest average Malmquist index is observed in Hong Kong which is due to improvement in efficiency performance which was the highest in the sample. In other words, Hong Kong not only improved its total factor productivity but also its speed of catching up the frontier. Turning to the technology Switzerland has the highest rate of average innovation. When we look at the worst performance Iran has the lowest Malmquist index on average which is due to efficiency change component as it has the lowest average rate of moving to the frontier. Finally, Sierra Leone has the lowest technical change index on average.

On the other hand, the overall picture can be captured by the mean productivity indexes reported in the below, Table2:

Table 2. Average Malmquist Productivity Change Index and Its Components (1965-1990)[15]

Income	Malm	Eff	Tech
high and upper middle income	1.0089	1.0068	1.0032
Low and lower middle income	1.0002	1.0082	0.9947
Average of all countries	1.0050	1.0074	0.9994

For purposes of simplification we further group our countries into two, high and upper middle income (high-income) and low and lower middle income (low-

[15] Due to the availability of capital stock data the data ends at 1990.

income). The mean Malmquist productivity index with a value slightly greater than one (1.005) indicates that for all countries in the sample on the average there has been productivity gain with 0.50% growth for each year. Between the two groups of countries, there is a productivity gain in both high-income countries (0.89% per year) and low-income countries (0.02% per year). As expected, higher income countries enjoyed high levels of productivity on average.

However, low income countries have a higher efficiency change index (0.82% per year) on average. Therefore, these countries approach the "best practice" frontier at a slightly faster rate than high-income countries which will imply convergence effect and the catch-up process.

Besides, when we compare technological change components one can observe that high-income countries have seen 0.32% growth rates per year in their innovation rates whereas low income countries deteriorate in their innovation performance by 0.53% on average.

It should be noted that a country having technical change component greater than one does not necessarily imply that it is the country that contributed to a shift in the world frontier. Although it is a necessary condition it is not sufficient. The necessary and sufficient conditions are having a technical change index greater than one and having $D_o^t(x_{t+1}, y_{t+1}) > 1$ and $D_o^{t+1}(x_{t+1}, y_{t+1}) = 1$. In almost all of the years U.S.A. is the innovator country or in the list of the innovator countries.

To sum up, these results indicate that while the main source of productivity growth for the high income countries is technological change, the main source of productivity growth for the low income countries is efficiency change. The change in the efficiency indicates the rate at which the country's approach to the "best practice" frontier. While there is overall improvement in the efficiency component with a growth rate of 0.07%, the high-income countries lay behind the samples average (0.68%). However, the low-income countries approach to the frontier slightly faster (0.82%). Therefore, one can claim that the catch-up process works faster for the low-income countries. So by the means of efficiency change there is a hope for convergence for low-income countries. On the other hand, when the technical change is considered low-income countries shows an average loss of 0.53%. They not only fall behind the world average but also the high-income countries. This result also indicates that the low-income countries can not improve themselves as much as their competitors do.

4.2 Static and Dynamic Fixed Effects Panel Data Models

In this section we will consider static and dynamic panel data models where we firstly present our estimation and methodology, next we will mention the empirical results and finally we will present the robustness checks.

4.2.1 Estimation and Methodology

In this section, we estimate the following equation with a panel data set of 48 countries where the data is averaged over 5-year intervals from 1965-1990 (1966-1970; 1971-1975; etc) in order to eliminate business cycle effects[16]:

$$Prod_{it} = \alpha_i + \beta\ Fi_{it-1} + [Con]_{it-1} + \varepsilon_{it} \qquad (1)$$

where, the dependent variable is Malmquist Productivity Change Index, Efficiency Change Index and Technical Change Index respectively. Financial development indicator is either taken to be value of **Finvar1 (**the private credit by deposit money banks and other financial institutions to GDP) or **Finvar2 (**deposit money bank assets to GDP) and denoted by Fi. Also, the intercept term α_i denote group specific constant term. Moreover, the conditioning set denoted by Cond, represents logarithm of initial income per capita, secondary school enrollment and the value of government size, inflation, openness and foreign direct investment.

Panel data set is considered to capture the additional information coming from the time dimension even though most of the growth equations are estimated with cross section analysis. Besides, the unobserved individual effect, which is in our setting country specific effect, will yield biases as it is considered as part of the error term in cross sectional studies. Considering the unit heterogeneity effects we plan to

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[16] We estimated the Malmquist index and its components for 56 countries however due to the data availability.

start with a fixed effects panel data model[17]. However, owing to the fact that the fixed effects estimator is inconsistent if an explanatory variable is correlated with the error term in some period, we search for alternative estimations.

The issue of simultaneity of some conditioning set and financial variables has been brought into attention in the previous growth estimations in the literature. A similar problem which is the endogeneity of the financial variables and some of the conditioning information set such as government expenditure share and inflation also exists for the Malmquist Productivity Change Index and its components. Macroeconomic environment jointly determine both the policy variables, trade variables and productivity change indexes. Hence special care is taken in avoiding the simultaneous equation bias that will be created by the use of explanatory variables that are correlated with the error terms.

First method of estimation is the fixed effects models estimated with the lagged variables of the explanatory variables used as an instrument for themselves. Here all explanatory variables other than the secondary school indicator and initial income are assumed to be weakly exogenous.

Another extension of the fixed effects model is employing two-step efficient GMM estimation where we again consider the explanatory variables as weakly exogenous except initial income and secondary school enrollment. Then, we

[17] We tested the presence of individual country specific effects. The data rejects the usage of common intercept, pooled OLS panel data estimator.

instrument the weakly exogenous explanatory variables with their one period lagged value. So we estimate the same equation with the same panel data averaged over 5 year intervals.

The reason behind the choice of GMM estimation over IV lies in the following: As the most of the explanatory variables are endogenous in the growth regressions, instrumental variables (IV) are used since they allow parameters to be estimated consistently. However, in the presence of heteroskedasticity the IV estimators are not only inconsistent but also inefficient (Baum and Schaffer, 2003). Although the use of heteroskedasticity consistent standard errors i.e. robust standard errors may solve the consistency problem, the efficiency problem needs to be addressed. As Baum and Schaffer (2003) point out GMM estimation brings efficiency in the presence of unknown heteroskedasticity. That is why we employ GMM estimation instead of IV.

The issue of the validity and the quality of the instruments are addressed with a series of tests. These are Hansen-Sargan Test of overidentifying restrictions, Anderson canonical correlations likelihood-ratio test and Shea's partial R-squared. Firstly, a test for validity of the instruments the Hansen-Sargan Test of overidentifying restrictions is applied. The joint null hypothesis of the test is that the instruments are valid instruments, i.e., uncorrelated with the error term. Under this null the test statistic is distributed as chi-squared with degrees of freedom equal to the number of overidentifying restrictions. A rejection of the null hypothesis implies that the instruments are not valid.

Next, in order to decide whether the instruments are relevant or not Anderson canonical correlations likelihood-ratio test is used. The null hypothesis of the test is that the matrix of reduced form coefficients has rank=K-1 where K=number of regressors, i.e., that the equation is underidentified. Under the null, the statistic is distributed as chi-squared with degrees of freedom= (L-K+1) where L=number of instruments (included+excluded). The statistic provides a measure of instrument relevance, and rejection of the null indicates that the model is identified.

Finally, in order to assess correlation of instruments and endogenous regressors F-test of joint significance of instruments or R-squared of the first stage regressions could be used. However, if there are more than one endogenous variable Shea's partial R-squared can be taken into account where a large value of R-squared with a small Shea measure indicates invalid instruments.

Many of the growth regressions address the dynamic nature of the process and include lagged dependent variable in the regression. We believe that like many dynamic growth models productivity shows time dependence. As Baltagi (2001) notes, there are two sources of persistence in this setup: the autocorrelation effect owing to the lagged dependent variable and the unit heterogeneity effects which are possibly correlated with the explanatory variables and considered as apart of error term.

In this context, we will utilize a difference GMM estimator, proposed for dynamic panel data models, introduced by Arellano and Bond (1991) in order to address the issue of omitted variables, unobserved country specific effects and simultaneity bias. In the dynamic setup, the empirical analysis is conducted on a panel data set of 48 countries for the period 1965-1990 where the variables are averaged for 5 year intervals. Notice that since our cross section dimension is large and time dimension is small, this estimator is appropriate for our data (Arellano and Bond, 1991).

Consider the model:

$$Prod_{it} = \alpha\ Prod_{it-1} + \beta\ Fi_{it} + [Cond]_{it} + \eta_{i} + \varepsilon_{it} \qquad (2)$$

where Prod is the Malmquist Productivity Change Index, Efficiency Change Index and Technical Change Index respectively. Financial development denoted by F_i is either taken to be the **Finvar1 (**the private credit by deposit money banks and other financial institutions to GDP) or **Finvar2 (**deposit money bank assets to GDP). In addition, η is an unobserved country specific effect. Moreover, the conditioning set represents the conditioning variables stated in section 3.2.3 and is denoted by Cond.

We firstly, difference the regression equation to eliminate country specific effects and then we get the model:

$$(Prod_{it} - Prod_{it-1}) = \alpha(Prod_{it-1} - Prod_{it-2}) + \beta\ (Fi_{it} - Fi_{it-1}) + [Con_{it} - Con_{it-1}] + (\varepsilon_{it} - \varepsilon_{it-1}) \qquad (3)$$

Although the problem arising from unit heterogeneity effects is solved, a new problem arises due to the correlation of an explanatory variable and error term in the differenced equation. Specifically, the new lagged dependent variable ($Prod_{it-1}$- $Prod_{it-2}$) and the new error term (ε_{it} -ε_{it-1}) will be correlated. Arellano and Bond (1991) propose to instrument the explanatory variables in the differenced equation with their lagged level values.

Therefore, following Arellano and Bond (1991) we utilize our dynamic panel data estimations with the difference estimator. The consistency of the results is investigated through two tests proposed by Arellano and Bond. A Sargan test of overidentifying restrictions and a second order autocorrelation test. The null hypothesis of the Sargan test is that the instruments are not correlated with the residuals. The null hypothesis of the serial correlation test is that the errors in the first difference regression exhibit no second-order serial correlation.

4.2.2 Empirical Results

Tables 3, 4 and 5 present the fixed effects OLS results from the estimation of the effects of financial development on productivity where the dependent variable is Malmquist Productivity Change Index, Efficiency Change Index and Technical Change Index respectively. The results of fixed effects GMM estimations are presented in Tables 6, 7 and 8. Finally, Tables 9, 10 and 11 represent the output of dynamic panel difference GMM estimation results. The results of Table 3 to Table 11 are summarized in Table 12.

Table 12. Summary of Static and Dynamic Productivity Change Index Equations with Lagged Values as Instruments

Table 12.1	(1)	(2)	(3)	(4)
Malm	Fixed Effects Lagged	Fixed Effects GMM	GMM Difference (with initial)	GMM Difference (without initial)
Iinitial	-0,1095	-0,1283	-0,1442	...
	[0.0245]***	[0.0279]***	[0.0384]***	...
Finvar1	0,0977	0,1559	0,2019	0,0735
	[0.0237]***	[0.0563]***	[0.0708]***	[0.0405]*

Table 12.2	(1)	(2)	(3)	(4)
Eff	Fixed Effects Lagged	Fixed Effects GMM	GMM Difference (with initial)	GMM Difference (without initial)
Iinitial	-0,0758	-0,0822	-0,1783	...
	[0.0259]***	[0.0315]***	[0.0454]***	...
Finvar1	0,0369	0,066	0,2835	0,1175
	[0.0289]	[0.0620]	[0.0980]***	[0.0639]*

Table 12.3	(1)	(2)	(3)	(4)
Tech	Fixed Effects Lagged	Fixed Effects GMM	GMM Difference (with initial)	GMM Difference (without initial)
Iinitial	-0,0339	-0,0466	-0,0133	...
	[0.0157]**	[0.0201]**	[0.0305]	...
Finvar1	0,0595	0,09	-0,071	-0,0811
	[0.0186]***	[0.0475]*	[0.0627]	[0.0492]*

Note: In the summary table 12.1 the dependent variable is Malmquist productivity change index. In the summary table 12.2 the dependent variable is Efficiency change index. In the summary table 12.3 the dependent variable is technical change index.The conditioning variables are Iinitial: logarithm of initial income per capita, secondary school enrollment rate,government consumption as a share of GDP, value of inflation which is the log difference of GDP deflator between two consecutive years, and value of foreign direct investment net inflows as a share of GDP. Finvar1 is the value of the private credit by deposit money banks and other financial institutions as a share of GDP. White's heteroskedasticity consistent (robust) standard errors are provided in brackets.*significant at 10%; ** significant at 5%; *** significant at 1%

All of the results are summarized in Table 12 where in the summary table 12.1 the dependent variable is Malmquist productivity change index. Columns (1) and (2) correspond to the static fixed effects panel data models whereas Column (3) and (4) corresponds to the dynamic panel data model. In fact, Column (1) corresponds to the fixed effects lagged explanatory variables estimation and Column

(2) corresponds to the fixed effects two step efficient GMM estimation. Finally, Column (3) corresponds to the difference dynamic panel GMM estimation with initial income and Column (4) corresponds to the difference dynamic panel GMM estimation without initial income. In all these regressions a specific model is chosen for representation purposes. We control for initial income, secondary school enrollment, government size, inflation and foreign direct investment net inflows. However, as indicated through Table 3 to Table 11, the results are robust to the controlling variable set.

Overall results of these estimations which include the full conditioning set of variables such as initial income secondary school enrollment and of the policy and trade variables indicate that financial development has a positive significant effect on the productivity change measured by Malmquist Productivity Change Index. In fact, the results of Table 12.1 suggest that financial development enters significantly with positive sign in all of models. Therefore, there is evidence that the exogenous component of financial intermediary development explain productivity differences when productivity is measured as Malmquist Productivity Index.

However, the effect of financial development on components of Malmquist Productivity Index is less clear. The results of the estimations for the productivity changes and its components for all countries are reported in Tables 12.2 and 12.3.

On the one hand, in the summary Table 12.2 the dependent variable is Efficiency change index. In a static panel data setting, columns (1) and (2), financial development does not foster productivity. However, if we consider the time dependence financial development consistently spurs efficiency change. In other words, only in the dynamic set up financial development have positive significant impact on efficiency change.

On the other hand in the summary table 12.3, the dependent variable is technical change index. Firstly, consider the dynamic model. Here a surprising result appears that in the dynamic specification financial development tend to decrease productivity change, yet this result is not robust to conditioning information sets. If the remaining conditioning sets are considered the coefficients of financial development indicator is insignificant. However, if static models are considered financial development enhance technical change.

An important literature in explaining differences of growth across countries addresses the question of convergence. The low-income countries grow faster to catch-up with the high-income countries. It is also possible to look at the impact of the starting position of these countries in the determination of the productivity changes. With this hypothesis in mind, in addition to the relationship between financial development and productivity the role of the initial per capita income level is examined.

In terms of Malmquist Productivity Change Index, there is evidence for a robust convergence effect. Besides, efficiency change negatively and significantly depend on the initial income level of countries. Note that the results are robust to the conditioning sets. This indicates that the countries with lower income per capita have larger efficiency change index, i.e. these countries experience a faster catch-up. For the technical change component, in the dynamic setting the coefficients of the initial income are insignificant. However, the static model suggests that changes in technology depend on the initial income and initial income enters to the regression with a negative sign.

4.2.3 Robustness

We experiment the results by altering the financial indicator. We use another financial development indicator; Finvar2 i.e. deposits money bank assets to GDP which measures the size of financial system. The results are presented in Table 23. This additional indicator also suggests the same conclusions.

4.3 Legal Origin and Productivity

In this section, we instrument financial development by legal origin where we employ cross sectional GMM estimator, panel data pooled GMM estimator and GMM dynamic panel estimator. After explaining the methodology, we will present the empirical results. Finally, we will focus on robustness checks.

4.3.1 Methodology and Estimation

Another method of addressing the simultaneity bias in the estimating equations is to use an instrumental variable which is not correlated with the dependent variable, i.e. growth indicator, but highly correlated with the independent variable which leads to endogeneity, i.e. financial development indicator. Following La Porta et al. (1998), many authors used legal origin as an instrument for financial development. Legal origin is an appropriate instrument as it is not correlated with economic growth due to the fact that countries obtained their legal origin through colonization or occupation. On the other hand, legal origin is an appropriate instrument as it is correlated with financial development owing to the evidence that country's legal origin affects the development of creditor rights and the enforcement of contracts in that country which is linked with financial environment or investment climate (Levine, 2000).

We use cross sectional data for 44 countries are averaged over 1965-1990. Legal origin is used as an instrument for financial development indicator and the following equation is estimated:

$$Prod_i = \alpha + \beta\ Fi_i + [Con]_i + \varepsilon_i \qquad (4)$$

where the dependent variable is Malmquist Productivity Change Index, Efficiency Change Index and Technical Change Index respectively. Financial development is either taken to be the **Finvar1 (**the private credit by deposit money banks and other financial institutions divided by GDP) or **Finvar2 (**deposit money bank assets to

GDP). Moreover, the conditioning set represents the conditioning variables stated in section 3.2.3. To evaluate the hypothesis that financial development explains productivity changes and the sources of productivity changes the financial development indicators are instrumented by legal origin variables where a two step efficient GMM estimation technique is used. However, we believe that in this case we could not address the issue of possible endogeneity arising from the remaining right hand side variables.

In addition, although the data proves the presence of unit effects as legal origin variable has no time dimension, we estimate the model by common intercept panel data estimator. In order to account for endogeneity of RHS variables we employ GMM two step estimator where legal origin and lagged values of the regressors are taken to be the appropriate instruments in a panel data framework with the following equation:

$$Prod_{it} = \alpha + \beta\, Fi_{it} + [Con]_{it} + \varepsilon_{it} \qquad (5)$$

where, we estimate the equation with the same panel data (48 countries from period 1965-1990) averaged over 5 year intervals.

Finally, we expand our dynamic panel data model by additional legal origin instruments. We estimate the same dynamic model:

$$(Prod_{it} - Prod_{it-1}) = \alpha\, (Prod_{it-1} - Prod_{it-2}) + \beta\, (Fi_{it} - Fi_{it-1}) + [Con_{it} - Con_{it-1}] + (\varepsilon_{it} - \varepsilon_{it-1}) \qquad (6)$$

4.3.2 Empirical Results

Table 13, 14 and 15 present the pure cross country effects GMM results from the estimations of the effects of financial development on productivity where legal origin is an instrumental variable. The results of pooled GMM estimations where legal origin is an instrumental variable are presented in Tables 16, 17 and 18. All of the three models pass the specification tests stated above. Finally, Tables 19, 20 and 21 represent the output of dynamic panel difference GMM estimation with additional IV results. In all of the tables the dependent variables are Malmquist productivity Index, Efficiency Change Index and Technical Change respectively. The results of Table 13 to Table 21 are summarized in Table 22.

Table 22. Summary of Productivity Change Index Equations with Legal Origin Instrument

Table 22.1	(1)	(2)	(3)	(4)
Malm	**Cross Section GMM**	**Pooled GMM**	**GMM Difference (with initial, with legal origin)**	**GMM Difference (without initial, with legal origin)**
Iinitial	-0,0009	-0,0005	-0,1532	...
	[0.0013]	[0.0024]	[0.0281]***	...
Finvar1	0,0077	0,0166	0,186	0,0756
	[0.0160]	[0.0081]**	[0.0442]***	[0.0327]**

Table 22.2	(1)	(2)	(3)	(4)
Eff	**Cross Section GMM**	**Pooled GMM**	**GMM Difference (with initial, with legal origin)**	**GMM Difference (without initial, with legal origin)**
Iinitial	-0,0031	-0,0045	-0,1444	...
	[0.0014]**	[0.0024]*	[0.0420]***	...
Finvar1	0,0008	0,0103	0,1622	0,0492
	[0.0146]	[0.0102]	[0.0537]***	[0.0386]

Table 22.3	(1)	(2)	(3)	(4)
Tech	**Cross Section GMM**	**Pooled GMM**	**GMM Difference (with initial, with legal origin)**	**GMM Difference (without initial, with legal origin)**
Iinitial	0,002	0,0036	-0,04	...
	[0.0009]**	[0.0019]*	[0.0263]	...
Finvar1	0,003	0,0052	0,0318	0,0004
	[0.0071]	[0.0085]	[0.0359]	[0.0251]

Note: In the summary Table 22.1 the dependent variable is Malmquist productivity change index. In the summary Table 22.2 the dependent variable is Efficiency change index. In the summary Table 22.3 the dependent variable is technical change index.The conditioning variables are Iinitial: logarithm of initial income per capita, secondary school enrollment rate,value of government consumption as ashare of GDP, value of inflation which is the log difference of GDP deflator between two consecutive years, and value of foreign direct investment net inflows as a share of GDP. Only in Table 22.1 with pooled GMM estimation since above specification is invalid,instead of that specification logarithm of initial income per capita, secondary school enrollment rate and value of foreign direct investment net inflows as a share of GDP are used as conditioning variables.Finvar1 is the value of the private credit by deposit money banks and other financial institutions as a share of GDP. White's heteroskedasticity consistent (robust) standard errors are provided in brackets.*significant at 10%; ** significant at 5%; *** significant at 1%

All of the results are summarized in Table 22 where in the summary table 22.1 the dependent variable is Malmquist productivity change index. Column (1) corresponds to the cross sectional GMM estimation with legal origin as instrumental variable and Column (2) corresponds to the pooled efficient GMM estimation with legal origin and lagged exogenous variables as instrumental variables. Finally, Column (3) corresponds to the difference dynamic panel GMM estimation with initial income and Column (4) corresponds to the difference dynamic panel GMM estimation without initial income.

In all these regressions a specific model is chosen for representation purposes where we control for initial income, secondary school enrollment, government size, inflation and foreign direct investment net inflows. However, as indicated through Table 13 to Table 21, the results are robust to the controlling variable set.

The results of the static and dynamic panel data models indicate a robust positive correlation but we fail to see a similar effect in the cross section analysis. The estimations conducted for the components of the productivity on the other hand clearly indicate that there is no evidence that financial development enhances efficiency or technological change. However, only when the dynamic model is considered financial development brings about efficiency change but this significance is not robust to addition of initial income as an explanatory variable.

The estimation of the determinants of components of productivity, efficiency change index and technological change index reveals details of the change in productivity. For instance, efficiency change index, negatively and significantly depend on the initial income level of countries in all of the models. This reflects the fact that countries with lower starting points move faster towards the frontier. For the technical change component unlike the efficiency index there is a robust positive correlation for the first two specifications. As this two effects work in opposite direction the effect of initial income on overall Malmquist index is found to be insignificant. However, when dynamic nature is incorporated the catching up process is observed as the efficiency change components are affected by convergence. Observe that, now convergence process is present in Malmquist Productivity Change Index too.

4.3.3 Robustness

We experiment the results by altering the financial indicator. We use another financial development indicator; Finvar2 i.e. deposits money bank assets to GDP which measures the size of financial system. The results are presented in Table 24. This additional indicator also suggests the same conclusions.

Previous conclusions do not change with this alternative financial development indicator. Hence, it is possible to conclude the previously mentioned effects of financial variables are robust to alternative definition of financial development.

CHAPTER 5

CONCLUSION

This paper examined the link between financial development and productivity. Apart from most of the literature on this topic, the growth measures are replaced with a specific productivity index, Malmquist productivity change index and its components of efficiency change and technological change index.

Firstly, Malmquist productivity index and its components are computed for a group of industrial and developing countries for the period 1965-1990 using GAMS. The mean Malmquist Index has with a value slightly greater than one (1.0050) indicates that for all countries in the sample on the average there has been productivity with 0.5% growth each year. Between the two groups of countries, there has been a productivity gain in both high income countries (0.89% per year) and low income countries (0.02% per year). As expected higher income countries enjoyed higher levels of productivity change. However, while the main source of productivity growth for the high income countries is technological change, the main source of productivity growth for the low income countries is efficiency change. So by the means of efficiency change there is a hope for convergence for low-income countries. On the other hand, in terms of technical change high income countries perform much better than lower counterparts.

Next, the relationship between financial development and Malmquist productivity Index and its Component Measures are investigated. We divide our methodology into two parts. Firstly, in addition to the fixed effects Ordinary Least Squares (OLS) estimators, the efficient Generalized Method of Moments (GMM) fixed effects estimators and GMM dynamic panel estimators is utilized to expose the relationship between the productivity and efficiency measures and the indicators of financial development while we control for simultaneity bias and unobserved country specific effects. Next, we utilize three econometric techniques where we instrument financial development by legal origin, a cross sectional GMM estimator, a common intercept GMM estimator and the difference estimator proposed by Arellano and Bond (1981). The results indicate that there is a positive link between Malmquist Productivity Index and financial development no matter which model is considered. However, when we consider the component measures, the results seem to be different between two methodologies. Starting with efficiency change, if we consider the static nature financial development does not seem to alter efficiency change. However, when dynamic nature is questioned financial development is positively associated with economic growth. On the other hand, for technical change component if we consider the dynamic nature financial development has almost no effect on technical change. Although the pooled GMM estimation and cross sectional estimations imply that technological change is not affected, we believe that these two specifications are somehow biased since in the former model fixed effects can not be captured and the latter ignores the endogeneity of the other variables. However, for the static fixed effects models there is a robust positive correlation. In conclusion, financial development triggers productivity but while for the static models this effect is stimulated by technical change for the dynamic ones it is supported by efficiency change.

Finally, there is an important literature regarding the convergence issue as it is considered to explain cross country differentials. Our results suggest that except the cross sectional and pooled GMM models there is robust evidence for catching up effects for Malmquist productivity index. We believe that the channel that this process works through is efficiency change as in all specification initial income per capita and efficiency change is negatively linked. However, for the technical change component the results differ as follows: For the dynamic models there is no relationship between the starting point of the countries and the technical change component whereas the cross sectional and pooled GMM models suggest a positive relationship. Besides, the remaining static models suggest the convergence effect.

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APPENDICES

APPENDIX A

More on Productivity Measures

In productivity measurement area, the idea of 'assessing performance in a relative way' led the economists to construct best practice frontiers and then build measures of efficiency. In building such measures one can pursue with an input or an output orientation. In this section, we will try to explain both types of orientations following Fare and Grosskopf[18].

To begin with, we will give some notation and assumptions regarding the economy. Then, we will define 'Input Requirement Set' and 'Output Possibility Set' both of which can be used to construct best practice frontiers.

Suppose there is an economy where there are K numbers of Decision Making Units (DMU), which use N inputs, denoted by the vector $x = (x_1, x_2, \ldots, x_N)$ with $\forall \quad n \in \{1, \ldots, N\} \quad x_n \geq 0$, in order to produce M outputs, denoted by the vector

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[18] In fact, in order to give a better understanding to the reader the thesis consists of this appendix section, which is a brief summary of the 'Reference Guide Manual to Onfront', written by Fare and Grosskopf.

$y = (y_1, y_2, ..., y_M)$ with $\forall \quad m \in \{1,...,M\} \quad y_m \geq 0$. Now, if we take k[th] decision making unit we have $x^k = (x_{k1},...,x_{kN})$ and $y^k = (y_{k1},...,y_{kM})$.

An Input Requirement Set L(y) denotes all of the possible input combinations in order to produce output vector y. Under the constant returns to scale (CRS) and strong disposability of inputs assumptions, it can be written as,

$$L(y) = \Big\{ (x_1, x_2, ..., x_N) : \quad \sum_{k=1}^{K} z_k y_{km} \geq y_m, m = 1,...,M, \quad \sum_{k=1}^{K} z_k x_{km} \leq x_n, n = 1,...,N, \quad z_k \geq 0, k = 1,...,K \Big\}.$$

An Output Possibility Set P(x) denotes all of the possible output combinations that can be produced from input vector x. Under the constant returns to scale[19] and strong disposability of inputs assumptions, it can be written as,

[19] Note that, both in the definition of input feasibility set and the output possibility set, the assumption of constant returns to scale could be relaxed by simply changing the restrictions on the intensity variables z_k. For instance, in order to define non-increasing returns to scale putting $\sum_{k=1}^{K} z_k \leq 1, z_k \geq 0, k = 1,...,K$ will be enough.

In addition, so as to define variable returns to scale inserting $\sum_{k=1}^{K} z_k = 1, z_k \geq 0, k = 1,...,K$ will suffice.

$$P(x) = \left\{ (y_1, y_2, ..., y_M) : \sum_{k=1}^{K} z_k y_{km} \geq y_m, m = 1,...,M, \sum_{k=1}^{K} z_k x_{km} \leq x_n, n = 1,...,N, z_k \geq 0, k = 1,...,K \right\}.$$

One can observe that the 'lower' boundary of Input Requirement Set forms the best practice frontier; whereas the 'upper' contour set of Output Possibility Set forms it.

After, mentioning how the reference technology could be constructed we will put emphasis on explaining the efficiency measures indicating how a DMU is doing relative to this reference technology. Farrell (1957) defined an economic efficiency measure which is comprised of a technical efficiency and allocative efficiency component. In his technical efficiency measure, a firm is evaluated with respect to its ability to produce the maximum amount of output from a given set of inputs. On the other hand, he defined allocative efficiency to be the DMU's ability to use the inputs in optimal proportions given their set of prices. However, there won't be any stress on the efficiency measures which uses price data in this appendix. Not surprisingly, with in this context an input or output orientation could be followed.

Appendix A1: Input-Oriented Technical Efficiency Measures

Input-oriented technical efficiency evaluates the performance of a DMU in producing a particular amount of output with using fewest possible resources.

As Coelli (1996: 6) says: input-oriented technical efficiency measure addresses the question: "By how much can input quantities be proportionally reduced without changing the output quantities produced?". In other words, input-oriented technical efficiency is the ratio of the minimum amount of feasible input usage to the amount of current input usage.

As mentioned above, this measure is called as "Farrell Input-Saving Measure of Technical Efficiency" and it is denoted by $F_i(y,x) = \min\{\lambda : \lambda x \in L(y)\}$[20]. This measure is a scaling down factor for the DMU's inputs. In fact, we have $0 < F_i(y,x) \leq 1$. Therefore, a DMU, say k, is considered to be technically input efficient if $F_i(y^k, x^k) = 1$ and inefficient if $F_i(y^k, x^k) < 1$ [21]. Therefore, if $F_i(y^k, x^k) = 1$ then the firm is operating on the frontier. Moreover, if the firm is

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[20] 'i' letter in the formula denotes input orientation. 'o' will be used for output orientation in the following section. In addition, CRS and strong disposability is assumed.

[21] If your firm is efficient than obviously the minimum of the $\lambda's$ will be 1. Hence, there will be no need for such a scaling factor for your inputs since the only possible way to produce that fixed amount of output will be using exactly that amount of inputs. In other words, it means you can not produce output y^k without using at least x^k. Putting differently, if the optimal $\lambda's$ smaller than 1 you can produce the same quantity of output with using less input.

operating inefficiently i.e. $F_i(y^k, x^k) < 1$, then the firm k should reduce the consumption of its inputs by an amount which is equal to $1 - F_i(y^k, x^k)$ without reducing the output.

Appendix A2: Output-Oriented Technical Efficiency Measures

Output-oriented technical efficiency evaluates the performance of a DMU in producing maximum amount of output from a set of given amount of inputs. Hence, in contrast to the input-saving measure, the evaluation will be done on DMU's ability in increasing the amount output not decreasing the amount of resources.

As Coelli (1996: 6) says: One could alternatively ask the question: "By how much can output quantities be proportionally expanded without altering the input quantities used?" In other words, output-oriented technical efficiency is the ratio of the minimum amount of maximal potential output to the amount of current output production taking the quantities of inputs as given.

As mentioned above, this measure is called as "Farrell Output-Oriented Measure of Technical Efficiency" and it is denoted by $F_o(x, y) = \max\{\theta : \theta y \in P(x)\}$. This measure is an expanding factor for the DMU's output. In fact, we have $F_o(x, y) \geq 1$. Therefore, a DMU, say k, is considered to be technically output efficient if $F_o(x^k, y^k) = 1$ and inefficient if $F_o(x^k, y^k) > 1$ [22]. Hence, if $F_o(x^k, y^k) = 1$ then the firm is operating on the frontier. Furthermore, if the firm is operating inefficiently i.e. $F_o(x^k, y^k) > 1$, then the firm k could expand the production of its output by an amount which is equal to $F_o(x^k, y^k) - 1$ with using exactly the same amount of inputs.

A last word on input and output oriented measures could be, that they are the reciprocals of each other under CRS and strong disposability assumptions, i.e.:

$$F_o(x, y) = (F_i(y, x))^{-1}$$

Input distance function $D_i(y, x)$ for an input requirement set L(y), can be defined as: $D_i(y, x) = 1 / F_i(y, x)$,

where $F_i(y, x)$ denotes "Farrell Input-Saving Measure of Technical Efficiency" which is equal to $F_i(y, x) = \min\{\lambda : \lambda x \in L(y)\}$

[22] If your firm is efficient than obviously the maximum of the $\lambda's$ will be 1. Hence, there will be no expanding factor for the firm's output since it is producing the maximum amount of output with its fixed amount of inputs. In other words, according to the firm, among $\theta y's$ that are feasible with given inputs, it can not produce a higher amount of output. Putting differently, if the optimal $\theta's$ greater than 1 then there is room for producing more output with given inputs.

Likewise, Output distance function $D_o(x, y)$ for an output possibility set P(x), can be defined as: $D_o(x, y) = 1/F_o(x, y)$,

where $F_o(x, y)$ denotes "Farrell Output-Oriented Measure of Technical Efficiency" which is equal to $F_o(x, y) = \max\{\theta : \theta y \in P(x)\}$.

APPENDIX B

We constructed a panel dataset of 56 OECD and non-OECD countries grouped into four categories according to World Bank's income group definitions, which are high income countries (AUSTRALIA, AUSTRIA, BELGIUM, CANADA, DENMARK, FINLAND, FRANCE, GERMANY, GREECE, HONG KONG, ICELAND, IRELAND, ISRAEL, ITALY, JAPAN, KOREA REP., LUXEMBOURG, NETHERLANDS, NEW ZEALAND, NORWAY, PORTUGAL, SPAIN, SWEDEN, SWITZERLAND, U.K., U.S.A.), upper middle income countries (ARGENTINA, CHILE, MAURITIUS, MEXICO, VENEZUELA), lower middle income countries (BOLIVIA, COLOMBIA, DOMINICAN, ECUADOR, GUATEMALA, IRAN, JAMAICA, MOROCCO, PANAMA, PARAGUAY, PERU, PHILIPPINES, SRI LANKA, SYRIA, THAILAND, TURKEY) and low income countries (HONDURAS, INDIA, KENYA, MADAGASCAR, MALAWI, NIGERIA, SIERRA LEONE, ZAMBIA, ZIMBABWE).

APPENDIX C

Table 1: Average Malmquist Productivity Change Index and its Components across Countries (1965-1990)

Income	Country	Malm	Eff	Tech
high income	AUSTRALIA	1,014567	1,00343	1,011365
	AUSTRIA	0,9998415	0,9978347	1,002493
	BELGIUM	1,012708	1,009208	1,003993
	CANADA	1,014326	1,006175	1,008279
	DENMARK	0,9974679	0,9983737	0,9994016
	FINLAND	1,020662	1,01547	1,005781
	FRANCE	1,00806	1,003518	1,005017
	GERMANY,WEST	1,012256	1,007696	1,004834
	GREECE	1,011595	1,009074	1,003077
	HONG KONG	1,04037	1,03905	1,00391
	ICELAND	1,00173	1,002192	1,00129
	IRELAND	1,014872	1,012763	1,003197
	ISRAEL	1,014996	1,016385	0,9990938
	ITALY	1,0113	1,013359	0,9982691
	JAPAN	1,013144	1,008064	1,005509
	KOREA, REP.	1,010867	1,030573	0,9853439
	LUXEMBOURG	1,024143	1,011918	1,012328
	NETHERLANDS	1,002479	1,003345	0,999579
	NEW ZEALAND	0,9974409	0,9939057	1,004108
	NORWAY	1,021522	1,00981	1,01212
	PORTUGAL	1,019728	1,019701	1,003712
	SPAIN	1,00393	1,000578	1,003898
	SWEDEN	1,00181	0,9989194	1,003493
	SWITZERLAND	1,013499	1,001521	1,012431
	U.K.	1,003261	1,002601	1,001504
	U.S.A.	1,003281	1	1,003281
upper middle income	ARGENTI.	0,993427	0,9907121	1,005514
	CHILE	0,9964104	1,001371	1,000085
	MAURITIUS	1,007482	1,01789	0,9928899
	MEXICO	1,006362	1,001107	1,006762
	VENEZUELA	0,9821637	0,9845476	0,9978737

Table 1 (Cont'd)

lower middle income	BOLIVIA	0,9881224	1,008151	0,9836559
	COLOMBIA	1,011203	1,009016	1,004529
	DOMINICAN	0,9860654	0,9992315	0,9887612
	ECUADOR	1,010739	1,006371	1,00643
	GUATEMALA	0,9966899	1,009871	0,989418
	IRAN	0,9692886	0,9745502	0,9967502
	JAMAICA	1,003271	1,010698	0,9969308
	MOROCCO	1,010659	1,018978	0,9944152
	PA.MA	1,000038	0,9959764	1,005407
	PARAGUAY	0,9966722	1	0,9966722
	PERU	0,991935	0,9923486	1,001958
	PHILIPPINES	1,005837	1,020391	0,9888768
	SRI LANKA	1,008239	1,014548	0,9993997
	SYRIA	1,027464	1,026749	1,002557
	THAILAND	1,010567	1,019998	0,9934717
	TURKEY	1,001141	1,019741	0,9850804
low income	HONDURAS	0,9963134	1,01337	0,9867164
	INDIA	1,010715	1,013449	1,000107
	KENYA	1,015571	1,018262	1,000779
	MADAGASCAR	0,9818431	0,9897436	0,9952289
	MALAWI	0,9916028	1,009348	0,9848743
	NIGERIA	1,015513	1,011328	1,005845
	SIERRA LEONE	0,970322	1	0,970322
	ZAMBIA	0,9893507	1,000835	0,9901529
	ZIMBABWE	1,016625	1,02254	0,9988422

Source: World Bank Income Group Classification

Table 2: Average Malmquist Productivity Change Index and its Components (1965-1990)

Income	Malm	Eff	Tech
high and upper middle income	1.0089	1.0068	1.0032
low and lower middle income	1.0002	1.0082	0.9947
Avarege of all countries	1.0050	1.0074	0.9994

Table 3: Fixed Effects OLS Regressions on Malmquist Productivity Change Index

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
sec	0,0066	0,0062	0,0054	0,005	0,0118	0,0034	0,0097
	[0.0053]	[0.0056]	[0.0053]	[0.0056]	[0.0070]*	[0.0058]	[0.0073]
linitial	-0,0862	-0,0865	-0,0872	-0,0929	-0,1102	-0,0952	-0,1095
	[0.0221]***	[0.0223]***	[0.0223]***	[0.0234]***	[0.0244]***	[0.0237]***	[0.0245]***
Finvar1	0,0871	0,0868	0,0891	0,0831	0,0942	0,0848	0,0977
	[0.0202]***	[0.0203]***	[0.0196]***	[0.0206]***	[0.0248]***	[0.0198]***	[0.0237]***
cg	...	0,0002	...	...	...	-0,0001	-0,0001
	...	[0.0013]	...	...	...	[0.0012]	[0.0012]
inf	...	...	0,0143	...	...	0,0162	0,013
	...	...	[0.0088]	...	...	[0.0090]*	[0.0094]
open	...	...	...	0,0003	...	0,0004	...
	...	...	...	[0.0003]	...	[0.0003]	...
fdigdp	...	...	...	...	0,0019	...	0,0015
	...	...	...	...	[0.0013]	...	[0.0014]
Observations	183	183	181	183	165	181	164
Number of country	48	48	48	48	48	48	48
R-squared	0,24	0,24	0,26	0,25	0,32	0,28	0,33

Note: The dependent variable is Malmquist Productivity Change Index. The regressions are fixed effects panel regressions with averaged data over 5-year periods. linitial is the logarithm of initial income per capita and sec is the secondary school enrollment. Cg denotes the value of government size which is government expenditure as a share of GDP. inf is the value of inflation which is the log difference of GDP deflator between two consecutive years. open denotes the value of openness to trade which is measured as the sum of exports plus imports as a share of GDP. fdigdp is the value of foreign direct investment net inflows as a share of GDP. Finvar1 is the value of the private credit by deposit money banks and other financial institutions as a share of GDP. Lagged values of the explanatory variables are used instruments. White's heteroskedasticity consistent (robust) standard errors are provided in brackets.*significant at 10%; ** significant at 5%; *** significant at 1%

Table 4: Fixed Effects OLS Regressions on Efficiency Change Index

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
sec	-0,009	-0,0102	-0,0096	-0,0125	-0,0083	-0,0143	-0,0097
	[0.0061]	[0.0062]	[0.0059]	[0.0064]*	[0.0091]	[0.0066]**	[0.0100]
linitial	-0,0683	-0,0694	-0,0671	-0,0838	-0,0769	-0,0834	-0,0758
	[0.0211]***	[0.0219]***	[0.0212]***	[0.0240]***	[0.0257]***	[0.0252]***	[0.0259]***
Finvar1	0,0469	0,0458	0,0471	0,0375	0,0381	0,0379	0,0369
	[0.0243]*	[0.0245]*	[0.0235]**	[0.0247]	[0.0301]	[0.0239]	[0.0289]
cg	...	0,0008	...	...	...	0,0005	0,0005
	...	[0.0016]	...	...	...	[0.0016]	[0.0018]
inf	...	...	0,0048	...	...	0,0077	0,0023
	...	...	[0.0209]	...	...	[0.0195]	[0.0216]
open	...	...	...	0,0008	...	0,0008	...
	...	...	...	[0.0004]**	...	[0.0004]**	...
fdigdp	...	...	...	...	0,001	...	0,001
	...	...	...	...	[0.0018]	...	[0.0019]
Observations	183	183	181	183	165	181	164
Number of country	48	48	48	48	48	48	48
R-squared	0,16	0,16	0,16	0,19	0,16	0,19	0,16

Note: The dependent variable is Efficiency change index. The regressions are fixed effects panel regressions with averaged data over 5-year periods. linitial is the logarithm of initial income per capita and sec is the secondary school enrollment.Cg denotes the value of government size which is government expenditure as a share of GDP. inf is the value of inflation which is the log difference of GDP deflator between two consecutive years. open denotes the value of openness to trade which is measured as the sum of exports plus imports as a share of GDP. fdigdp is the value of foreign direct investment net inflows as a share of GDP. Finvar1 is the value of the private credit by deposit money banks and other financial institutions as a share of GDP. Lagged values of the explanatory variables are used as instruments. White's heteroskedasticity consistent (robust) standard errors are provided in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%

Table 5: Fixed Effects OLS Regressions on Technical Change Index

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
sec	0,0143	0,0149	0,0135	0,0164	0,0182	0,0162	0,0173
	[0.0050]***	[0.0050]***	[0.0048]***	[0.0053]***	[0.0068]***	[0.0052]***	[0.0068]**
linitial	-0,0199	-0,0193	-0,0218	-0,0107	-0,0338	-0,0133	-0,0339
	[0.0150]	[0.0157]	[0.0149]	[0.0167]	[0.0158]**	[0.0173]	[0.0157]**
Finvar1	0,0405	0,041	0,0423	0,046	0,0548	0,0472	0,0595
	[0.0154]***	[0.0154]***	[0.0161]***	[0.0165]***	[0.0180]***	[0.0168]***	[0.0186]***
cg	...	-0,0004	...	...	...	-0,0004	-0,0005
	...	[0.0011]	...	...	...	[0.0012]	[0.0012]
inf	...	...	0,0106	...	...	0,0094	0,0117
	...	...	[0.0133]	...	...	[0.0122]	[0.0131]
open	...	...	...	-0,0005	...	-0,0004	...
	...	...	...	[0.0003]	...	[0.0003]	...
fdigdp	...	...	...	...	0,0008	...	0,0004
	...	...	...	...	[0.0017]	...	[0.0017]
Observations	183	183	181	183	165	181	164
Number of country	48	48	48	48	48	48	48
R-squared	0,11	0,11	0,12	0,13	0,12	0,14	0,14

Note: The dependent variable is Technical Change Index. The regressions are fixed effects panel regressions with averaged data over 5-year periods. linitial is the logarithm of initial income per capita and sec is the secondary school enrollment. Cg denotes the value of government size which is government expenditure as a share of GDP. inf is the value of inflation which is the log difference of GDP deflator between two consecutive years. open denotes the value of openness to trade which is measured as the sum of exports plus imports as a share of GDP. fdigdp is the value of foreign direct investment net inflows as a share of GDP. Finvar1 is the value of the private credit by deposit money banks and other financial institutions as a share of GDP. White's heteroskedasticity consistent (robust) standard errors are provided in brackets. Lagged values of the explanatory variables are used as instruments. * significant at 10%; ** significant at 5%; *** significant at 1%

Table 6: Fixed Effects GMM Estimations on Malmquist Productivity Change Index

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
sec	0,0006	-0,0003	-0,0065	-0,0005	0,0126	-0,0047	0,0102
	[0.0079]	[0.0088]	[0.0117]	[0.0081]	[0.0073]*	[0.0099]	[0.0084]
linitial	-0,1038	-0,1061	-0,1026	-0,1055	-0,1275	-0,0995	-0,1283
	[0.0262]***	[0.0278]***	[0.0283]***	[0.0257]***	[0.0289]***	[0.0263]***	[0.0279]***
Finvar1	0,1612	0,1673	0,1935	0,1558	0,1432	0,1624	0,1559
	[0.0493]***	[0.0554]***	[0.0699]***	[0.0514]***	[0.0549]***	[0.0624]***	[0.0563]***
cg	...	0,0013	...	...	...	-0,003	-0,0041
	...	[0.0046]	...	...	...	[0.0050]	[0.0038]
inf	...	...	0,08	...	...	0,0623	0,0346
	...	...	[0.1079]	...	...	[0.0695]	[0.0472]
open	...	...	...	0,0004	...	0,0006	...
	...	...	...	[0.0008]	...	[0.0008]	...
fdigdp	...	...	...	...	0,0065	...	0,0011
	...	...	...	...	[0.0051]	...	[0.0062]
Observations	182	182	179	182	163	179	161
Number of country	47	47	46	47	46	46	45
Shea Partial R2	0,2275	0,2279	0,2267	0,2029	0,2062	0,1605	0,2077
Identification/IV Relevance Test (p-value)	0,0000	0,0003	0,0326	0,0000	0,0000	0,0108	0,0084
Hansen J Stat. (p- value)	equation exactly identified	equation exactly identified	equation exactly identified	equation exactly identified	equation exactly identified	equation exactly identified	equation exactly identified

Note: The dependent variable is Malmquist Productivity Change Index. The regressions are panel regressions with averaged data over 5-year periods. linitial is the logarithm of initial income per capita and sec is the secondary school enrollment. Cg denotes the value of government size which is government expenditure as a share of GDP. inf is the value of inflation which is the log difference of GDP deflator between two consecutive years. open denotes the value of openness to trade which is measured as the sum of exports plus imports as a share of GDP. fdigdp is the value of foreign direct investment net inflows as a share of GDP. Finvar1 is the value of the private credit by deposit money banks and other financial institutions as a share of GDP. Efficient GMM estimation is conducted where lagged values of weakly exogenous variables are used as instruments.

The null hypothesis of the Hansen-Sargan J test is that the instruments are not correlated with the error term by means of overidentifying restrictions. Since the number of intruments exactly equal to the number of explanatory variables the system is identified. The null hypothesis of the Anderson canonical LR test is that model is not identified, instruments are not relevant. White's heteroskedasticity consistent (robust) standard errors are provided in brackets.* significant at 10%; ** significant at 5%; *** significant at 1%

Table 7: Fixed Effects GMM Estimations on Efficiency Change Index

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
sec	-0,0122	-0,0143	-0,015	-0,0166	-0,0082	-0,0198	-0,0103
	[0.0071]*	[0.0079]*	[0.0095]	[0.0076]**	[0.0085]	[0.0090]**	[0.0100]
linitial	-0,0778	-0,0829	-0,0756	-0,0845	-0,0824	-0,0793	-0,0822
	[0.0235]***	[0.0280]***	[0.0240]***	[0.0253]***	[0.0301]***	[0.0274]***	[0.0315]***
Finvar1	0,0867	0,1007	0,0978	0,0647	0,0545	0,0759	0,066
	[0.0473]*	[0.0548]*	[0.0552]*	[0.0553]	[0.0536]	[0.0661]	[0.0620]
cg	...	0,003	...	...	...	-0,0004	-0,0001
	...	[0.0058]	...	...	...	[0.0049]	[0.0050]
inf	...	...	0,0292	...	...	0,0351	0,0198
	...	...	[0.0971]	...	...	[0.0811]	[0.0672]
open	...	...	...	0,0015	...	0,0015	...
	...	...	...	[0.0009]*	...	[0.0009]	...
fdigdp	...	...	...	...	0,0035	...	0,0024
	...	...	...	...	[0.0066]	...	[0.0085]
Observations	182	182	179	182	163	179	161
Number of country	47	47	46	47	46	46	45
Shea Partial R2	0,2275	0,1908	0,1807	0,2029	0,1605	0,2077	0,2275
Identification/IV Relevance Test (p-value)	0,0000	0,0003	0,0326	0,0000	0,0108	0,0084	0,0000
Hansen J Stat. (p- value)	equation exactly identified	equation exactly identified	equation exactly identified	equation exactly identified	equation exactly identified	equation exactly identified	equation exactly identified

Note: The dependent variable is Efficiency Change Index. The regressions are panel regressions with averaged data over 5-year periods. linitial is the logarithm of initial income per capita and sec is the secondary school enrollment. Cg denotes the value of government size which is government expenditure as a share of GDP. inf is the value of inflation which is the log difference of GDP deflator between two consecutive years. open denotes the value of openness to trade which is measured as the sum of exports plus imports as a share of GDP. fdigdp is the value of foreign direct investment net inflows as a share of GDP. Finvar1 is the value of the private credit by deposit money banks and other financial institutions as a share of GDP. Efficient GMM estimation is conducted where lagged values of weakly exogenous variables are used as instruments.

The null hypothesis of the Hansen-Sargan J test is that the instruments are not correlated with the error term by means of overidentifying restrictions. Since the number of intruments exactly equal to the number of explanatory variables the system is identified. The null hypothesis of the Anderson canonical LR test is that model is not identified, instruments are not relevant. White's heteroskedasticity consistent (robust) standard errors are provided in brackets.* significant at 10%; ** significant at 5%; *** significant at 1%

Table 8: Fixed Effects GMM Estimations on Technical Change Index

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
sec	0,0115	0,0123	0,0066	0,0149	0,019	0,0133	0,0184
	[0.0059]*	[0.0060]**	[0.0107]	[0.0067]**	[0.0069]***	[0.0078]*	[0.0073]**
linitial	-0,028	-0,026	-0,0287	-0,0227	-0,0456	-0,0221	-0,0466
	[0.0167]*	[0.0197]	[0.0173]*	[0.0197]	[0.0199]**	[0.0196]	[0.0201]**
Finvar1	0,0749	0,0695	0,0981	0,0921	0,0872	0,0909	0,09
	[0.0325]**	[0.0387]*	[0.0557]*	[0.0430]**	[0.0400]**	[0.0488]*	[0.0475]*
cg	...	-0,0012	...	...	...	-0,0025	-0,0041
	...	[0.0042]	...	...	...	[0.0048]	[0.0041]
inf	...	...	0,0563	...	...	0,0337	0,0178
	...	...	[0.1075]	...	...	[0.0605]	[0.0450]
open	...	...	...	-0,0012	...	-0,0009	...
	...	...	...	[0.0008]	...	[0.0007]	...
fdigdp	...	...	...	...	0,0028	...	-0,0017
	...	...	...	...	[0.0055]	...	[0.0052]
Observations	182	182	179	182	163	179	161
Number of country	47	47	46	47	46	46	45
Shea Partial R2	0,2275	0,1908	0,1807	0,2029	0,2062	0,1605	0,2077
Identification/IV Relevance Test (p-value)	0,0000	0,0003	0,0326	0,0000	0,0000	0,0108	0,0084
Hansen J Stat. (p- value)	equation exactly identified	equation exactly identified	equation exactly identified	equation exactly identified	equation exactly identified	equation exactly identified	equation exactly identified

Note: The dependent variable is Technical Change Index. The regressions are panel regressions with averaged data over 5-year periods. linitial is the logarithm of initial income per capita and sec is the secondary school enrollment. Cg denotes the value of government size which is government expenditure as a share of GDP. inf is the value of inflation which is the log difference of GDP deflator between two consecutive years. open denotes the value of openness to trade which is measured as the sum of exports plus imports as a share of GDP. fdigdp is the value of foreign direct investment net inflows as a share of GDP. Finvar1 is the value of the private credit by deposit money banks and other financial institutions as a share of GDP. Efficient GMM estimation is conducted where lagged values of weakly exogenous variables are used as instruments.

The null hypothesis of the Hansen-Sargan J test is that the instruments are not correlated with the error term by means of overidentifying restrictions. Since the number of intruments exactly equal to the number of explanatory variables the system is identified. The null hypothesis of the Anderson canonical LR test is that model is not identified, instruments are not relevant. White's heteroskedasticity consistent (robust) standard errors are provided in brackets.* significant at 10%; ** significant at 5%; *** significant at 1%

Table 9a: Difference Estimator Results of Malmquist Productivity Change Index (With Initial Income)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
LD.malm	...	-0,5221	...	-0,4685	-0,3821	-0,4929	-0,3479
	...	[0.1507]***	...	[0.1439]***	[0.1491]**	[0.1571]***	[0.1566]**
D.sec	...	0,0022	...	-0,0002	0,0104	0,0004	0,011
	...	[0.0069]	...	[0.0076]	[0.0066]	[0.0068]	[0.0071]
D.linitial	...	-0,0906	...	-0,1027	-0,138	-0,0904	-0,1442
	...	[0.0440]**	...	[0.0422]**	[0.0388]***	[0.0409]**	[0.0384]***
D.Finvar1	...	0,1386	...	0,1298	0,1918	0,1228	0,2019
	...	[0.0794]*	...	[0.0623]**	[0.0742]***	[0.0625]**	[0.0708]***
D.cg	...	-0,0042	...	...	...	-0,0039	-0,0013
	...	[0.0033]	...	...	...	[0.0024]	[0.0028]
D.inf	...	...	...	...	...	0,0114	0,0213
	...	...	...	...	...	[0.0173]	[0.0132]
D.open	...	...	...	0,001	...	0,0006	...
	...	...	...	[0.0007]	...	[0.0006]	...
D.fdigdp	...	...	...	...	0,0044	...	0,0015
	...	...	...	...	[0.0039]	...	[0.0034]
Observations	138	138	138	138	133	138	133
Number of country2	48	48	48	48	48	48	48
Sargan Test (p-value)	0,0459	0,1583	0,0769	0,1947	0,2423	0,2747	0,4091
Serial Correlation Test (p-value)	0,1767	0,2829	0,231	0,1588	0,8583	0,4318	0,7209

Note: The dependent variable is Malmquist Productivity Change Index. The regressions are dynamic panel regressions with averaged data over 5-year periods and using lagged levels as instruments as described in the text. Difference operator is denoted by "D". linitial is the logarithm of initial income per capita and sec is the secondary school enrollment. D.Cg denotes the differenced value of government size which is government expenditure as a share of GDP. D.inf is the differenced value of inflation which is the log difference of GDP deflator between two consecutive years. D.open denotes the differenced value of openness to trade which is measured as the sum of exports plus imports as a share of GDP. D.fdigdp is the differenced value of foreign direct investment net inflows as a share of GDP. D.Finvar1 is the differenced value of the private credit which is private credit by deposit money banks and other financial institutions as a share of GDP. Models (1) and (3) are not valid.

The null hypothesis of the Sargan test is that the instruments are not correlated with the residuals. The null hypothesis of the serial correlation test is that the errors in the first difference regression exhibit no second-order serial correlation. White's heteroskedasticity consistent (robust) standard errors are provided in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 9b: Difference Estimator Results of Malmquist Productivity Change Index (Without Initial Income)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
LD.malm	-0,257	-0,3018	-0,2946	-0,3259	-0,2534	-0,3553	-0,3331
	[0.1451]*	[0.1710]*	[0.1706]*	[0.1728]*	[0.1529]*	[0.2231]	[0.1961]*
D.sec	-0,0156	-0,014	-0,0147	-0,0189	-0,0152	-0,0158	-0,0139
	[0.0083]*	[0.0099]	[0.0086]*	[0.0086]**	[0.0086]*	[0.0090]*	[0.0101]
D.Initial	...	...	...	...	...	...	...
	...	...	...	...	...	...	...
D.Finvar1	0,0711	0,0814	0,0748	0,0508	0,065	0,0494	0,0735
	[0.0336]**	[0.0442]*	[0.0381]**	[0.0267]*	[0.0347]*	[0.0312]	[0.0405]*
D.cg	...	-0,0069	...	...	...	-0,0068	-0,0049
	...	[0.0030]**	...	...	...	[0.0024]***	[0.0024]**
D.inf	...	...	-0,0353	...	...	-0,0097	-0,0143
	...	...	[0.0279]	...	...	[0.0215]	[0.0121]
D.open	...	...	...	0,0008	...	0,001	...
	...	...	...	[0.0007]	...	[0.0006]	...
D.fdigdp	...	...	...	...	0,0085	...	0,0059
	...	...	...	...	[0.0030]***	...	[0.0035]*
Observations	141	141	139	141	135	139	134
Number of country2	48	48	48	48	48	48	48
Sargan Test (p-value)	0,4049	0,3981	0,2577	0,3263	0,3248	0,4701	0,5849
Serial Correlation Test (p-value)	0,9072	0,5715	0,9704	0,8029	0,2432	0,4223	0,4369

Note: The dependent variable is Malmquist Productivity Change Index. The regressions are dynamic panel regressions with averaged data over 5-year periods and using lagged levels as instruments as described in the text. Difference operator is denoted by "D". Iinitial is the logarithm of initial income per capita and sec is the secondary school enrollment. D.Cg denotes the differenced value of government size which is government expenditure as a share of GDP. D.inf is the differenced value of inflation which is the log difference of GDP deflator between two consecutive years. D.open denotes the differenced value of openness to trade which is measured as the sum of exports plus imports as a share of GDP. D.fdigdp is the differenced value of foreign direct investment net inflows as a share of GDP. D.Finvar1 is the differenced value of the private credit which is private credit by deposit money banks and other financial institutions as a share of GDP.

The null hypothesis of the Sargan test is that the instruments are not correlated with the residuals. The null hypothesis of the serial correlation test is that the errors in the first difference regression exhibit no second-order serial correlation. White's heteroskedasticity consistent (robust) standard errors are provided in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 10a: Difference Estimator Results of Efficiency Change Index (With Initial Income)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
LD.eff	0,0275	0,0604	-0,0042	-0,0463	...	-0,0549	-0,0444
	[0.2104]	[0.2253]	[0.1967]	[0.2203]	...	[0.2171]	[0.2262]
D.sec	-0,0081	-0,0106	-0,0102	-0,0118	...	-0,0142	-0,0143
	[0.0093]	[0.0105]	[0.0094]	[0.0112]	...	[0.0111]	[0.0143]
D.linitial	-0,1246	-0,1405	-0,1169	-0,1108	...	-0,1188	-0,1783
	[0.0420]***	[0.0534]***	[0.0394]***	[0.0413]***	...	[0.0502]**	[0.0454]***
D.Finvar1	0,1685	0,1914	0,1725	0,1361	...	0,1939	0,2835
	[0.0866]*	[0.1030]*	[0.0830]**	[0.0732]*	...	[0.0964]**	[0.0980]***
D.cg	...	0,0066	...	...	...	0,0049	0,0061
	...	[0.0040]*	...	...	...	[0.0038]	[0.0043]
D.inf	...	...	-0,0062	...	...	0,0035	0,0107
	...	...	[0.0300]	...	...	[0.0271]	[0.0152]
D.fdigdp	...	...	...	...	...	...	-0,0015
	...	...	...	...	...	...	[0.0046]
D.open	...	...	...	0,0009	...	-0,0001	...
	...	...	...	[0.0007]	...	[0.0007]	...
Observations	138	138	138	138	133	138	133
Number of country2	48	48	48	48	48	48	48
Sargan Test (p-value)	0,1049	0,2397	0,1864	0,1708	0,5944	0,1502	0,1119
Serial Correlation Test (p-value)	0,2081	0,2556	0,2015	0,1621	0,0519	0,2299	0,4498

Note: The dependent variable is Efficiency Change Index. The regressions are dynamic panel regressions with averaged data over 5-year periods and using lagged levels as instruments as described in the text. Difference operator is denoted by "D". linitial is the logarithm of initial income per capita and sec is the secondary school enrollment. D.Cg denotes the differenced value of government size which is government expenditure as a share of GDP. D.inf is the differenced value of inflation which is the log difference of GDP deflator between two consecutive years. D.open denotes the differenced value of openness to trade which is measured as the sum of exports plus imports as a share of GDP. D.fdigdp is the differenced value of foreign direct investment net inflows as a share of GDP. D.Finvar1 is the differenced value of the private credit which is private credit by deposit money banks and other financial institutions as a share of GDP. Note that model (5) is invalid.

The null hypothesis of the Sargan test is that the instruments are not correlated with the residuals. The null hypothesis of the serial correlation test is that the errors in the first difference regression exhibit no second-order serial correlation. White's heteroskedasticity consistent (robust) standard errors are provided in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 10b: Difference Estimator Results of Efficiency Change Index (Without Initial Income)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
LD.eff	...	-0,0514	0,054	-0,1176	-0,0489	-0,056	-0,0412
	...	[0.1721]	[0.2191]	[0.1788]	[0.1813]	[0.1958]	[0.2264]
D.sec	...	-0,0326	-0,0317	-0,0292	-0,0366	-0,0326	-0,0435
	...	[0.0116]***	[0.0128]**	[0.0127]**	[0.0125]***	[0.0132]**	[0.0153]***
D.linitial	...	...	...	...	...	...	...
	...	...	...	...	...	...	...
D.Finvar1	...	0,0832	0,0968	0,0559	0,0808	0,0826	0,1175
	...	[0.0495]*	[0.0573]*	[0.0448]	[0.0506]	[0.0494]*	[0.0639]*
D.cg	...	0,0021	...	...	...	0,0006	0,0019
	...	[0.0027]	...	...	...	[0.0028]	[0.0030]
D.inf	...	...	-0,0677	...	...	-0,0252	-0,0314
	...	...	[0.0588]	...	...	[0.0303]	[0.0250]
D.open	...	...	...	0,0005	...	0,0002	...
	...	...	...	[0.0006]	...	[0.0007]	...
D.fdigdp	...	...	...	...	0,0026	...	0,0039
	...	...	...	...	[0.0047]	...	[0.0045]
Observations	141	141	139	141	135	139	134
Number of country2	48	48	48	48	48	48	48
Sargan Test (p-value)	0,0611	0,1999	0,1586	0,1025	0,3969	0,1870	0,1154
Serial Correlation Test (p-value)	0,5435	0,2859	0,9188	0,5000	0,6210	0,4873	0,7917

Note: The dependent variable is Efficiency Change Index. The regressions are dynamic panel regressions with averaged data over 5-year periods and using lagged levels as instruments as described in the text. Difference operator is denoted by "D". linitial is the logarithm of initial income per capita and sec is the secondary school enrollment. D.Cg denotes the differenced value of government size which is government expenditure as a share of GDP. D.inf is the differenced value of inflation which is the log difference of GDP deflator between two consecutive years. D.open denotes the differenced value of openness to trade which is measured as the sum of exports plus imports as a share of GDP. D.fdigdp is the differenced value of foreign direct investment net inflows as a share of GDP. D.Finvar1 is the differenced value of the private credit which is private credit by deposit money banks and other financial institutions as a share of GDP. Note that model (1) is invalid.

The null hypothesis of the Sargan test is that the instruments are not correlated with the residuals. The null hypothesis of the serial correlation test is that the errors in the first difference regression exhibit no second-order serial correlation. White's heteroskedasticity consistent (robust) standard errors are provided in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 11a: Difference Estimator Results of Technical Change Index (With Initial Income)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
LD.tech	...	...	...	...	...	0,0149	-0,1042
	...	...	...	...	...	[0.2021]	[0.1803]
D.sec	...	...	...	...	...	0,0264	0,0367
	...	...	...	...	...	[0.0114]**	[0.0124]***
D.linitial	...	...	...	...	...	-0,0142	-0,0133
	...	...	...	...	...	[0.0266]	[0.0305]
D.Finvar1	...	...	...	...	...	-0,0588	-0,071
	...	...	...	...	...	[0.0632]	[0.0627]
D.cg	...	...	...	...	...	-0,0086	-0,0066
	...	...	...	...	...	[0.0037]**	[0.0029]**
D.inf	...	...	...	...	...	0,0266	0,0242
	...	...	...	...	...	[0.0227]	[0.0256]
D.open	...	...	...	...	...	0,0011	...
	...	...	...	...	...	[0.0005]*	...
D.fdigdp	...	...	...	...	...	...	0,0011
	...	...	...	...	...	...	[0.0037]
Observations	138	138	138	138	133	138	133
Number of country2	48	48	48	48	48	48	48
Sargan Test (p-value)	0,0006	0,0229	0,0033	0,0211	0,013	0,109	0,1028
Serial Correlation Test (p-value)	0,0162	0,1345	0,0956	0,0048	0,0243	0,4107	0,2673

Note: The dependent variable is Technical Change Index. The regressions are dynamic panel regressions with averaged data over 5-year periods and using lagged levels as instruments as described in the text. Difference operator is denoted by "D". linitial is the logarithm of initial income per capita and sec is the secondary school enrollment. D.Cg denotes the differenced value of government size which is government expenditure as a share of GDP. D.inf is the differenced value of inflation which is the log difference of GDP deflator between two consecutive years. D.open denotes the differenced value of openness to trade which is measured as the sum of exports plus imports as a share of GDP. D.fdigdp is the differenced value of foreign direct investment net inflows as a share of GDP. D.Finvar1 is the differenced value of the private credit which is private credit by deposit money banks and other financial institutions as a share of GDP. Models (1)...(5) are not valid.

The null hypothesis of the Sargan test is that the instruments are not correlated with the residuals. The null hypothesis of the serial correlation test is that the errors in the first difference regression exhibit no second-order serial correlation. White's heteroskedasticity consistent (robust) standard errors are provided in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 11b: Difference Estimator Results of Technical Change Index (Without Initial Income)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
LD.tech	...	...	...	...	...	0,0091	-0,1036
	...	...	...	...	...	[0.1779]	[0.1774]
D.sec	...	...	...	...	...	0,0242	0,0342
	...	...	...	...	...	[0.0110]**	[0.0118]***
D.linitial	...	...	...	...	...	...	...
	...	...	...	...	...	...	...
D.Finvar1	...	...	...	...	...	-0,0597	-0,0811
	...	...	...	...	...	[0.0469]	[0.0492]*
D.cg	...	...	...	...	...	-0,0078	-0,0071
	...	...	...	...	...	[0.0030]**	[0.0029]**
D.inf	...	...	...	...	...	0,0227	0,021
	...	...	...	...	...	[0.0235]	[0.0243]
D.open	...	...	...	...	...	0,0008	...
	...	...	...	...	...	[0.0005]	...
D.fdigdp	...	...	...	...	...	...	0,0014
	...	...	...	...	...	...	[0.0036]
Observations	141	141	139	141	135	139	134
Number of country2	48	48	48	48	48	48	48
Sargan Test (p-value)	0,001	0,0242	0,005	0,0282	0,0203	0,1224	0,2057
Serial Correlation Test (p-value)	0,0125	0,1144	0,0402	0,0035	0,0138	0,4166	0,1814

Note: The dependent variable is Technical Change Index. The regressions are dynamic panel regressions with averaged data over 5-year periods and using lagged levels as instruments as described in the text. Difference operator is denoted by "D". linitial is the logarithm of initial income per capita and sec is the secondary school enrollment. D.Cg denotes the differenced value of government size which is government expenditure as a share of GDP. D.inf is the differenced value of inflation which is the log difference of GDP deflator between two consecutive years. D.open denotes the differenced value of openness to trade which is measured as the sum of exports plus imports as a share of GDP. D.fdigdp is the differenced value of foreign direct investment net inflows as a share of GDP. D.Finvar1 is the differenced value of the private credit which is private credit by deposit money banks and other financial institutions as a share of GDP. Models (1)...(5) are not valid.

The null hypothesis of the Sargan test is that the instruments are not correlated with the residuals. The null hypothesis of the serial correlation test is that the errors in the first difference regression exhibit no second-order serial correlation. White's heteroskedasticity consistent (robust) standard errors are provided in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 12: Summary of Static and Dynamic Productivity Change Index Equations with Lagged Values as Instruments

Table 12.1	**(1)**	**(2)**	**(3)**	**(4)**
Malm	**Fixed Effects Lagged**	**Fixed Effects GMM**	**GMM Difference (with initial)**	**GMM Difference (without initial)**
Iinitial	-0,1095	-0,1283	-0,1442	...
	[0.0245]***	[0.0279]***	[0.0384]***	...
Finvar1	0,0977	0,1559	0,2019	0,0735
	[0.0237]***	[0.0563]***	[0.0708]***	[0.0405]*

Table 12.2	**(1)**	**(2)**	**(3)**	**(4)**
Eff	**Fixed Effects Lagged**	**Fixed Effects GMM**	**GMM Difference (with initial)**	**GMM Difference (without initial)**
Iinitial	-0,0758	-0,0822	-0,1783	...
	[0.0259]***	[0.0315]***	[0.0454]***	...
Finvar1	0,0369	0,066	0,2835	0,1175
	[0.0289]	[0.0620]	[0.0980]***	[0.0639]*

Table 12.3	**(1)**	**(2)**	**(3)**	**(4)**
Tech	**Fixed Effects Lagged**	**Fixed Effects GMM**	**GMM Difference (with initial)**	**GMM Difference (without initial)**
Iinitial	-0,0339	-0,0466	-0,0133	...
	[0.0157]**	[0.0201]**	[0.0305]	...
Finvar1	0,0595	0,09	-0,071	-0,0811
	[0.0186]***	[0.0475]*	[0.0627]	[0.0492]*

Note: In the summary table 12.1 the dependent variable is Malmquist productivity change index. In the summary table 12.2 the dependent variable is Efficiency change index. In the summary table 12.3 the dependent variable is technical change index.The conditioning variables are Iinitial: logarithm of initial income per capita, secondary school enrollment rate,government consumption as a share of GDP, value of inflation which is the log difference of GDP deflator between two consecutive years, and value of foreign direct investment net inflows as a share of GDP. Finvar1 is the value of the private credit by deposit money banks and other financial institutions as a share of GDP. White's heteroskedasticity consistent (robust) standard errors are provided in brackets.*significant at 10%; ** significant at 5%; *** significant at 1%

Table 13: Cross Sectional Instrumental Variables Regressions on Malmquist Productivity Change Index

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
sec	0.0000	0.0000	0,0006	0.0000	-0,0009	0,0004	0,0002
	[0.0025]	[0.0024]	[0.0022]	[0.0025]	[0.0025]	[0.0021]	[0.0023]
linitial	-0,0009	-0,0008	-0,0009	-0,0014	-0,0009	-0,0011	-0,0009
	[0.0014]	[0.0014]	[0.0013]	[0.0014]	[0.0014]	[0.0013]	[0.0013]
Finvar1	0,0149	0,0146	0,0071	0,0156	0,0173	0,0075	0,0077
	[0.0105]	[0.0114]	[0.0123]	[0.0100]	[0.0110]	[0.0135]	[0.0160]
cg	...	0.0000	...	...	...	-0,0002	0.0000
	...	[0.0004]	...	...	...	[0.0004]	[0.0005]
inf	...	...	-0,0158	...	...	-0,0113	-0,0147
	...	...	[0.0088]*	...	...	[0.0098]	[0.0110]
open	...	...	...	0,0001	...	0,0001	...
	...	...	...	[0.0001]**	...	[0.0001]	...
fdigdp	...	...	...	...	0,0029	...	0,0011
	...	...	...	...	[0.0034]	...	[0.0038]
Observations	45	45	45	45	45	45	45
Shea partial R2	0,2967	0,261	0,2315	0,2943	0,284	0,1921	0,1549
Identification/IV Relevance Test (p-value)	0,0012	0,0035	0,0079	0,0013	0,0018	0,0223	0,0557
Hansen J Stat. (p-value)	0,6071	0,6033	0,802	0,634	0,6162	0,7698	0,7726

Note: The dependent variable is Malmquist Productivity Change Index. The regressions are cross section regressions where efficient GMM estimator is used.Legal origin is used to instrument privatecredit. linitial is the logarithm of initial income per capita and sec is the secondary school enrollment. Cg denotes the value of government size which is government expenditure as a share of GDP. inf is the value of inflation which is the log difference of GDP deflator between two consecutive years. open denotes the value of openness to trade which is measured as the sum of exports plus imports as a share of GDP. fdigdp is the value of foreign direct investment net inflows as a share of GDP. Finvar1 is the value of the private credit by deposit money banks and other financial institutions as a share of GDP.

The null hypothesis of the Hansen-Sargan J test is that the instruments are not correlated with the error term by means of overidentifying restrictions. The null hypothesis of the Anderson canonical LR test is that model is not identified, instruments are not relevant. White's heteroskedasticity consistent (robust) standard errors are provided in brackets.* significant at 10%; ** significant at 5%; *** significant at 1%

Table 14: Cross Sectional Instrumental Variables Regressions on Efficiency Change Index

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
sec	-0,0013	-0,0013	-0,0003	-0,0012	-0,0013	-0,0006	-0,0002
	[0.0019]	[0.0020]	[0.0017]	[0.0020]	[0.0022]	[0.0019]	[0.0021]
linitial	-0,0028	-0,0031	-0,0029	-0,0034	-0,0028	-0,0034	-0,0031
	[0.0015]*	[0.0015]**	[0.0014]**	[0.0014]**	[0.0015]*	[0.0014]**	[0.0014]**
Finvar1	0,0079	0,0107	-0,0003	0,0085	0,0079	0,0039	0,0008
	[0.0101]	[0.0108]	[0.0116]	[0.0094]	[0.0106]	[0.0123]	[0.0146]
cg	...	0,0004	...	...	...	0,0002	0,0003
	...	[0.0003]	...	...	...	[0.0002]	[0.0003]
inf	...	...	-0,016	...	...	-0,0099	-0,0169
	...	...	[0.0078]**	...	...	[0.0090]	[0.0097]*
open	...	...	...	0,0002	...	0,0001	...
	...	...	...	[0.0000]***	...	[0.0000]***	...
fdigdp	...	...	...	...	0.0000	...	-0,0005
	...	...	...	...	[0.0026]	...	[0.0033]
Observations	45	45	45	45	45	45	45
Shea partial R2	0,2967	0,261	0,2315	0,2943	0,284	0,1921	0,1549
Identification/IV Relevance Test (p-value)	0,0012	0,0035	0,0079	0,0013	0,0018	0,0223	0,0557
Hansen J Stat. (p-value)	0,5352	0,5757	0,7111	0,6427	0,54	0,7436	0,7778

Note: The dependent variable is Efficiency Change Index. The regressions are cross section regressions where efficient GMM estimator is used.Legal origin is used to instrument privatecredit. linitial is the logarithm of initial income per capita and sec is the secondary school enrollment. Cg denotes the value of government size which is government expenditure as a share of GDP. inf is the value of inflation which is the log difference of GDP deflator between two consecutive years. open denotes the value of openness to trade which is measured as the sum of exports plus imports as a share of GDP. fdigdp is the value of foreign direct investment net inflows as a share of GDP. Finvar1 is the value of the private credit by deposit money banks and other financial institutions as a share of GDP.

The null hypothesis of the Hansen-Sargan J test is that the instruments are not correlated with the error term by means of overidentifying restrictions. The null hypothesis of the Anderson canonical LR test is that model is not identified, instruments are not relevant. White's heteroskedasticity consistent (robust) standard errors are provided in brackets.* significant at 10%; ** significant at 5%; *** significant at 1%

Table 15: Cross Sectional Instrumental Variables Regressions on Technical Change Index

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
sec	0,001	0,0009	0,0009	0,0009	0,0003	0,0009	0,0005
	[0.0015]	[0.0014]	[0.0016]	[0.0016]	[0.0014]	[0.0013]	[0.0014]
linitial	0,0016	0,002	0,0016	0,0018	0,0017	0,002	0,002
	[0.0010]	[0.0009]**	[0.0010]*	[0.0010]*	[0.0009]*	[0.0009]**	[0.0009]**
Finvar1	0,0058	0,0025	0,0061	0,0058	0,0067	0,0023	0,003
	[0.0053]	[0.0058]	[0.0060]	[0.0053]	[0.0054]	[0.0068]	[0.0071]
cg	...	-0,0004	...	...	...	-0,0003	-0,0003
	...	[0.0003]	...	...	...	[0.0003]	[0.0003]
inf	...	...	0,0013	...	...	-0,0004	0,0011
	...	...	[0.0063]	...	...	[0.0059]	[0.0055]
open	...	...	...	0.0000	...	0.0000	...
	...	...	...	[0.0000]	...	[0.0000]	...
fdigdp	...	...	...	...	0,0021	...	0,0011
	...	...	...	...	[0.0020]	...	[0.0017]
Observations	45	45	45	45	45	45	45
Shea partial R2	0,2967	0,261	0,2315	0,2943	0,284	0,1921	0,1549
Identification/IV Relevance Test (p-value)	0,0012	0,0035	0,0079	0,0013	0,0018	0,0223	0,0557
Hansen J Stat. (p-value)	0,9064	0,8294	0,8662	0,8687	0,8497	0,7945	0,7605

Note: The dependent variable is Technical Change Index. The regressions are cross section regressions where efficient GMM estimator is used.Legal origin is used to instrument privatecredit. linitial is the logarithm of initial income per capita and sec is the secondary school enrollment. Cg denotes the value of government size which is government expenditure as a share of GDP. inf is the value of inflation which is the log difference of GDP deflator between two consecutive years. open denotes the value of openness to trade which is measured as the sum of exports plus imports as a share of GDP. fdigdp is the value of foreign direct investment net inflows as a share of GDP. Finvar1 is the value of the private credit by deposit money banks and other financial institutions as a share of GDP.

The null hypothesis of the Hansen-Sargan J test is that the instruments are not correlated with the error term by means of overidentifying restrictions. The null hypothesis of the Anderson canonical LR test is that model is not identified, instruments are not relevant. White's heteroskedasticity consistent (robust) standard errors are provided in brackets.* significant at 10%; ** significant at 5%; *** significant at 1%

Table 16: Common Intercept Panel Data GMM Regressions on Malmquist Productivity Change Index

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
sec	-0,0014	...	-0,0019	-0,0014	-0,0003	...	...
	[0.0021]	...	[0.0021]	[0.0021]	[0.0029]	...	...
linitial	-0,0003	...	-0,0001	-0,0007	-0,0005	...	...
	[0.0022]	...	[0.0022]	[0.0022]	[0.0024]	...	...
Finvar1	0,015	...	0,0141	0,0162	0,0166	...	...
	[0.0059]**	...	[0.0066]**	[0.0058]***	[0.0081]**	...	...
cg	...	...	...	...	...	...	...
	...	...	...	...	...	...	...
inf	...	...	-0,0036	...	...	...	...
	...	...	[0.0108]	...	...	...	...
open	...	...	...	0,0001	...	...	...
	...	...	...	[0.0001]	...	...	...
fdigdp	...	...	...	...	-0,0035	...	...
	...	...	...	...	[0.0040]	...	...
Observations	183	183	181	183	165	181	164
Shea partial R2	0,8331	0,8311	0,6963	0,8323	0,7772	0,6715	0,5682
Hansen J Stat. (p-value)	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
Identification/IV Relevance Test (p-value)	0,1520	0,0709	0,1450	0,1670	0,2469	0,0347	0,0711

Note: The dependent variable is Malmquist Productivity Change Index. The regressions are common intercept panel regressions with averaged data over 5-year periods where efficient GMM estimator is used.Legal origin and lagged values of weakly exogenous variables are used as instruments. linitial is the logarithm of initial income per capita and sec is the secondary school enrollment. Cg denotes the value of government size which is government expenditure as a share of GDP. inf is the value of inflation which is the log difference of GDP deflator between two consecutive years. open denotes the value of openness to trade which is measured as the sum of exports plus imports as a share of GDP. fdigdp is the value of foreign direct investment net inflows as a share of GDP. Finvar1 is the value of the private credit by deposit money banks and other financial institutions as a share of GDP.

The null hypothesis of the Hansen-Sargan J test is that the instruments are not correlated with the error term by means of overidentifying restrictions. The null hypothesis of the Anderson canonical LR test is that model is not identified, instruments are not relevant. White's heteroskedasticity consistent (robust) standard errors are provided in brackets.* significant at 10%; ** significant at 5%; *** significant at 1%

Table 17: Common Intercept Panel Data GMM Regressions on Efficiency Change Index

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
sec	-0,0041	-0,0037	-0,004	-0,004	-0,003	-0,0038	-0,0038
	[0.0023]*	[0.0022]*	[0.0023]*	[0.0023]*	[0.0032]	[0.0023]	[0.0031]
linitial	-0,0036	-0,0038	-0,0036	-0,0046	-0,0046	-0,0045	-0,0045
	[0.0023]	[0.0023]*	[0.0023]	[0.0024]*	[0.0024]*	[0.0024]*	[0.0024]*
Finvar1	0,0086	0,0082	0,0071	0,0109	0,009	0,0083	0,0103
	[0.0068]	[0.0067]	[0.0074]	[0.0071]	[0.0088]	[0.0081]	[0.0102]
cg	...	0,0001	...	...	...	-0,0001	0,0001
	...	[0.0003]	...	...	...	[0.0003]	[0.0004]
inf	...	...	-0,0119	...	...	-0,0103	-0,009
	...	...	[0.0196]	...	...	[0.0207]	[0.0198]
open	...	...	...	0,0001	...	0,0001	...
	...	...	...	[0.0001]*	...	[0.0001]	...
fdigdp	...	...	...	...	-0,0008	...	0,001
	...	...	...	...	[0.0036]	...	[0.0039]
Observations	183	183	181	183	165	181	164
Shea partial R2	0,8331	0,8311	0,6963	0,8323	0,7772	0,6715	0,5682
Hansen J Stat. (p-value)	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
Identification/IV Relevance Test (p-value)	0,3069	0,2835	0,3064	0,3904	0,4854	0,2211	0,3597

Note: The dependent variable is Efficiency Change Index. The regressions are common intercept panel regressions with averaged data over 5-year periods where efficient GMM estimator is used.Legal origin and lagged values of weakly exogenous variables are used as instruments. linitial is the logarithm of initial income per capita and sec is the secondary school enrollment. Cg denotes the value of government size which is government expenditure as a share of GDP. inf is the value of inflation which is the log difference of GDP deflator between two consecutive years. open denotes the value of openness to trade which is measured as the sum of exports plus imports as a share of GDP. fdigdp is the value of foreign direct investment net inflows as a share of GDP. Finvar1 is the value of the private credit by deposit money banks and other financial institutions as a share of GDP.

The null hypothesis of the Hansen-Sargan J test is that the instruments are not correlated with the error term by means of overidentifying restrictions. The null hypothesis of the Anderson canonical LR test is that model is not identified, instruments are not relevant. White's heteroskedasticity consistent (robust) standard errors are provided in brackets.* significant at 10%; ** significant at 5%; *** significant at 1%

Table 18: Common Intercept Panel Data GMM Regressions on Technical Change Index

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
sec	0,0018	0,0019	0,0015	0,0019	0,0016	0,0015	0,0019
	[0.0016]	[0.0016]	[0.0016]	[0.0016]	[0.0022]	[0.0016]	[0.0023]
linitial	0,0031	0,0029	0,0032	0,0034	0,0039	0,0033	0,0036
	[0.0017]*	[0.0017]*	[0.0018]*	[0.0018]*	[0.0019]**	[0.0019]*	[0.0019]*
Finvar1	0,0062	0,0064	0,0075	0,0059	0,0066	0,0062	0,0052
	[0.0052]	[0.0054]	[0.0063]	[0.0054]	[0.0064]	[0.0066]	[0.0085]
cg	...	0.0000	...	...	...	0,0001	-0,0001
	...	[0.0002]	...	...	...	[0.0003]	[0.0003]
inf	...	...	0,0009	...	...	-0,004	-0,0046
	...	...	[0.0137]	...	...	[0.0138]	[0.0133]
open	...	...	...	0.0000	...	0.0000	...
	...	...	...	[0.0001]	...	[0.0001]	...
fdigdp	...	...	...	...	-0,0023	...	-0,0027
	...	...	...	...	[0.0027]	...	[0.0029]
Observations	183	183	181	183	165	181	164
Shea partial R2	0,8331	0,8311	0,6963	0,8323	0,7772	0,6715	0,5682
Hansen J Stat. (p-value)	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
Identification/IV Relevance Test (p-value)	0,3372	0,2917	0,3213	0,3240	0,5758	0,2877	0,3701

Note: The dependent variable is Technical Change Index. The regressions are common intercept panel regressions with averaged data over 5-year periods where efficient GMM estimator is used.Legal origin and lagged values of weakly exogenous variables are used as instruments. linitial is the logarithm of initial income per capita and sec is the secondary school enrollment. Cg denotes the value of government size which is government expenditure as a share of GDP. inf is the value of inflation which is the log difference of GDP deflator between two consecutive years. open denotes the value of openness to trade which is measured as the sum of exports plus imports as a share of GDP. fdigdp is the value of foreign direct investment net inflows as a share of GDP. Finvar1 is the value of the private credit by deposit money banks and other financial institutions as a share of GDP.

The null hypothesis of the Hansen-Sargan J test is that the instruments are not correlated with the error term by means of overidentifying restrictions. The null hypothesis of the Anderson canonical LR test is that model is not identified, instruments are not relevant. White's heteroskedasticity consistent (robust) standard errors are provided in brackets.* significant at 10%; ** significant at 5%; *** significant at 1%

Table 19a: Difference Estimator Results of Malmquist Productivity Change Index (With Initial Income, Legal Origin)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
LD.malm	-0,2749	-0,2818	-0,2636	...	-0,2319	-0,2532	-0,212
	[0.1445]*	[0.1507]*	[0.1449]*	...	[0.1443]	[0.1591]	[0.1493]
D.sec	0,0075	0,0071	0,0063	...	0,0171	0,0039	0,0171
	[0.0077]	[0.0074]	[0.0078]	...	[0.0071]**	[0.0072]	[0.0077]**
D.linitial	-0,1094	-0,1063	-0,1103	...	-0,1498	-0,1087	-0,1532
	[0.0347]***	[0.0350]***	[0.0344]***	...	[0.0274]***	[0.0345]***	[0.0281]***
D.Finvar1	0,1336	0,1339	0,1396	...	0,1825	0,1289	0,186
	[0.0471]***	[0.0479]***	[0.0461]***	...	[0.0439]***	[0.0424]***	[0.0442]***
D.cg	...	-0,0016	...	...	...	-0,0022	-0,0004
	...	[0.0025]	...	...	...	[0.0022]	[0.0025]
D.inf	...	...	0,0182	...	...	0,0195	0,0238
	...	...	[0.0175]	...	...	[0.0151]	[0.0137]*
D.open	...	...	...	...	...	0,0007	...
	...	...	...	...	...	[0.0005]	...
D.fdigdp	...	...	...	...	0,0048	...	0,0027
	...	...	...	...	[0.0034]	...	[0.0029]
Observations	138	138	138	138	133	138	133
Number of country	48	48	48	48	48	48	48
Sargan Test (p-value)	0,1386	0,2086	0,2066	0,0474	0,454	0,1646	0,5365
Serial Correlation Test (p-value)	0,8745	0,7946	0,864	0,9138	0,5688	0,4838	0,6854

Note: The dependent variable is Malmquist Productivity Change Index. The regressions are dynamic panel regressions with averaged data over 5-year periods and using lagged levels and legal origin as instruments as described in the text. Difference operator is denoted by "D". linitial is the logarithm of initial income per capita and sec is the secondary school enrollment. D.Cg denotes the differenced value of government size which is government expenditure as a share of GDP. D.inf is the differenced value of inflation which is the log difference of GDP deflator between two consecutive years. D.open denotes the differenced value of openness to trade which is measured as the sum of exports plus imports as a share of GDP. D.fdigdp is the differenced value of foreign direct investment net inflows as a share of GDP. D.Finvar1 is the differenced value of the private credit which is private credit by deposit money banks and other financial institutions as a share of GDP. Model (4) is not valid.

The null hypothesis of the Sargan test is that the instruments are not correlated with the residuals. The null hypothesis of the serial correlation test is that the errors in the first difference regression exhibit no second-order serial correlation. White's heteroskedasticity consistent (robust) standard errors are provided in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 19b: Difference Estimator Results of Malmquist Productivity Change Index (Without Initial Income, With Legal Origin)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
LD.malm	-0,0856	-0,1101	-0,0602	-0,1232	-0,0496	-0,1121	-0,0954
	[0.1641]	[0.1873]	[0.1779]	[0.1805]	[0.1738]	[0.2209]	[0.2005]
D.sec	-0,014	-0,0129	-0,0119	-0,0176	-0,0116	-0,0167	-0,0116
	[0.0070]**	[0.0083]	[0.0073]	[0.0074]**	[0.0068]*	[0.0079]**	[0.0085]
D.linitial	...	...	...	...	...	...	...
	...	...	...	...	...	...	...
D.Finvar1	0,0701	0,0764	0,0689	0,0482	0,0631	0,0526	0,0756
	[0.0264]***	[0.0305]**	[0.0291]**	[0.0227]**	[0.0303]**	[0.0264]**	[0.0327]**
D.cg	...	-0,0048	...	...	...	-0,0054	-0,0037
	...	[0.0023]**	...	...	...	[0.0023]**	[0.0024]
D.inf	...	...	-0,037	...	...	-0,0111	-0,0145
	...	...	[0.0294]	...	...	[0.0221]	[0.0118]
D.open	...	...	...	0,001	...	0,0012	...
	...	...	...	[0.0007]	...	[0.0007]*	...
D.fdigdp	...	...	...	...	0,0092	...	0,0084
	...	...	...	...	[0.0036]**	...	[0.0038]**
Observations	141	141	139	141	135	139	134
Number of country	48	48	48	48	48	48	48
Sargan Test (p-value)	0,4049	0,3981	0,2577	0,3263	0,3248	0,4701	0,5849
Serial Correlation Test (p-value)	0,9072	0,5715	0,9704	0,8029	0,2432	0,4223	0,4369

Note: The dependent variable is Malmquist Productivity Change Index. The regressions are dynamic panel regressions with averaged data over 5-year periods and using lagged levels and legal origin as instruments as described in the text. Difference operator is denoted by "D". linitial is the logarithm of initial income per capita and sec is the secondary school enrollment. D.Cg denotes the differenced value of government size which is government expenditure as a share of GDP. D.inf is the differenced value of inflation which is the log difference of GDP deflator between two consecutive years. D.open denotes the differenced value of openness to trade which is measured as the sum of exports plus imports as a share of GDP. D.fdigdp is the differenced value of foreign direct investment net inflows as a share of GDP. D.Finvar1 is the differenced value of the private credit which is private credit by deposit money banks and other financial institutions as a share of GDP.

The null hypothesis of the Sargan test is that the instruments are not correlated with the residuals. The null hypothesis of the serial correlation test is that the errors in the first difference regression exhibit no second-order serial correlation. White's heteroskedasticity consistent (robust) standard errors are provided in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 20a: Difference Estimator Results of Efficiency Change Index (With Initial Income, Legal Origin)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
LD.eff	...	...	0,0054	-0,021	...	...	-0,0438
	...	...	[0.1652]	[0.1503]	...	...	[0.1859]
D.sec	...	...	-0,0054	-0,0091	...	...	-0,0053
	...	...	[0.0076]	[0.0095]	...	...	[0.0108]
D.linitial	...	...	-0,1054	-0,1039	...	...	-0,1444
	...	...	[0.0351]***	[0.0343]***	...	...	[0.0420]***
D.Finvar1	...	...	0,1174	0,1061	...	...	0,1622
	...	...	[0.0491]**	[0.0416]**	...	...	[0.0537]***
D.cg	...	...	...	...	...	...	0,0046
	...	...	...	...	...	...	[0.0032]
D.inf	...	...	-0,0082	...	...	...	0,0049
	...	...	[0.0279]	...	...	...	[0.0143]
D.open	...	...	...	0,0008	...	...	...
	...	...	...	[0.0006]	...	...	...
D.fdigdp	...	...	...	...	...		0,0003
	...	...	...	...	...		[0.0034]
Observations	138	138	138	138	133	138	133
Number of country	48	48	48	48	48	48	48
Sargan Test (p-value)	0,1383	0,1045	0,2344	0,2326	0,6743	0,2084	0,0967
Serial Correlation Test (p-value)	0,0507	0,0759	0,1002	0,1009	0,0432	0,095	0,2067

Note: The dependent variable is Efficiency Change Index. The regressions are dynamic panel regressions with averaged data over 5-year periods and using lagged levels and legal origin as instruments as described in the text. Difference operator is denoted by "D". linitial is the logarithm of initial income per capita and sec is the secondary school enrollment. D.Cg denotes the differenced value of government size which is government expenditure as a share of GDP. D.inf is the differenced value of inflation which is the log difference of GDP deflator between two consecutive years. D.open denotes the differenced value of openness to trade which is measured as the sum of exports plus imports as a share of GDP. D.fdigdp is the differenced value of foreign direct investment net inflows as a share of GDP. D.Finvar1 is the differenced value of the private credit which is private credit by deposit money banks and other financial institutions as a share of GDP. Note that models (1), (2), (5) and (6) is invalid.

The null hypothesis of the Sargan test is that the instruments are not correlated with the residuals. The null hypothesis of the serial correlation test is that the errors in the first difference regression exhibit no second-order serial correlation. White's heteroskedasticity consistent (robust) standard errors are provided in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 20b: Difference Estimator Results of Efficiency Change Index (Without Initial Income, With Legal Origin)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
LD.eff	...	0,0183	0,1145	-0,0348	0,0861	-0,0038	0,0548
	...	[0.1557]	[0.1809]	[0.1442]	[0.1473]	[0.1685]	[0.1914]
D.sec	...	-0,0269	-0,0237	-0,0263	-0,0278	-0,0274	-0,0329
	...	[0.0080]***	[0.0098]**	[0.0100]***	[0.0088]***	[0.0107]**	[0.0106]***
D.Linitial	...	...	...	...	...	...	...
	...	...	...	...	...	...	...
D.Finvar1	...	0,049	0,0462	0,0358	0,0224	0,0491	0,0492
	...	[0.0275]*	[0.0378]	[0.0252]	[0.0309]	[0.0313]	[0.0386]
D.cg	...	0,0017	...	...	...	0,0001	0,0019
	...	[0.0024]	...	...	...	[0.0025]	[0.0028]
D.inf	...	...	-0,0664	...	...	-0,0268	-0,0328
	...	...	[0.0557]	...	...	[0.0311]	[0.0232]
D.fdigdp	...	...	...	...	0,0049	...	0,006
	...	...	...	...	[0.0043]	...	[0.0041]
D.open	...	...	...	0,0005	...	0,0003	...
	...	...	...	[0.0007]	...	[0.0007]	...
Observations	138	138	138	138	133	138	133
Number of country	48	48	48	48	48	48	48
Sargan Test (p-value)	0,0611	0,1999	0,1586	0,1025	0,3969	0,187	0,1154
Serial Correlation Test (p-value)	0,5435	0,2859	0,9188	0,5	0,621	0,4873	0,7917

Note: The dependent variable is Efficiency Change Index. The regressions are dynamic panel regressions with averaged data over 5-year periods and using lagged levels and legal origin as instruments as described in the text. Difference operator is denoted by "D". linitial is the logarithm of initial income per capita and sec is the secondary school enrollment. D.Cg denotes the differenced value of government size which is government expenditure as a share of GDP. D.inf is the differenced value of inflation which is the log difference of GDP deflator between two consecutive years. D.open denotes the differenced value of openness to trade which is measured as the sum of exports plus imports as a share of GDP. D.fdigdp is the differenced value of foreign direct investment net inflows as a share of GDP. D.Finvar1 is the differenced value of the private credit which is private credit by deposit money banks and other financial institutions as a share of GDP. Note that models (1), (2), (5) and (6) are invalid.

The null hypothesis of the Sargan test is that the instruments are not correlated with the residuals. The null hypothesis of the serial correlation test is that the errors in the first difference regression exhibit no second-order serial correlation. White's heteroskedasticity consistent (robust) standard errors are provided in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 21a: Difference Estimator Results of Technical Change Index (With Initial Income, Legal Origin)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
LD.tech	...	...	...	...	...	0,0951	0,1322
	...	...	...	...	...	[0.1545]	[0.1625]
D.sec	...	...	...	...	...	0,0203	0,0318
	...	...	...	...	...	[0.0094]**	[0.0113]***
D.linitial	...	...	...	...	...	-0,0229	-0,04
	...	...	...	...	...	[0.0227]	[0.0263]
D.Finvar1	...	...	...	...	...	-0,0006	0,0318
	...	...	...	...	...	[0.0308]	[0.0359]
D.cg	...	...	...	...	...	-0,0053	-0,0048
	...	...	...	...	...	[0.0031]*	[0.0027]*
D.inf	...	...	...	...	...	0,0276	0,0376
	...	...	...	...	...	[0.0204]	[0.0257]
D.open	...	...	...	...	...	0,0008	...
	...	...	...	...	...	[0.0005]*	...
D.fdigdp	...	...	...	...	...	...	-0,0006
	...	...	...	...	...	...	[0.0029]
Observations	138	138	138	138	133	138	133
Number of country	48	48	48	48	48	48	48
Sargan Test (p-value)	0,0032	0,0298	0,0151	0,0495	0,0449	0,146	0,1545
Serial Correlation Test (p-value)	0,0556	0,2469	0,1655	0,0215	0,0986	0,3068	0,2664

Note: The dependent variable is Technical Change Index. The regressions are dynamic panel regressions with averaged data over 5-year periods and using lagged levels as instruments as described in the text. Difference operator is denoted by "D". linitial is the logarithm of initial income per capita and sec is the secondary school enrollment. D.Cg denotes the differenced value of government size which is government expenditure as a share of GDP. D.inf is the differenced value of inflation which is the log difference of GDP deflator between two consecutive years. D.open denotes the differenced value of openness to trade which is measured as the sum of exports plus imports as a share of GDP. D.fdigdp is the differenced value of foreign direct investment net inflows as a share of GDP. D.Finvar1 is the differenced value of the private credit which is private credit by deposit money banks and other financial institutions as a share of GDP. Models (1)...(5) are not valid.

The null hypothesis of the Sargan test is that the instruments are not correlated with the residuals. The null hypothesis of the serial correlation test is that the errors in the first difference regression exhibit no second-order serial correlation. White's heteroskedasticity consistent (robust) standard errors are provided in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 21b: Difference Estimator Results of Technical Change Index (Without Initial Income, With Legal Origin)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
LD.tech	...	...	...	...	...	0,1027	0,1255
	...	...	...	...	...	[0.1501]	[0.1684]
Linitial	...	...	...	...	...	...	...
	...	...	...	...	...	...	...
D.Finvar1	...	...	...	...	...	-0,0122	0,0004
	...	...	...	...	...	[0.0227]	[0.0251]
D.sec	...	...	...	...	...	0,017	0,0244
	...	...	...	...	...	[0.0082]**	[0.0087]***
D.cg	...	...	...	...	...	-0,0054	-0,0058
	...	...	...	...	...	[0.0027]**	[0.0028]**
D.inf	...	...	...	...	...	0,0225	0,0281
	...	...	...	...	...	[0.0208]	[0.0229]
D.fdigdp	...	...	...	...	...	...	0,0007
	...	...	...	...	...	...	[0.0031]
D.open	...	...	...	...	...	0,0007	...
	...	...	...	...	...	[0.0005]	...
Observations	141	141	139	141	135	139	134
Number of country	48	48	48	48	48	48	48
Sargan Test (p-value)	0,001	0,0242	0,005	0,0282	0,0203	0,1224	0,2057
Serial Correlation Test (p-value)	0,0125	0,1144	0,0402	0,0035	0,0138	0,4166	0,1814

Note: The dependent variable is Technical Change Index. The regressions are dynamic panel regressions with averaged data over 5-year periods and using lagged levels as instruments as described in the text. Difference operator is denoted by "D". linitial is the logarithm of initial income per capita and sec is the secondary school enrollment. D.Cg denotes the differenced value of government size which is government expenditure as a share of GDP. D.inf is the differenced value of inflation which is the log difference of GDP deflator between two consecutive years. D.open denotes the differenced value of openness to trade which is measured as the sum of exports plus imports as a share of GDP. D.fdigdp is the differenced value of foreign direct investment net inflows as a share of GDP. D.Finvar1 is the differenced value of the private credit which is private credit by deposit money banks and other financial institutions as a share of GDP. Models (1)...(5) are not valid.

The null hypothesis of the Sargan test is that the instruments are not correlated with the residuals. The null hypothesis of the serial correlation test is that the errors in the first difference regression exhibit no second-order serial correlation. White's heteroskedasticity consistent (robust) standard errors are provided in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 22: Summary of Productivity Change Index Equations with Legal Origin Instrument

Table 22.1	(1)	(2)	(3)	(4)
Malm	**Cross Section GMM**	**Pooled GMM**	**GMM Difference (with initial, with legal origin)**	**GMM Difference (without initial, with legal origin)**
Iinitial	-0,0009	-0,0005	-0,1532	...
	[0.0013]	[0.0024]	[0.0281]***	...
Finvar1	0,0077	0,0166	0,186	0,0756
	[0.0160]	[0.0081]**	[0.0442]***	[0.0327]**

Table 22.2	(1)	(2)	(3)	(4)
Eff	**Cross Section GMM**	**Pooled GMM**	**GMM Difference (with initial, with legal origin)**	**GMM Difference (without initial, with legal origin)**
Iinitial	-0,0031	-0,0045	-0,1444	...
	[0.0014]**	[0.0024]*	[0.0420]***	...
Finvar1	0,0008	0,0103	0,1622	0,0492
	[0.0146]	[0.0102]	[0.0537]***	[0.0386]

Table 22.3	(1)	(2)	(3)	(4)
Tech	**Cross Section GMM**	**Pooled GMM**	**GMM Difference (with initial, with legal origin)**	**GMM Difference (without initial, with legal origin)**
Iinitial	0,002	0,0036	-0,04	...
	[0.0009]**	[0.0019]*	[0.0263]	...
Finvar1	0,003	0,0052	0,0318	0,0004
	[0.0071]	[0.0085]	[0.0359]	[0.0251]

Note: In the summary Table 22.1 the dependent variable is Malmquist productivity change index. In the summary Table 22.2 the dependent variable is Efficiency change index. In the summary Table 22.3 the dependent variable is technical change index.The conditioning variables are Iinitial: logarithm of initial income per capita, secondary school enrollment rate,value of government consumption as ashare of GDP, value of inflation which is the log difference of GDP deflator between two consecutive years, and value of foreign direct investment net inflows as a share of GDP. Only in Table 22.1 with pooled GMM estimation since above specification is invalid,instead of that specification logarithm of initial income per capita, secondary school enrollment rate and value of foreign direct investment net inflows as a share of GDP are used as conditioning variables.Finvar1 is the value of the private credit by deposit money banks and other financial institutions as a share of GDP. White's heteroskedasticity consistent (robust) standard errors are provided in brackets.*significant at 10%; ** significant at 5%; *** significant at 1%

Table 23: Robustness Check of Static and Dynamic Productivity Change Index Equations with Lagged Values as Instruments

Table 12.1	(1)	(2)	(3)	(4)
Malm	**Fixed Effects Lagged**	**Fixed Effects GMM**	**GMM Difference (with initial)**	**GMM Difference (without initial)**
Iinitial	-0,1075	-0,1147	-0,1024	...
	[0.0265]***	[0.0273]***	[0.0377]***	...
Finvar2	0,0779	0,0916	0,0698	0,0378
	[0.0216]***	[0.0553]*	[0.0635]	[0.0429]

Table 12.2	(1)	(2)	(3)	(4)
Eff	**Fixed Effects Lagged**	**Fixed Effects GMM**	**GMM Difference (with initial)**	**GMM Difference (without initial)**
Iinitial	-0,0746	-0,078	-0,1368	...
	[0.0264]***	[0.0326]**	[0.0412]***	...
Finvar2	0,0265	0,0437	0,143	0,0824
	[0.0326]	[0.0671]	[0.0529]***	[0.0416]**

Table 12.3	(1)	(2)	(3)	(4)
Tech	**Fixed Effects Lagged**	**Fixed Effects GMM**	**GMM Difference (with initial)**	**GMM Difference (without initial)**
Iinitial	-0,033	-0,0367	...	...
	[0.0161]**	[0.0237]	...	...
Finvar2	0,0487	0,0462	...	-0,0572
	[0.0208]**	[0.0508]	...	[0.0398]

Note: In the summary table 12.1 the dependent variable is Malmquist productivity change index. In the summary table 12.2 the dependent variable is Efficiency change index. In the summary table 12.3 the dependent variable is technical change index.The conditioning variables are Iinitial: logarithm of initial income per capita, secondary school enrollment rate,government consumption as a share of GDP, value of inflation which is the log difference of GDP deflator between two consecutive years, and value of foreign direct investment net inflows as a share of GDP. Finvar2 is the value of the private credit by deposit money banks and other financial institutions as a share of GDP. White's heteroskedasticity consistent (robust) standard errors are provided in brackets.*significant at 10%; ** significant at 5%; *** significant at 1%

Table 24: Robustness Check of Productivity Change Index Equations with Legal Origin Instrument

Table 22.1	**(1)**	**(2)**	**(3)**	**(4)**
Malm	**Cross Section GMM**	**Pooled GMM**	**GMM Difference (with initial, with legal origin)**	**GMM Difference (without initial, with legal origin)**
Iinitial	-0,001	0,0015	-0,1472	...
	[0.0013]	[0.0027]	[0.0336]***	...
Finvar1	0,0097	-0,0038	0,1348	0,0591
	[0.0154]	[0.0123]	[0.0432]***	[0.0297]**
Table 22.2	**(1)**	**(2)**	**(3)**	**(4)**
Eff	**Cross Section GMM**	**Pooled GMM**	**GMM Difference (with initial, with legal origin)**	**GMM Difference (without initial, with legal origin)**
Iinitial	-0,0033	-0,0042	-0,1334	...
	[0.0015]**	[0.0026]	[0.0428]***	...
Finvar1	0,0032	0,0038	0,1161	0,0361
	[0.0142]	[0.0100]	[0.0480]**	[0.0333]
Table 22.3	**(1)**	**(2)**	**(3)**	**(4)**
Tech	**Cross Section GMM**	**Pooled GMM**	**GMM Difference (with initial, with legal origin)**	**GMM Difference (without initial, with legal origin)**
Iinitial	0,0019	0,0057	-0,043	...
	[0.0009]**	[0.0022]***	[0.0318]	...
Finvar1	0,0041	-0,0068	0,0281	-0,0017
	[0.0079]	[0.0091]	[0.0492]	[0.0310]

Note: In the summary Table 22.1 the dependent variable is Malmquist productivity change index. In the summary Table 22.2 the dependent variable is Efficiency change index. In the summary Table 22.3 the dependent variable is technical change index.The conditioning variables are Iinitial: logarithm of initial income per capita, secondary school enrollment rate,value of government consumption as ashare of GDP, value of inflation which is the log difference of GDP deflator between two consecutive years, and value of foreign direct investment net inflows as a share of GDP. Finvar1 is the value of the private credit by deposit money banks and other financial institutions as a share of GDP. White's heteroskedasticity consistent (robust) standard errors are provided in brackets.*significant at 10%; ** significant at 5%; *** significant at 1%