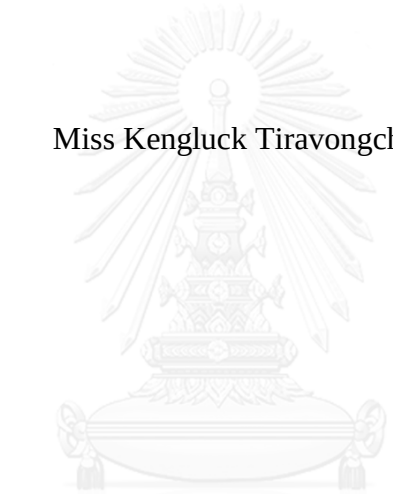
Effect of Leverage on the Growth of Total Factor Productivity: Empirical Evidence from the U.S.A.

Miss Kengluck Tiravongchaipunt



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ผลกระทบของหนี้สินต่อการเจริญเติบโตของประสิทธิภาพการผลิตของปัจจัยโดยรวม หลักฐานเชิงประจักษ์จากประเทศสหรัฐอเมริกา

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วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิทยาศาสตรมหาบัณฑิต
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เก่งลัค ถิรวงศ์ชัยพันธุ์ : ผลกระทบของหนี้สินต่อการเจริญเติบโตของประสิทธิภาพการผลิตของปัจจัยโดยรวม หลักฐานเชิงประจักษ์จากประเทศสหรัฐอเมริกา (Effect of Leverage on the Growth of Total Factor Productivity: Empirical Evidence from the U.S.A.) อ.ที่ปรึกษาวิทยานิพนธ์หลัก: ดร. รัฐชัย ศีลาเจริญ, 49 หน้า.

บทวิจัยนี้ศึกษาถึงความสัมพันธ์ระหว่างหนี้สินและการขยายตัวของประสิทธิภาพการผลิตปัจจัยโดยรวม โดยหวังที่จะแสดงให้เห็นว่าหนี้สินนั้นสามารถส่งผลกระทบต่อมูลค่าของบรรษัทเนื่องมากจากการเปลี่ยนแปลงของประสิทธิภาพการดำเนินงาน ซึ่งหมายถึงประสิทธิภาพทั้งทางด้านการบริหารและการผลิต นอกจากนี้ทฤษฎีโครงสร้างการเงินที่เหมาะสม (Trade-off Theory) ยังได้กล่าวถึงการกู้ยืมเกินกว่าระดับที่เหมาะสมนั้นจะส่งผลกระทบให้มูลค่าของบรรษัทลดลง ดังนั้นการค้นคว้าจึงเกิดขึ้นภายใต้หลักคิดของทฤษฎีโครงสร้างทางการเงินดังกล่าว โดยอาศัยแบบจำลองการวิเคราะห์สมการถดถอยขีดแบ่ง (Threshold regression model) และข้อมูลของบริษัทจดทะเบียนในอุตสาหกรรมการผลิตประเทศสหรัฐอเมริกา ครอบคลุมช่วงเวลาระหว่างปี ค.ศ. 2000 ถึง 2012 ซึ่งพบว่าเป็นช่วงเวลาที่มีการขยายตัวของหนี้สินภาคเอกชนอย่างรวดเร็ว ผลการศึกษาพบว่าการขยายตัวของประสิทธิภาพการผลิตเกิดขึ้นไปพร้อมกับการขยายตัวของจำนวนหนี้สิน ซึ่งแสดงให้เห็นว่าหารกู้ยืมนั้นช่วยยกระดับความมีประสิธภาพ หลักฐานชิ้นนี้เป็นการยืนยันได้ว่าแท้จริงแล้วหนี้สินส่งผลต่อมูลค่าของบริษัทได้อย่างไร หลักฐานอีกชิ้นหนึ่งที่ยืนยันกระบวนการนี้คือการค้นพบว่าประสิทธิภาพการผลิตมีความสัมพันธ์ในเชิงบวกต่อมูลค่า มากไปกว่านั้นในงานศึกษานี้ยังได้ศึกษาความสัมพันธ์ระหว่างหนี้สินและมูลค่าของบริษัทอีกด้วย และพบว่าทั้งสองปัจจัยสัมพันธ์กันอย่างไม่เป็นเส้นตรง อย่างไรก็ตามมีเพียงความสัมพันธ์ในเชิงลบเท่านั้นที่ถูกพบ จึงอาจกล่าวโดยสรุปได้ว่าการกู้ยืมสามรถยกระดับความมีประสิทธิภาพซึ่งเป็นประโยชน์ต่อมูลค่าของทรัพย์สินของผู้ถือหุ้น แต่ในขณะเดียวกันก็ยังชี้ให้เห็นถึงความเสี่ยงทางการเงินที่อาจตามมา

ภาควิชา การธนาคารและการเงิน ลายมือชื่อนิสิต .....

สาขาวิชา การเงิน ลายมือชื่อ อ.ที่ปรึกษาหลัก .....

ปีการศึกษา 2557

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KENGLUCK TIRAVONGCHAIPUNT: Effect of Leverage on the Growth of Total Factor Productivity: Empirical Evidence from the U.S.A.. ADVISOR: RUTTACHAI SEELAJAROEN, Ph.D., 49 pp.

This paper examines the relationship between leverage and the total factor productivity (TFP) growth hoping to give an answer that leverage affects firm value through the change in company' operating efficiency which means both managerial and production parts. Further, the trade-off theory also points out that borrowing beyond the optimal point could dampen value. Therefore, the investigation is conducted in the spirit of the capital structure theory. The threshold model is estimated on a sample of U.S. listed manufacturing companies during 2000 to 2012 which is the period that the economy encounters with a rapid credit growth in the corporate sector. Results indicate that productivity growth increases with leverage implying that leverage helps improving efficiency. This reveals how change in firm value happens by the use of leverage. The additional piece of evidence to confirm this mechanism is that firm value has a positive relation with productivity. Moreover, the link between leverage and firm value is also tested. The non-linear is found, however, the correlation is negative in all regimes. Therefore, it can be concluded that debt financing has the ability to increase efficiency which is beneficial to shareholders' wealth at the same time with the cost of higher financial risk.

Department:	Banking and Finance	Student's Signature	.....
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Section I: Introduction

1.1 Background and problem reviews

The use of debt allows ones to invest beyond their capital base taking opportunities once they can't achieve. In macroeconomic, it has played a major role in economic growth and development. Due to many financial crises, much attention has been placed on the size of public debt. Numerous studies examine the role of government borrowing and its consequences on economic growth. It is found that growth is associated with public debt differently depending on its size. At a low level of debt, borrowing more money induces greater economic activities and growth. However, the outcome of leveraging of a country that is already highly indebted is different. Poirson, Pattillo et al. (2004) find that additional debt beyond a certain level begins to generate adverse impacts on growth which is consistent with Checherita-Westphal and Rother (2012). In these works, countries with debt level beyond 90% of GDP are found to grow at a slower rate comparing to those with lower debt. Focusing on highly indebted countries, Woo and Kumar (2010) find that a 10% point increase of initial debt to GDP causes the real per capita GDP to slow down at 0.2% per year.

However, public debt is just a part of a nation's overall debt level. Corporate debt is another important driving force behind economic activities. Financial conditions in corporations do not just affect their own performances but also have powerful impacts on the macroeconomic outcome. Firms with bad financial situation are not able to make useful investments or employing more people and altogether will create unpleasant results for the economy. Bernanke, Gertler et al. (1999) indicate that a sharp increase in insolvencies and bankruptcies, rising real debt burden, collapsing asset prices, bank failures, and deteriorate credit market conditions are important elements depressing economic activities.

Talking about debt, studies in finance literature are mostly concentrated on how leverage affects firm value which is mentioned in the trade-off theory. According to the theory,

firms have to weigh between the costs and benefits of an extra unit of money before making any financing decision. This is because debt has both drawbacks and benefits. Moreover, borrowing beyond the optimal point, debt would cause the firm value to drop.

On one hand, debt creates financial burdens because part of firms' cash flow has to be used in paying interest expenses. Next, the bigger amount of debt, the higher financial risk corporates need to bear. On the other hand, debt has the tax shield benefits which increase managers' incentive to make investments because it makes the cost of fund cheaper. Other than that, debt is believed to have the ability to reduce the principal-agent conflict. Due to the different amount of information between debtholders and managers of the firms have on hand, the first party will require high interest payment in order to protect itself from opportunistic behaviors of the latter. Consequently, the optimal debt ratio of firms retreats. When managers have limited fund to access while they see many business opportunities, this constraint would pressure them to be more careful when it comes to decision making. They have to avoid suboptimal investment projects so resources are being used more efficiently. By making rational decisions whether to forego or invest in any things, not only managers are improving the firm profitability, they are doing these for their own good at the same time. Good projects make money improving managers' performance and reputation which are all beneficial to their career. These convince them to work harder. Thus reductions in agency problems would result in higher firm value. The situation would be different when debt is high, managers may become more reckless and concentrate more on short term activities because survival is an emergency matter and that resources may be utilized less efficiently.

Here comes the purpose of this study. In this paper, I study the role of debt at corporate level and its relationship with the TFP growth as I believe that the mechanism of change in value happens because firms' efficiency which can be proxy by productivity has changed. The theory also mentions that the link between the two factors can be either positive or negative, so it convinces me to think that the relation of them should be non-linear. Below optimal level,

debt can improve performance by pushing managers to work more carefully but things go the different direction when debt exceeds the threshold level.

There is neither explicit evidence of how debt reduces agency problems nor how it affects value. Comparing to previous studies about this topic, the majority focuses on the accounting ratios as a proxy of value which is, for example, the return on equity ratio, the return on asset ratio, or the fixed asset turnover ratio. The weakness of these proxy is that their implication is narrow. Taking the fixed asset turnover ratio for instance, it only measures how efficiently investments in fixed assets can generate revenues. Differently, TFP is a broader and better proxy. It can capture the aspects of both managerial and production of a firm.

In various macroeconomic papers, it is found that there are various channels which transmit effects of the financial expenses to output growth. These channels are the changes in total factor productivity growth, capital per worker, investment, and physical-factor accumulation (Poirson, Pattillo et al. 2004, Checherita-Westphal and Rother 2012, Afonso and Jalles 2013). However, the majority of output growth attributes to growth of productivity Abramovitz (1956), Kendrick (1961), Denison (1985), and Jones (1997). Moreover, and Solow (1956) finds that the TFP growth is the most crucial driven force behind the growth of income in the long run.

At corporate level, TFP also has been used to represent performance in several literatures such as the corporate control literature, the corporate finance literature, and the management accounting literature. It is advantageous in considerable ways. Firstly, long term growth depends on growth in TFP (Solow 1956). Secondly, it explains labor productivity and output. It represents efficiency level; higher efficiency allows workers to spend less hour working while they are able to increase output. Higher productivity enhances profitability which eventually results in boosted firm value (Palia and Lichtenberg 1999).Thirdly, it determines how risky the firms are (Imrohoroglu and Tüzel 2014). Low TFP firms are riskier because of their high cost of capital. During a business cycle fluctuation such as an economic

downturn, due to the higher cost of adjustment, low TFP entities are less flexible than the high TFP ones which their survivability is in danger.

What makes TFP an important number? According to the Cobb-Douglas production function, the error term measures TFP. The figures explain the incremental part of sales that is not created by the utilization of capital and labor, or it can be said that the two tangible asset created only some part of sales. Another part is the TFP. The factor reflects a joint effect of firm's intangible inputs which allow efficiently and productively working process holding the cost constant. The effects of these inputs that drive TFP work interdependent. Determinant behinds TFP does not mean innovation as it has been simply defined in many papers. TFP means creations of knowledge which come from investment in R&D. R&D could lead to new product, new process, and new knowledge. TFP means creation of skillful and healthy labor because these new things from R&D investments need to be absorbed and adopted. TFP also means effective policies from the managerial decisions on the structural change and the financial aspect because it is managers' responsibility to decide how to allocate resources. All in all, at a point where more tangible inputs no longer produce more goods, TFP as innovations will come in to create output that firms still use the same amount of tangible assets.

This study aims to study the linkage between leverage and TFP, so one will wonder how TFP is affected. According to the determinants of TFP, it can be seen that leverage affects TFP through a change in cash flow that could be used in innovative projects and also affects managers' incentive. To investigate the relationship between leverage and the productivity growth, a threshold regression model (Hansen 2000) is employed. The model has the ability to capture whether different leverage size would affect growth differently. Next step of this paper is to test whether TFP is positively related to firm value which is represented by Tobin's Q. If the result shows positive connection, so it confirms that the change in productivity is the mechanism showing how leverage transmits its impacts to affect firm value. Further, productivity could be a better proxy of firms' performance instead of the stock prices. One is

because it would confirm that the efficiency gain can boost firm value because it can be realized by investors. Two, comparing between equity prices and productivity, stock price is a weaker proxy in a way that it is a rough indicator due to the fact that it contains too much information and speculation which make it so volatile. Moreover, using price to reflect the value, one has to implicitly assume that the market is efficient. TFP is different in a way that it is the result of firms' investment implying efficiency, the higher the better. Consequently, it is expected to be used as a warning sign indicating changes in fundamental aspect instead of stock prices. Finally, since the inspiration of this paper is the trade-off theory, I expect to see the kinked connection between leverage and Tobin's Q. The finding should provide supporting evidence to the theory.

The sample consists of the U.S. manufacturing firms listed in S&P 1500. It is interesting for several reasons. After 2000, an unusually low interest rate situation makes it more interesting for firms to take loans. Especially during 2006-2009, U.S. nonfinancial corporations experienced a sharp growth in debt size. Therefore, it is important in order to maintain a sustainable level of credit growth. If this standard is overlooked allowing the credit size to grow too fast and too big that their current profitability cannot catch up with, it may need deleveraging which is costly and painful. Second, as it is the largest economy and catches global attention, changes in its economic activity would not only affect itself but also its trade partners. Finally, U.S. is the country that provides a very complete set of data which is very useful for the study.

1.2 Research questions

There are three questions I concern in this study which are

1. Does leverage affects productivity growth non-linearly?
2. Does productivity increase firm value?
3. Does leverage have a non-monotonic relation with firm value?

1.3 Objectives of the study

The first objective of this study is to find out whether leverage can continuously generate positive influences on the productivity growth by employing the threshold model. Since TFP said to be an important factor for firm value, this leads to the second objective which is to find out whether productivity is positively related to Tobin's Q, a proxy of value. For the final objective, as a provision of evidence to the trade-off theory, it is to find out how leverage would affect firm value.

1.4 Hypothesis

This study consists of four hypothesizes which are

Hypothesis I.I: There is a relation between productivity and leverage.

Hypothesis I.II: There is a non-liner relation between productivity and leverage.

Hypothesis II: There is a positive relation between firm value and productivity.

Hypothesis III: There is a non-linear relation between firm value and leverage.

1.5 Contributions

Results of my study are supposed to benefit three parties which are policy makers, financial regulators, and business executives.

This should serve policy makers and financial regulators as an evidence of the consequences of how debt in the private sector can affect total factor productivity growth which is an important element determining corporate long term growth. Allowing corporate debt to grow larger can push firms into distressed position and can adversely affect overall economic activities. Therefore, they should keep monitoring and be willing to adopt policies to slow down borrowing activity.

For business executives, this would show them how leverage can affect firms' productivity which will eventually show up in change in profitability and firm value. Therefore, to protect shareholder wealth, they should pay attention to debt size.

The rest of paper is organized as follows: Section 2 presents a review of previous studies regarding the definition of TFP, the connection between TFP and leverage, between Tobin's Q and TFP, and between Tobin's Q and leverage. Section 3 is about hypothesis setting while Section 4 contains the data used in the paper and summary statistics. Section 5explains the system GMM for the production function estimate, the threshold model for the nonlinear linkage investigation, and the fixed effect model. Section 6 provides the empirical results and the final section, Section 7, is the conclusion of this study.

Section II: Literature reviews

There are 5 areas has been reviewed relating to this work. The first topic starts with the definition of TFP. Next, evidences of how leverage influences TFP at macro level are presented. The third topic talks about the relationship between leverage and TFP at the corporate level. The following part is the evidence of how productivity creates value. Finally, Part V is reviews of the linkage between leverage and value.

2.1 Definition of TFP

When people talk about productivity, labor productivity is commonly referred. However, improvements in provision of firm-level data and in econometric methods have increased popularity in studying another type of productivity called the total factor productivity (TFP henceforth) in recent years.

For the ease of understanding the meaning of TFP, let's assume that to produce something (output) it requires two things: capital and labor (inputs). Further, assume that a firm only uses *X* units of capital and *Y* units of labor. This set of inputs can produce *Z* units of output. The firm wants to increase sale volume but does want to buy new capital or hire more employees. Therefore, the firm sends all of their employees to a training course and at the end of the course they are smarter than they used to be. They come back to work. This time the same set of *X* units of capital and *Y* units of smarter labor now can produce *Z+5* unit of output. The firm now has more goods to be sold using the same old amount of inputs.

Instead of training the employees, the firm can decide to upgrade the machines' software. The *X* machines then spend shorter processing time allowing the *Y* workers to produce more goods says *Z+7* units of output at the same amount of working hours. From both examples, the incremental amount of output (either the additional 5 units or the additional 7 units) is from the effect of TFP.

According to the example above, capital and labor are the tangible inputs while TFP is the intangible one (a training program and a newer software) which comes into the production system to increase the ability of the tangible inputs so that they can produce more goods. Thus it can be stated that TFP is the factor behind increasing capacity of both labor and capital. Where does TFP come from?

It can be said that TFP is technology. This technology is not bounded to the result of investments in R&D projects only. It also means the creation of intelligent labors making them skillful so that they are able to absorb and adopt new innovations that come into the firm. It also means the rationality of the managerial parties how to best organize and utilize resources at hand. TFP is a broader indicator of productivity than the labor productivity because what it measures all work interdependently (Beck, Levine et al. 2000, Comin 2006, Isaksson 2007).

For measurement, TFD is the residual from the Cobb-Douglas production equation. At aggregate level, TFP is calculated as an index number defining as the ratio of an aggregated output index to an aggregated input index. There are two methods to calculate it which are the Tornqvist-Theil index and the Malmquist productivity index (Fan, Hazell et al. 2000). However, the estimation using firm-level data is different due to the different data requirement and estimate difficulties.

In corporate-level TFP, it is the differences between the actual firm sales (output) and the estimated value. Therefore, the first step is to estimate the production function. By nature of estimating the production function, there is a potential correlation between inputs and unobserved firm-specific productivity shock because firms that encounter a substantial positive productivity shock may increase the use of inputs in response. Estimation using ordinary least square method gives biased estimators and the coefficient of capital is too subtle. One solution is to estimate the function using the system general method of moments suggested by Blundell and Bond (2000). The technique will be discussed in details in Section 5.

2.2 The connection between leverage and TFP at macroeconomic

Poirson, Pattillo et al. (2004), using developing countries data, study the connection between total external debt (public and private debt) and the growth rate of GDP. They find that increasing debt induces growth when initial debt level is still low but the effect is different when debt is high. The debt level that is found to produce unsatisfied impacts is around 35-40% of GDP. Schclarek (2004) also offers empirical evidence for the debt-growth nexus covering 59 developing and 24 industrial countries over 1970-2002. Owing to the definition of debt and the source of data from which it is available, data will be regressed separately between the two groups of countries. For developing countries, debt is segregated into two types: public and private external debt. For industrialized countries, it is meant to study only the role of government debt. This study also examines 3 channels which debt is expected to affect growth: capital accumulation, private saving, and total factor productivity. From the finding, debt is negatively associated with economic growth in the group of developing nations. When decomposing debt into private and public components, government debt is found to have negative impacts on growth while there is no significant evidence from the private debt factor. Channels of transmission of effect of debt on growth, there is only significant evidence for capital accumulation. For industrial nations, a paradox result is found. There is no evidence of correlation between debt and growth.

Woo and Kumar (2010) provide empirical evidence on the impact of high initial debt on subsequent growth based on a range of econometric techniques for a panel of advanced and emerging market economies over the period of 1970–2007. They find that different debt level affects growth differently. In the study, debt is split into 3 regions: low (below 30% of GDP), medium (between 30-90%), and high (over 90% of GDP). There is no relation between the factors for the debt level in the first region. However, at high debt level, the coefficient is significant through all estimation methodology showing that a 10 percentage point increases in initial debt-to-GDP ratio are associated with growth slowdown around 0.3–0.4 percent in

emerging economies while the adverse impact is smaller in advanced countries. They also take the growth accounting approach to explore channels through which government debt influences growth. There is only an evidence for this adverse impact reflecting a slowdown in labor productivity and no significant evidence for the growth of TFP.

Focusing on the European countries which have experience a sharp increase in public debt, Checherita-Westphal and Rother (2012) also reach a similar finding. GDP growth contracts when the public debt reaches 90-100% of GDP. Further, they suspect how government debt affects the nations' growth so they test these channels: private saving, public investment, total factor productivity, and sovereign long-term nominal and real interest rates. The results from the private savings, public investment, and TFP are significant and the non-linear linkage holds across models used. Afonso and Jalles (2013) find a similar result with previous studies but provided clearer evidence for the impact of debt on growth when debt is low. Using cross-sectional/time-series data from 155 countries covering both developing and advanced (OECD) countries from 1970-2008, a 10% increase in debt causes the growth to decrease by 0.2% for countries with debt level over 90% of GDP. However, the result is different for countries with low debt level say below 30%: a 10% increase in debt is associated with 0.1% increase in growth. Further in the study they also take the growth accounting approach based on measures of TFP and capital stock per worker to see to how government debt affects growth. They found that the size of government debt positively affects TFP growth rates.

In the corporate aspect, there also exist some evidences of the interaction between financing and productivity growth. Back to Schumpeter (1934), banking system helps enhancing productivity by efficiently allocates capital to the more innovative entrepreneurs. Developed financial system also allows firms to easier accessing financing by reducing financial friction so that they can engage in a high productivity activities. Beck, Levine et al. (2000) study the contribution of financial intermediary development and sources of which it

will create growth. In the study, one measurement of financial progress is defined as credits to the private sector to GDP since it is believed that advanced financial market is able to screen out bad borrowers and efficiently generates fund to entrepreneurs with positive return projects. Employing cross-country data over 63 countries during 1960-1995, the result found that better developed financial intermediary associated with higher real per capita GDP growth. For the channel of growth, they only found evidence of the growth of TFP which is positively related and the result is robust through all estimations while evidences for physical capital and private saving growth are ambiguous.

2.3 The connection between leverage and TFP at corporate level

In a similar research topic at a corporate level, Nucci, Pozzolo et al. (2005) find that firms with different propensity to invest in innovative projects seem to have a different level of total factor productivity. Further these firms which have relatively high intangible assets will face higher cost of capital according to the theory of capital structure. Jensen and Meckling (1979) and Hart (1995) suggest that firms with larger intangible asset should rely on more on equity financing in order to avoid bankruptcy costs, conflicts of interest between equity holders and debt holders, and control rights. In contrast, based on the agency problem and information asymmetry theories, Myers and Majluf (1984) suggest that firms should not rely on equity financing because they will confront severe underpricing. The research, employs a detailed dataset for a panel of Italian firms, find that leverage is negatively related to productivity: firms with lower leverage experience higher level of total factor productivity. It provides implicit evidence that better real economic activities come from a market-based system.

Owing to a long period of stagnancy Japanese economy experienced during 1990s, some say that it was because of the inefficiencies in production sector while some believe that it was the huge debt amount of bad loans in the banking system. Hayashi and Prescott (2002) find that it is due to a retreat in the rate of TFP and the institution of shorter working hours.

Then, Ogawa (2007) investigate what causes TFP to slowdown during that period. Based on a panel data set of manufacturing firms in research-intensive industries, the result shows debt affects firms' R&D investment adversely. Further, they also find evidence showing a close relation between R&D investment and firm-level TFP so they extended their study to see the impact on debt on TFP growth. The result shows that a 10% increase in the debt-asset ratio lowers TFP growth by 0.26% over the period 1999-2000.

Arizala, Cavallo et al. (2009) study directly the relation between financial development (private credit to GDP) and the growth of TFP using industry level data covering the manufacturing sector of 77 countries. The idea is based on Schumpeter (1934) and Bagehot (1878): Financial markets enhance productivity through efficient capital reallocation in the process of creative destruction, shifting capital from declining industries to those with good growth prospects. Result of the study shows that there is a significant relationship between financial development, private credit to GDP, and industry-level TFP growth. Result shows that one standard deviation increase in financial development can increase up to 0.6% of productivity per year. Levine and Warusawitharana (2014) employ firm-level data of four European countries consisting of France, Great Britain, Italy, and Spain and conduct a test of each country individually. The result shows a significant evidence of the relation between debt growth and future TFP growth: 10% increase in debt is associated with 0.08-0.23% increase in TFP in the next period. As well as the study wants to give a contribution to the existing literatures of how financial development improves economic growth, they found that the observed decline in loans from 2009-2011 corresponds to an estimated decline in labor input between 1.5-3% by the end of 2012. The study suggests that financing for the productivity improvement projects possibly be the channel of which financial development affects output and growth. In contrast to the previous studies, by employing a different method of study, Coricelli, Driffield et al. (2012) find a non-linear connection. Employing the threshold model, they find that leverage is non-monotonically associated with the growth of TFP. The model

estimated on a sample of Central and Eastern countries concludes that there are threshold values which an increase in debt from one regime to another regime causes TFP to grow differently. At low debt level, borrowing more money is beneficial to TFP growth. However, when a firm is already incurred in a huge financial burden, having more debt will cause productivity growth to contract.

2.4 The connection between corporate TFP and firm value

Kaplan (1992) believes that productivity is a driving force behind the firm value. Firms allocating resources efficiently will experience higher productivity level and that allows them to maintain a high profit margin even though they have to reduce the prices of their products. Kendrick (1961) finds that these firms are in a position to generate profit and to remain autonomous, competitive, and survival in the long run. Further, these factors will finally increase share price.

Bao and Bag (1989) study the relationship between the two factors in the U.S. oil refining and apparel industries. They measure productivity in term of productivity index: the ratio of added value (TFP) to the number of employees and find that the firm value is positively related to productivity. Riahi-Belkaoui (1999) studies the role of productivity in predicting future profitability and its impacts on firm valuation. Value-added is used to proxy for productivity, profitability is proxy by ROE, and firm value is based on the market value of the firm at the end of the year. Productivity is found not to provide much information in predicting future profitability but can explain the difference in cross-sectional market value.

Dwyer and Mercer (2001) define productivity differently but reach a similar conclusion. In the study productivity is defined in 4 different ways: capital productivity, labor productivity, average productivity, and total factor productivity. Highly productive manufacturing firms have higher Tobin's Q. Balasubramanyan and Mohan (2010) employ data of U.S. food manufacturing plants from 1958 to 1996 studied how shock to productivity (TFP)

affects firm value (Tobin's Q). The result shows that one standard deviation of TFP growth results in approximately 3% increase in firm value.

2.5 The connection between leverage and firm value

Firms have two choices of financing which are equity financing and debt financing. In the trade off theory, if firms were to choose debt financing, they will reach a decision by comparing between benefits and costs of debt. According to Kraus and Litzenberger (1973), one of the benefits comes from the interest tax shields while one of the costs is the bankruptcy problem. However, the benefits also include the mitigation of agency problem due to the reduction in the amount of free cash flow (Jensen 1986). For the costs, they also include debt overhang (Myers 1977), risk shifting (Jensen and Meckling 1979), and asset fire sales (Shleifer and Vishny 1992). Therefore, firms will borrow more and more money for their investments until expected marginal benefits are equivalent to the expected marginal costs. At that level of debt, it is believed to maximize value of the firm optimal theoretically. In brief, the theory predicts that the net benefits of debt are positive when the debt level is low and drops when debt goes higher.

In the irrelevant theorem of Modigliani and Miller (MM), the firm's value is said to be not pertained to its capital structure, after allowing for the tax advantage of interest paid on debt. To test this hypothesis, Sarma and Rao (1969) use the same set variables and the same measurement methods with what is done in MM with two exceptions. The first is fixed asset is used as a deflator since it produces meaningful result comparing with sales. They also use the earnings growth rate to proxy for growth since the fixed asset growth is not consistent with economic reasoning. The results show that firm value is tied to its debt. Further, the coefficient of debt factor is greater than the corporate tax rate , so they come up with a conclusion that benefits of debt do not solely come from the tax shield, there exists a non-tax part and the firm's value will rise up to the level leverage is considered prudent.

Firms with high debt can somehow turn to be financially distressed and the cost of finding itself in a bad situation is getting a bad rating and facing higher cost of borrowing. What else will the firms face? Opler and Titman (1994) have chosen industries experiencing an economic downturn for their investigation. The investigation seeks to determine how highly leveraged firms prior to the slowdown period end up comparing to their more conservatively financed counterparts. During the distressed period, financially distressed firms are found losing their market share to their opposing parties. This loss is possibly due to three things: customer driven, competitor-driven, and manager driven. Customers may feel uncomfortable and distrust in doing business with distressed firms. For those less leveraged firms, they may find this is a good opportunity to easier drive out vulnerable competitors by aggressively advertise or price their products. Finally, it could indicate that higher leveraged firms are faster in efficiently downsizing in response to the slowdown. However, the first and the additional forces are clearly harmful to the wealth of shareholders. These findings are contradicted to Jensen (1986) and Wruck (1990) which state that financial distress can improve performance. Highly indebtedness reduces the amount of free cash flow in the hand of managers and forces them to make difficult value-maximizing decisions, which they would otherwise let go. However, after splitting sample by size, it is found that leverage is positively related to sale growth for large, highly indebted firms that are not in contracted industries. Then the research is extended to find out whether the distress is actually a cost or a benefit by looking at the firm value. However, data on stock price and operating income are used instead of the total market value due to the lack of data on market value of firm debt. In distressed industries, high leverage firms are found to have lower equity return comparing to their less leveraged counterparts. The result is the same as in the case of operating income. In conclusion, this supports the idea that financial distress is a cost which is driven by customer and competitor prospects. Lang, Ofek et al. (1996) also find a negative relation between leverage and growth, however, the result only holds for firms that have low Tobin's Q firms which are those without a valuable investment

opportunity known to outside investors. Such relation is not located in the sample of firms with high q. The result holds irrespective of size, leverage measurement, and variables used to proxy for growth. This is consistent with the agency cost of managerial discretion which says that debt has disciplinary role.

Graham (2000) tries to answer if tax benefits of debt affect firm's decision and how big the benefits are added to firm value. For a typical firm, the tax benefit equals 9.7 percent of the firm market value and falls to 4-7 percent of firm value after net off personal taxes. Further, by observing the tax benefit function, he finds that there is a kink point (the ratio of amount of interest required to make the tax function to slope downward to the actual interest expense) where marginal benefits start to decline. Firms with kink less than one use debt aggressively (they are operating in a downward sloping area) and firm with kink greater than one can increase debt use to capture the full benefit from tax deductibility. 44 percent of the sample firms are found to have a kink at least two, they are conservatism. Further, these firms are found to be large, profitable, liquid, in stable industries, and face low cost of distress.

Cheng and Tzeng (2011) first find that debt is positively related to value of the firm which is measured by Tobin's Q without the bankruptcy cost (Altman's Z-Score (Altman 1984)) being considered. However, when incorporating the proxies of bankruptcy problems in to the model, the result shows that the positive influences of leverage to value of the firm are even higher for the firm with low bankruptcy cost. This is due to the facts that firm with lower bankruptcy probability will have better credit rationing, facing lower cost of funds, and finally contributed to higher firm value. However, based on the optimal capital structure theory which states that an increase of debt beyond optimum will decrease its value, the study does not provide any reliable evidence.

Section III: Hypothesis Development

There are pieces of evidence showing the relationship between TFP and leverage. Kollmann and Zeugner (2012) find that the higher the leverage, the more fragile the economic situation will be. Similarly, Arcand, Berkes et al. (2012) study the connection between financial depth in term of the size of private credit to GDP and economic growth. The finding is borrowing beyond the critical point creates smaller benefits. The benefits vanish as a result of growing interest expense which slows down the output growth. The result is consistent with Coricelli, Driffield et al. (2012) who find that firms' productivity increases with leverage but the benefits become smaller as leverage increases and growth turns negative finally which leverage at that point is considered excessive. They think this is because the debt burden becomes bigger so that the money assigned to the productivity improvement projects becomes less and that affects the growth rate. Thus, according to these evidences, I expect that TFP is related to leverage and the relation should be non-liner.

Hypothesis I.I: There is a relation between productivity and leverage.

Hypothesis I.II: There is a non-liner relation between productivity and leverage.

Productivity is positively associated with firm's value. Increased TFP contributes to a higher stock price. Kaplan (1992) and Kumar and Charles (2009) find that change in TFP contributes to higher stock price. Baily, Gordon et al. (1988) finds that there was a fell in capital services and in market value of equity during the 1970s productivity slowdown of U.S. industries. The result is consistent with Kaufman and Jacoby (1986) who use aggregate data from U.S., Canada, Japan, and UK. In a more recent piece of work Dwyer and Mercer (2001), using Tobin's Q for firm valuation, it is found that highly productive firms have higher value than the low productivity ones. If increase in productivity level means firms can utilize

resources effectively, market should value them higher. According to these reasons, I expect that productivity should have a positive relation with firm value.

Hypothesis II: There is a positive relation between firm value and productivity.

In the irrelevant theorem, a company's stock price will be unaffected by its capital structure. This theorem is set up under some assumptions: no tax, no bankruptcy cost, no transaction costs, and etc. However, in reality, these costs exist so firms' financing activity influences its value which is better explained by the trade-off theory. In the theory, manager would decide whether to create more leverage or not by weighting between the benefits and costs of the extra unit of the borrowed money. Borrowing beyond the optimal point would negatively impact the firm value because the costs exceed the benefits.

Studies show that productivity growth is one component that creates value. These evidences are mentioned in the previous hypothesis. Next the empirical finding of Coricelli, Driffield et al. (2012) and the trade-off theory mention non-linear relationship. Therefore, the same relation that happens between leverage and productivity growth should show up in the linkage between leverage and firm value.

Hypothesis III: There is a non-linear relation between firm value and leverage.

Section IV: Data

The data in this study come from the DataStream including U.S. manufacturing firms listed in S&P1500 from December31, 2000 to December 31, 2012. Firms listed in S&P1500 are chosen because it covers all size of firms (small, medium, and large) avoiding the size-biased issue. Further, only firms in the manufacturing sector are selected because the main interest of this study is paid to the productivity which has a start point at the production function. Due to the differences in the nature of input intensity (i.e. service sector is labor intensive while the manufacturing sector is capital intensive), by choosing all sectors, it is possible that the results will be bias and less reliable.

The use of company-level panel data allows for a better capture of firm-specific characteristics than the use of industry-level data. Moreover, improved econometric techniques have allowed researchers to attain a satisfactory result from Cobb-Douglas production function estimation using company-level panel data since the OLS regression lacks of the ability to avoid the heterogeneity and simultaneity problems.

The initial dataset consists of 771 firms with 10023 year-observations. Owing to the different standard of how companies are categorized as manufacturing industries between S&P1500 and the Standard Industrial Classification (SIC), this paper relies on the definition according to the SIC which is the standard used in most papers. The reason is the standard can group firms into each industry at a more detailed level. According to the SIC, manufacturing firms are the ones that have two-digit SIC code ranging from 20 to 39. Therefore, within these 771 firms, firms in forestry (SIC 08), metal mining (SIC 10), coal mining (SIC 12), oil and gas extraction (SIC 13), and nonmetallic minerals, except fuels (SIC 14) are omitted.

Missing and irrational observations are dropped. These observations, for instance, are firms without fixed assets, firms with zero employee, or firms with negative value of intangible assets. Distressed firms are also left out of the sample. These are firms that have zero sales or negative book value of equity. Lastly, this study uses winsorization at the 2.5% level in order

to lessen the impact of outliers. The method aims to alter the extreme values with a certain percentile value from both ends. The usefulness of this method is it takes into account of the impact of those outliers allowing for some influences. In total, the sample consists of 452 firms with 4545 firm-year observations.

Table 1: Amount of companies in each industry

This table presents the amount of firms in each industry in manufacturing sector. In my sample the firms have SIC ranged from 20 to 37.

Industry	SIC code	Amount of firms	Observations
Food and kindred products	20	43	437
Tobacco products	21	7	62
Printing and publishing	27	6	36
Chemical and allied products	28	42	427
Petroleum and coal products	29	3	14
Leather and leather products	31	27	274
Primary metal industries	33	18	163
Industrial machinery and equipment	35	51	577
Electronic and other electric equipment	36	198	1,972
Transportation equipment	37	57	583
Total		452	4,545

All hypotheses testing here employ13 variables in total which are listed below:

1. Sales (SALES)
2. Fixed assets (FIX)
3. Number of employees (EMP)
4. Total factor productivity growth (ΔTFP)
5. Total factor productivity (TFP)
6. Book leverage (B-lev)

7. Market leverage (M-lev)
8. Total assets (TA)
9. Age (AGE)
10. Intangible asset ratio (INT)
11. Foreign ownership (FRGN)
12. Tobin's Q (TQ)
13. Market share (MS)
14. Industry median leverage (INDL)

The first step before moving to testing hypotheses is the estimate of the production function to get the total factor productivity value (TFP). TFP is the residual term in the equation which is the difference between the actual and the estimated value of output (SALES). Three crucial variables which are sales (SALES) as a representative of output, fixed asset (FIX) as a representative of capital and number of employees (EMP) as a proxy of labor are essential for estimation. All nominal values are deflated by the consumer price index and are converted to log form. Next, to obtain the coefficients of each variable, the system general method of moment (the system GMM) is employed which is discussed in greater details in the methodology part. Summary statistics of variables used in the production function are presented in Table 2.

Table 2: Summary statistics of variables in production function

This table shows summary statistics of variables used in the production function estimate. All variables are in million dollars except the employees which the unit is in the number of persons. Firm sales (SALES) are a proxy of output, book fixed asset (FIX) is a proxy of capital, and employees (EMP) is a proxy of labor. Nominal variables (sales and fixed assets) will be deflated by the consumer price index and turned into log form before using in the regression.

Statistics	SALES	FIX	EMP
Mean	6,189,678.9610	1,477,071.9795	18,161.5973
Median	1,628,652.0000	281,744.0000	5,500.0000
Minimum	20,129.0000	552.0000	39.0000
Maximum	180,929,000.0000	84,435,000.0000	354,431.0000
Std. Dev.	15,168,881.7830	4,706,960.1794	36,697.7358
Skewness	53.2110	132.1372	27.3168
Kurtosis	6.4140	9.8810	4.558
Observation	4,545	4,545	4,545

Leverage is defined in two ways: book and market value (B-lev and M-lev). Book leverage is the long term debt over book value of total assets while market leverage is the long term debt over the sum of book value of debt and market value of equity. Long term debt is more interesting than the short term one because the short term debt mostly relates to firms' common activity while important investments which require a huge amount of money and require a long period to pay back are in long term category of debt. Table 3 shows the average leverage of firms in different industries. The average book leverage ratio ranges between 0.1414 (Electronic and other electric equipment) and 0.3135 (Printing and publishing) while the average market leverage ratio ranges between 0.0954 (Electronic and other electric equipment) and 0.2635 (Printing and publishing).

Table 3: Variation of leverage across industry

This table shows the mean and standard deviation of leverage in each industry. Book leverage (B-lev) is the long term debt over book value of total assets which has the mean value ranges from 0.1414 to 0.3135. Market leverage (M-lev) is the long term debt over the sum of book value of debt and market value of equity which has the mean value ranges from 0.0954 to 0.2635.

Industry	SIC code	B-lev		M-lev	
		Mean	S.D.	Mean	S.D.
Food and kindred products	20	0.2079	0.1407	0.1346	0.1116
Tobacco products	21	0.2403	0.1123	0.1787	0.1157
Printing and publishing	27	0.3135	0.1028	0.2635	0.0986
Chemical and allied products	28	0.2088	0.1161	0.1381	0.0896
Petroleum and coal products	29	0.1868	0.1635	0.1935	0.1980
Leather and leather products	31	0.1723	0.1526	0.1169	0.1278
Primary metal industries	33	0.1912	0.1074	0.1556	0.1074
Industrial machinery and equipment	35	0.2075	0.1176	0.1414	0.1008
Electronic and other electric equipment	36	0.1414	0.1514	0.0954	0.1129
Transportation equipment	37	0.2058	0.1389	0.1522	0.1226

Intangible asset ratio (INT), a representative of firm intellectual asset, is the value of firms' intangible assets over total asset. For the second and third hypothesis which is about the firm value, Tobin's Q (TQ) is used as a proxy. This study use the approximated q (Chung and Pruitt 1994) which is the firm market valuation over its replacement cost. The numerator is a sum of the market value of equity and the market value of liability while the denominator is the book value of total asset. Market share (MS) is the ratio of a firm's sales in year *t* over the sum of sale amount of all firms in the same industry. Table 4 and Table 5 are the summary statistics of all variables used throughout four hypotheses.

Table 5: Summary statistics of variables

Statistics	ΔTFP	TFP	B-lev	M-lev	TA
Mean	0.0228	2.2502	0.1773	0.1225	7,952,271.0733
Median	0.0283	2.1852	0.1683	0.1037	1,588,600.0000
Minimum	-1.0217	0.6703	0.0000	0.0000	34,423.0000
Maximum	1.2238	4.8790	0.6815	0.5858	797,769,000.0000
Std. Dev.	8.0218	1.1228	-0.2390	1.2117	273.2293
Kurtosis	-0.0028	0.7051	0.5400	1.1116	15.4347
Skewness	0.0228	2.2502	0.1773	0.1225	7,952,271.0733
Observations	4,545	4,545	4,545	4,545	4,545

Table 4: Summary statistics of variables

Statistics	AGE	INTAR	FRGN	TQ	MS	INDL
Mean	33.4095	0.2039	0.8152	1.8462	0.0242	0.1536
Median	34.0000	0.1600	0.0000	1.5859	0.0044	0.1666
Minimum	12.0000	0.0000	0.0000	0.3991	0.0000	0.0455
Maximum	50.0000	0.8875	65.0000	7.6150	1.0000	0.3076
Std. Dev.	-1.3460	0.0646	93.1605	7.5011	77.5441	-1.1077
Kurtosis	-0.1579	0.8673	8.9300	2.3099	7.8873	-0.0711
Skewness	33.4095	0.2039	0.8152	1.8462	0.0242	0.1536
Observations	4,545	4,545	4,545	4,545	4,545	4,545

Section V: Methodology

The first step in this study is to regress the production function to obtain the TFP values. Due to the fixed effect and simultaneity problems, the equation has to be estimated by using the system GMM method. When the value of this factor is obtained, then I can switch to the testing hypothesis step. In testing them, the first and the last hypotheses are to test for the nonlinear connection between factors which will be tested using the threshold regression model developed by Hansen (2000). For the second hypothesis, it is the test of the existence of the relation between factors using the fixed effect model.

5.1 TFP estimation

TFP is the residual part in the production function. Thus it is needed to estimate the coefficients in the equation first in order to obtain the value which is the difference between the actual value and the estimated value of the dependent variable from the equation (1). Therefore, the TFP growth which is the dependent variable in the first hypothesis is the TFP in period *t+1* minus TFP in period *t*.

Beginning with Cobb-Douglas production (in log-linear form):

$$y_{it} = c + \beta_n n_{it} + \beta_k k_{it} + (\eta_i + v_{it}) \quad (1)$$

$$v_{it} = \rho v_{i,t-1} + e_{it} \qquad |\rho| < 1 \quad (2)$$

$$e_{it}, \sim \text{MA}(0) \quad (3)$$

Where y_{it} is the sale of firm *i* in year *t*, c is an intercept capturing common macro technology shock, n_{it} is the number of employees (labor), and k_{it} is the fixed assets (capital) and. Of the error term, η_i is time-invariant firm-specific effects, v_{it} is assumed to be idiosyncratic and thus serially uncorrelated. β can be interpreted as the elasticity of output with respect to that factor. The equation above is not imposed a constant return-to-scale restriction.

One worry is that v_{it} may not be idiosyncratic, but may persist over time. Therefore, it is solved by allowing serially correlation (equation (2)) in this component where e_{it} is idiosyncratic error term.

In traditional estimation of the production function (1), there are problems which make the OLS method yield bias parameters which are the fixed effect and the serial correlations. To solve the problem, the solution is the implementation of GMM estimators which is to take the first difference of the equation to eliminate the firm-fixed effects and the use of lagged values of dependent variables in the first-differenced equation to eliminate the serial correlation.

However, the result is not satisfying because it produces a very low capital coefficient. This is possibly because of the weak correlation between the lagged variables and their current values making them weak instruments in the context of first-differenced GMM. As a result, Blundell and Bond (2000) suggests using lagged first-differences as instruments for equations in levels, in addition to the usual lagged levels as instruments for equations in first-differences. Therefore, the model has a dynamic representation:

$$y_{it} = c + \pi_1 n_{it} + \pi_2 n_{i,t-1} + \pi_3 k_{it} + \pi_4 k_{i,t-1} + \pi_5 y_{i,t-1} + (\eta_i^* + e_{it}) \qquad (4)$$

Where $\pi_1 = \beta_n,\ \pi_2 = -\rho\beta_n,\ \pi_3 = \beta_k,\ \pi_4 = -\rho\beta_k,\ and\ \pi_5 = \rho$. Equation (4) is in unrestricted form and is the equation needed to be estimated by the method suggested above. Therefore, after achieving consistent estimation of π_i in equation (4), they have to be tested and imposed using minimum distance method. The purpose of this step is to obtain the restricted parameter vectors β_n and β_k in equation (1).

TFP is the log productivity measured by the residual from the equation (1). To get the TFP, after obtaining the labor and capital coefficients and the intercept, ones need to calculate the value of estimated sales according to the equation (1) and deducted from the actual values. For the productivity growth which is the dependent variable in the first hypothesis, it can be estimated by taking the difference between TFP in period *t+1*and period *t*.

5.2 Threshold regression model

To search for the existence of non-monotonic connection between factors, this study employs the threshold regression model developed by Hansen (2000). The usefulness of the model for this study is the ability to identify different effects of leverage on the TFP growth while allowing for temporary deviations from the optimum. The simplest threshold model of TFP growth for the period [*t, t+1*] is

$$\Delta TFP_{i,t+1} = \alpha_1 L_{it} + \beta' X_{it} + \varepsilon_{it} \quad \text{if } L_{it} \leq \gamma \tag{5}$$

$$\Delta TFP_{i,t+1} = \alpha_2 L_{it} + \beta' X_{it} + \varepsilon_{it} \quad \text{if } L_{it} > \gamma \tag{6}$$

On the right hand side, L_{it} is leverage of firm *i* in year *t*, X_{it} is a set of explanatory variables in year *t* including: total asset (TA), age (AGE), the proportion of intangible asset in total asset (INT), foreign ownership (FRGN), productivity (TFP) to account for convergence effects (Barro, 1988) and sectoral dummies.

Total asset which is a proxy of size effect is a factor to capture differences in technology and innovative capacity that could vary across firms with different sizes. It can be either beneficial or disadvantageous to productivity. Bigger firms tend to get access to larger pool knowledge and also to enjoy the benefits of economic to scale. On the contrary, it can be a hindrance owing to the flexibility issue.

According to the previous studies of the connection between firm age and productivity, the findings are ambiguous. Young firms tend to response to recent innovations faster, having a more flexible decisions-making process, and equipping with newer capital stock. On the other hand, there is a possibility that they have less experience due to learning-by-doing and the incomparable organizational management which will put adverse impacts on overall efficiency.

Knowledge and innovation as represented by the intangible asset ratio has a direct positive impact on TFP. In a production of goods, there are two essential parts which are inputs

(employees and machines) and knowledge. In the neoclassical growth tradition, change in technology can be known as TFP growth or technological progress. Creations and accumulations of knowledge open the new way for innovations. Therefore, while inputs are to produce, knowledge and innovation make specialization that concerns how best labor and capital are utilized.

There are plenty methods to enhance productivity, the most famous way is to invest in R&D projects. The goal is to create new knowledge. Other than new knowledge, investment in these projects is expected to yield a better understanding and to find an easier way to imitate those existing discoveries. R&D can come from two sources. It can come from either domestic or from international spillovers. Both channels are found to be essential for TFP growth.

By combining the equation (4) and (5), it becomes

$$\Delta \mathrm{TFP}_{\mathrm{i,t+1}} = \alpha_1 \mathrm{L}_{\mathrm{it}}\, l(\mathrm{L}_{\mathrm{it}} \leq \gamma) + \alpha_2 \mathrm{L}_{\mathrm{it}}\, l(\mathrm{L}_{\mathrm{it}} > \gamma) + \beta' \mathrm{X}_{\mathrm{it}} + \varepsilon_{it} \qquad (7)$$

l(...) is an indicator function showing whether leverage of firm i at time t is less than, equal, or greater than the threshold parameter. The error term $\varepsilon_{it}$is assumed to be independent and identically distributed error with mean zero and finite variance.

After the threshold value is identified, sample will be divided into regimes. For regressions of the sample in each regime, the coefficients α and β are found to be dependent on the leverage threshold value. According to this, the sum of square error (SSE hereafter) of the equation (7) is not linear in the parameters; it becomes a step function where steps appear at some values of threshold variable. To solve this problem, linear assumption of SSE in α and β has to be made. Hence the threshold value that is valid according to the condition is the one that gives the lowest SSE. To identify the value, this can be done by doing the grid search over 393 leverage quintiles (1%, 1.25%… 98.75%, 99%). Once the value of γ (the one that produces the lowest SSE) is found, the estimations of the slope parameters ($\hat{\beta}$and $\hat{\alpha}$) are now ready.

If the threshold exists (meaning that α_1 is not equal to α_2), one can test its significance by employing Lagrange multiplier and form confidence interval by inverting the likelihood ratio ($LR_n(\gamma)$). However, Hansen (2000) shows that the $LR_n(\gamma)$ appears to be nonstandard and non pivotal in the model. Accordingly, it is suggested that the correct distribution function and appropriate asymptotic critical value can be computed from the bootstrapped standard errors.

Forming confidence interval allows us to split the sample into three groups (low, intermediate, high) and to see whether the size of leverage affect the TFP growth differently. To this step, the equation becomes

$$\Delta TFP_{i,t+1} = \alpha_1 L_{it} I(L_{it} \leq \gamma_1) + \alpha_2 L_{it} I(\gamma_1 < L_{it} \leq \gamma_2) + \alpha_3 L_{it} I(L_{it} > \gamma_2) + \beta' X_{it} + v_{it} \quad (8)$$

After splitting samples into each regime, coefficients α and β now can be estimated. To establish the asymptotic distribution of the slope coefficients, normal distribution theory is applied. Even though the values of these parameters still depend on the threshold values, Hansen (2000) has shown that this dependence is not of first-order importance. Consequently, I can use the usual distribution theory to calculate p-value for testing the coefficients ($\alpha_1 = \alpha_2 = \alpha_3 = 0$). Rejection of the null hypothesis indicates a significant threshold effect.

These procedures are applied to the test of the third hypothesis which is the finding of the evidence of the non-linear relation between leverage and Tobin's Q. The equation is

$$q_{it} = \alpha_3 L_{it} + \beta' X_{it} + \varepsilon_{it} \qquad \text{if } L_{it} \leq \gamma \quad (9)$$

$$q_{it} = \alpha_4 L_{it} + \beta' X_{it} + \varepsilon_{it} \qquad \text{if } L_{it} > \gamma \quad (10)$$

Where q_{it} is the Tobin's Q of firm *i* in year *t*, L_{it} is leverage and X_{it} is a set of controlling variables including of the firm *i* in year *t*: employees (EMP) which is a proxy of size effects, market share (MS) which is a proxy of firms' reputation, the proportion of intangible asset in total asset (MS) is a representative of firms' knowledge capital, and industry median leverage.

Section VI: Empirical Result

There are 3 parts according to my research questions. The first point is the relation between the growth of productivity and firms' leverage. The second issue is the link between the q ratio and the productivity and the last one is the connection between the q ratio and leverage. The first step of all is to estimate the production function. As an initial assessment of all hypothesis testing, I check the correlations between variables. Finally, the non-monotonic relation is investigated using the threshold model and coefficients are measured by the fixed effect method corrected for the heteroskedasticity.

6.1 Production function estimate

This part reports the result of the production equation estimate. Here I report both the unrestricted and restricted models. The unrestricted model (equation (4)) is the outcome from the system GMM and then the model needs to be transformed back to the restricted form (equation (1)) by imposing minimum distance procedure to get the restricted coefficients of labor and capital which are essential for TFP calculation.

The result of the unrestricted form is reported in Table 6. To test for the validity of instruments used in the equation (4), the Sargan test reports a p-value of 0.024 meaning that the results estimated are reasonable (reject the null hypothesis at 1% significant).

Table 6: Coefficients estimated from the unrestricted form of production function

This table presents the result of the production equation (4) estimated by the system GMM. The method is to use the lagged values as instruments to solve the serial correlation problem.

Dependent variable: $SALES_t$ / **Variables**	**Coefficients**	**Standard error**
EMP_t	0.4691 ***	0.1375
EMP_{t-1}	-0.2083 *	0.1234
FIX_t	0.3227 ***	0.1097
FIX_{t-1}	-0.2824 ***	0.1063
$SALES_{t-1}$	0.6225 ***	0.6201
Intercept	0.8015**	0.3327

∗significant at 10% level; ∗∗significant at 5% level; ∗∗∗significant at 1% level.

The next step is to get the common factor restrictions (the labor and capital coefficients in the equation (1)) and test its validity by imposing a minimum distance procedure. The result is presented in Table 7. The reported probability of common factor is 0.274 which means that these restricted coefficients are accepted. The value of labor coefficient is 0.507 while the capital coefficient is 0.224.

Table 7: Coefficients estimated from the restricted form of production function

This table shows the post estimation procedure of the equation (4). It is to obtain the labor and capital coefficients in the equation (1) which can be done by imposing the minimum distance process to the production equation (4).

Dependent variable: $SALES_t$ / **Variables**	**Coefficients**	**Standard error**
EMP	0.5074***	0.1137
FIX	0.2243***	0.0744
Intercept	0.8015**	0.3327
Prob [COMFAC]	0.2745	

∗significant at 10% level; ∗∗significant at 5% level; ∗∗∗significant at 1% level.

As it can be seen in Table 7, the sum of the labor and capital coefficients is less than one. This is because the constant return to scale (CRS) is not constrained which has become the

way of doing in recent production function estimate taking Levine and Warusawitharana (2014), Coricelli, Driffield et al. (2012), Yasar, Raciborski et al. (2008) for example. Under the CRS condition, if each input is paid according to its marginal product, long run economic profit in the perfect competitive market will be zero because all output is distributed to inputs. However, in fact, this zero economic profit can happen by the competition regardless of the nature of production function. Good firms will dominate the market and bad firms will have to exits the market. Therefore, the input coefficients are allowed to be estimated freely.

Coefficients shown in Table 7 will be applied to equation (1) to get the estimated values of sales. Therefore, to get TFP, it is the product when the estimated sales are deducted from the actual sales. Its statistics are already presented in Table 4.

6.2 The relationship between leverage and productivity growth

Table 8 shows the correlations between factors employed to test the link between the productivity growth and leverage.

Table 8: Correlations between variables for testing the link between the productivity growth and leverage

	ΔTFP_{t+1}	$B\text{-}lev_t$	$M\text{-}lev_t$	TFP_t	TA_t	AGE_t	INT_t	$FRGN_t$
ΔTFP_{t+1}	1							
$B\text{-}lev_t$	0.0301	1						
$M\text{-}lev_t$	0.0043	0.8908	1					
TFP_t	-0.1666	0.1386	0.1322	1				
TA_t	-0.0423	0.2787	0.2328	0.3379	1			
AGE_t	-0.0258	0.0523	0.0277	0.1494	0.3307	1		
INT_t	0.0317	0.2386	0.1698	0.0525	0.2293	0.0798	1	
$FRGN_t$	0.0357	-0.0245	-0.0101	0.0475	0.0198	-0.0812	-0.0138	1

From the table, the correlation between leverage and the productivity growth shows a positive sign for both the book and market measures. The correlation is 0.0301 for the book leverage while it is 0.0043 for the market leverage.

According to the correlation matrix, leverage is positively related to productivity growth regardless of the debt measurements. Therefore, before moving to the threshold effect investigation, it is better to check whether this relationship is significant or not first.

Interest expense varies according to the amount of debt firms have in each period, so the different debt burden could affect productivity differently. This result in the fluctuation of the error terms and as a consequence it is likely to cause heteroskedasticity. Thus I do the Breusch-Pagan test and the results indicate the error terms are heteroskedastic for both definitions of the leverage. I use the heteroskedastic-consistent procedure for the regression and the result is showed in Table 9.

Table 9: Result of the regression between the TFP growth and leverage

The table presents the regression result between the TFP growth and leverage after controlling for firm characteristics and correcting for the fixed effect and heteroskedasticity.

Dependent variable: ΔTFP_{t+1}	**Coefficients**	**Coefficients**	**Dependent variable: ΔTFP_{t+1}**	**Coefficients**	**Coefficients**
Variables			**Variables**		
B-lev$_t$	0.0336**	0.0511***	M-lev$_t$	0.0889*	0.0390*
TFP$_t$	-0.4799***	-0.0618***	TFP$_t$	-0.4883***	-0.0621***
TA$_t$	0.0477***	0.0102***	TA$_t$	0.0526***	0.0108***
AGE$_t$	-0.0411***	-0.0003*	AGE$_t$	-0.0413***	-0.0003*
INT$_t$	0.0942*	0.0230*	INT$_t$	0.1098**	0.0277*
FRGN$_t$	-0.0004	0.0009	FRGN$_t$	-0.0005	0.0009
Intercept	1.4358*	-0.0495*	Intercept	1.4071*	-0.0530*
Firm fixed effect	Yes	-	Firm fixed effect	Yes	-
Industry dummy	-	Yes	Industry dummy	-	Yes
Year dummy	Yes	Yes	Year dummy	Yes	Yes
R-square	0.2423	0.1673	R-square	0.2431	0.1656
Observations	4,545	4,545	Observations	4,545	4,545

∗significant at 10% level; ∗∗significant at 5% level; ∗∗∗significant at 1% level.

The regression results confirm that leverage and the productivity growth are positively correlated after controlling for other firm characteristics. Next, to check the non-linear effect, the leverage threshold is established by using the heteroskedasticity-consistent procedure of the

threshold model. The results of threshold identification is in Table10. Results find that the book leverage threshold is 0.3120 and the market leverage threshold is 0.5954. However, the significant test of the threshold values shows p-value of 0.1352 and 0.6424 respectively meaning that both of them are not significant. Therefore it can be concluded that productivity growth is linearly and positively related to the firm leverage.

Table 10: Result of the threshold identification from the regression between the TFP growth and leverage

Threshold variables	Threshold estimates	95% CI	Bootstrapped p-value	Observations
B-lev	0.3120	0.2193-0.4737	0.1352	4,545
M-lev	0.5954	0.5859-0.5954	0.6424	4,545

∗significant at 10% level; ∗∗significant at 5% level; ∗∗∗significant at 1% level.

Without the threshold effect, it means that the TFP growth is associated with leverage linearly. Therefore, the relations between the dependent variable and the independent variables are the result of the initial step which is already displayed in Table 9.

Table 9 reveals that leverage is positively related to productivity growth. The result is consistent in both measurements of leverage. The coefficient of book leverage (B-lev) is 0.0336 while it is 0.0889 for market leverage (M-lev) (based on the model with highest R^2). For book leverage case a firm that has a debt ratio of 0.2, for example, would enjoy net benefits from leverage in form of 0.6720% extra productivity growth compared with a firm without debt. For the market leverage case, the firm would leap net benefits in form of 1.778% extra productivity growth compared with a firm with zero debt.

My finding is similar to Ogawa (2007), Levine and Warusawitharana (2014), and Coricelli, Driffield et al. (2012).

For other variables that could have impacts on firms' productivity growth, firms' initial productivity level (TFP), size (TA), age (AGE), and proportion of intangible asset (INT) are significant. The coefficient of lagged productivity (TFP) is negative which is in line with the

prediction of the neoclassical model and the finding of Barro (1996). This negative sign indicates a conditional rate of convergence meaning that there is an inertia for a firm to reach its long-term position. For size aspect, the coefficient is positive implying that larger firms would have higher competitive advantages in accessing a larger pool of knowledge and also the benefits from the economic to scale. In the correlation matrix (Table 8), the correlation between size and age is positive, therefore, larger firms would have less flexibility in the decision making process due to the negative sign of the age coefficient. The intangible asset ratio coefficient (INT) is positive. This factor is an implication of firms' investment in intangible factor which can be patents or trademarks. Improvement in these components is found to be beneficial to productivity growth.

6.3 The relationship between productivity and firm value

Table 11 is the result of the relation between firm value and productivity. It shows that productivity (TFP) is positively related to value (Tobin's Q) meaning higher productive firms are valued higher. The result is consistent with Kaplan (1992), Riahi-Belkaoui (1999), and Dwyer and Mercer (2001). They explain that an increase in productivity means the ability to produce good using less time and/or lower cost. The ability to work efficiently and productively would make firms to be more competitive leading to higher profitability which in the long run the market will realize it and value them higher.

Table 11: Result of the regression between TFP and Tobin's Q

Dependent variable: TQ_t	Coefficients	Coefficients
Variables		
TFP_t	0.2654***	0.1274**
Firm fixed effect	Yes	-
Industry dummy	-	Yes
Year dummy	Yes	Yes
R-square	0.1337	0.1321
Observations	4,545	4,545

∗significant at 10% level; ∗∗significant at 5% level; ∗∗∗significant at 1% level.

6.4 The relation between leverage and firm value

The first part of this study is the investigation of the impact of leverage on the productivity growth which is to find out whether leverage is associated with productivity growth in a non-monotonic manner. The finding is that corporate debt is linearly related to the productivity growth in a positive direction. Next, in the second part, productivity is found to be positively linked to firm value suggesting that firms with higher productivity will be valued more.

As this study is inspired by the trade-off theory, this part aims to provide evidence to it by testing the relation between leverage and the q ratio which is a proxy of firm value. According to the theory, leverage is related to value positively until it reaches a critical point. At low debt level, firm value increases as leverage increases, however, net benefits diminish as leverage goes up and vanishes finally. Beyond this point, having more leverage jeopardize the value because the burden from the borrowed fund outweighs the benefits.

The first step of the investigation is to see the correlation between the two factors and other controlling variables. Table 12 is the correlation matrix and it shows that the link between leverage and the q ratio is negative for both book and market leverage. The correlation is -0.2646 for the book leverage (B-lev) and -0.4498 for market leverage (M-lev).

Table 12: Correlations between variables for testing the link between the Tobin's Q and leverage

	TQ_t	$B\text{-}lev_t$	$M\text{-}lev_t$	EMP_t	MS_t	INT_t	$INDB_t$
TQ_t	1						
$B\text{-}lev_t$	-0.2646	1					
$M\text{-}lev_t$	-0.4498	0.8945	1				
EMP_t	-0.1075	0.2643	0.2073	1			
MS_t	-0.0164	0.1270	0.1099	0.3823	1		
INT_t	-0.1124	0.2384	0.1667	0.2243	0.0055	1	
$INDB_t$	-0.1690	0.2461	0.2450	0.1993	0.2191	0.0786	1

Next I test the heteroskedastic problem and the result indicates that the error does not have a constant variance in both book and market equations. Therefore, in the threshold diagnosing step, the heteroskedasticity-consistent regression is employed.

Table 13: Result from the threshold regression between the firm value and leverage

Dependent variable: Tobin's Q				
	Threshold variable: B-lev			
	Threshold estimate	**95% CI**	**Bootstrapped p-value**	**Observation**
1st regression	0.0943***	0.0804-0.1130	0.0000	4,545
2nd regression	0.4360***	0.1172-0.4425	0.0000	3,040
	Threshold variable: M-lev			
	Threshold estimate	**95% CI**	**Bootstrapped p-value**	**Observation**
1st regression	0.1012***	0.0997-0.1054	0.0000	4,545
2nd regression	0.1780***	0.1762-0.1797	0.0000	2,323

∗significant at 10% level; ∗∗significant at 5% level; ∗∗∗significant at 1% level.

The result is located in Table 13. After testing the non-linear relation, there is clear evidence that the relation between Tobin's Q and leverage is not monotonic. Using the book leverage as a threshold variable, in the first regression using the full sample (4,545 observations), the threshold value is found at 0.0943 and is highly significant. In methodology, after finding the threshold value, the sample should be divided into three regimes according to the confident interval (1. B-lev $\leq$ 0.0804, 2. 0.0804 < B-lev $\leq$ 0.1130, 3. B-lev > 0.1130).

However, by following that method, the amount of observations in the second group (0.0804 < B-lev ≤ 0.1130) is not sufficient for further regression which is the step to get the leverage's and other variables' coefficients. Instead I split observations into two groups according to the threshold value (1. B-lev ≤ 0.0943 and 2. B-lev > 0.0943) and use the second group sample (B-lev > 0.0943) which has 3,039 observations for further threshold regression.

In the second regression which uses the data of firm observations that have book debt greater than 0.0943, the leverage threshold is found at 0.4360 and it is significant. In sum, to search for the leverage threshold using book leverage as an indicator, observations can be divided into three groups:

1.) B-lev ≤ 0.0943

2.) 0.0943 < B-lev ≤ 0.4360

3.) B-lev > 0.4360

The same procedures are repeated when the market leverage is used as a threshold variable. In this case, there are two threshold values found which is 0.1012 and 0.1780. Therefore, observations are split into three regimes:

1.) M-lev ≤ 0.1012

2.) 0.1012 < M-lev ≤ 0.1780

3.) M-lev > 0.1780.

After separating observations into groups, each group is regressed separately to get the coefficients. The results are shown in Table 14. For book leverage case, even I have found evidence of threshold effects, only the debt coefficient in the second regime (0.0943 < B-lev ≤ 0.4360) is significant. It indicates that value and leverage share a negative connection (-0.6240). For market leverage case, the debt coefficients are significant in all regimes showing a negative sign of the relation between leverage and value. However, the magnitude is smaller as debt increases. At low debt level (M-lev ≤ 0.1012), the coefficient is -5.4781, the coefficient

becomes smaller at -3.0569 when moving to the higher regime ($0.1012 < \text{M-lev} \leq 0.1780$) and finally it becomes -1.3723 in the last regime ($\text{M-lev} > 0.1780$).

Table 14: Result from the threshold regression between the firm value and leverage

Dependent variable: Tobin's Q					
B-lev ≤ 0.0943			**M-lev ≤ 0.1012**		
Variables	**Coefficients**	**Coefficients**	**Variables**	**Coefficients**	**Coefficients**
B-lev	-0.5010	-1.5021	B-lev	-5.4781***	-5.3331**
EMP	-0.2590	-0.1211*	EMP	-0.2657*	-0.0462
MS	9.9371***	7.6834***	MS	8.7391***	3.4530**
INT	1.9009***	1.5868***	INT	1.5870***	1.1926***
INDB	-2.6843**	-2.7343**	INDB	-1.9078***	-1.8869**
Intercept	5.2111***	4.7605***	Intercept	5.3079***	3.9858***
Firm fixed effect	Yes	-	Firm fixed effect	Yes	-
Industry dummy	-	Yes	Industry dummy	-	Yes
Year dummy	Yes	Yes	Year dummy	Yes	Yes
R-square	0.2365	0.2311	R-square	0.2321	0.2236
Observations	1,506	1,506	Observations	2,236	2,236
0.0943 < B-lev ≤ 0.4360			**0.1012 < M-lev ≤ 0.1780**		
Variables	**Coefficients**	**Coefficients**	**Variables**	**Coefficients**	**Coefficients**
B-lev	-0.6240***	-0.5883***	B-lev	-3.0569***	-3.1204***
EMP	-0.1589***	-0.0588**	EMP	-0.1572**	-0.0798***
MS	0.7754*	0.7099	MS	0.3915	0.4684
INT	0.9890***	0.8106***	INT	0.5122**	0.2794*
INDB	-0.0211	0.1396	INDB	0.4000	0.5323
Intercept	3.4569***	2.7152***	Intercept	3.5939***	2.9311***
Firm fixed effect	Yes	-	Firm fixed effect	Yes	-
Industry dummy	-	Yes	Industry dummy	-	Yes
Year dummy	Yes	Yes	Year dummy	Yes	Yes
R-square	0.1997	0.1925	R-square	0.2444	0.2300
Observations	2,825	2,825	Observations	1,101	1,101
B-lev > 0.4360			**M-lev > 0.1780**		
Variables	**Coefficients**	**Coefficients**	**Variables**	**Coefficients**	**Coefficients**
B-lev	0.7501	0.4696	B-lev	-1.3723***	-1.3896***
EMP	-0.1059	-0.0571	EMP	-0.0639**	-0.0347**
MS	0.5266	0.4988	MS	0.2738	0.1653
INT	0.8756	0.1203	INT	0.3487**	0.1169
INDB	-1.9622	-2.1518*	INDB	0.2962	0.3308
Intercept	2.6922	2.2872***	Intercept	2.2757***	2.0147***
Firm fixed effect	Yes	-	Firm fixed effect	Yes	-
Industry dummy	-	Yes	Industry dummy	-	Yes
Year dummy	Yes	Yes	Year dummy	Yes	Yes
R-square	0.2555	0.2442	R-square	0.4263	0.4184
Observations	214	214	Observations	1,208	1,208

∗significant at 10% level; ∗∗significant at 5% level; ∗∗∗significant at 1% level.

In the first hypothesis, I find that leverage help increasing productivity. Next, this productivity is found to be beneficial to firm value. However, in this part, the result is different because leverage does not seem to be supportive of firm value as I have expected.

Based on the properties of debt, finding in this part support the notion saying that borrowing incurs costs. These costs are the interest expenses and bankruptcy cost. Therefore, the negative relation that I have found can be interpreted that leveraging increases financial risk and that firms with high financial burden are valued less.

For other controlling variables, coefficients of intangible asset ratio (INT) which is a proxy of stock of intellectual assets and market share (MS) which is a proxy for reputation and trustworthiness show positive sign to value while the coefficients of industry median leverage and number of employees are negatively related to value. The negative sign of the size proxy indicates that, even large firms can access to a bigger pool of resources or knowledge, they are less flexible to exploit them.

Section VII: Conclusion

In the tradeoff theory, leverage can be either supportive or discourage firm value which is a key issue to both managers and equity holders. Debt is beneficial to value because of the tax shield and discipline of the managers. In contrast, debt also can be dangerous because interest expenses and financial risk accelerate as it increases. The theorem indicates that the relation between the two components is not linear, it can be positive when leverage is low and it can turn to be negative if debt is too high. However, several studies on this topic focus on the use of accounting ratios such as the return on asset ratio, the return on equity ratio, or the fixed asset turnover ratio as a proxy. The weakness of these ratios is the fact that they provide a narrow aspect of firms. Therefore, instead of using accounting components, this work uses the total factor productivity (TFP henceforth).

This paper investigates the non-linear relation between leverage and productivity growth using the threshold regression model (Hansen 2000). The model is suitable in the way that it has the ability to identify different effects leverage could have on productivity growth providing evidence whether the non-linear linkage exists. Further, it is also expected to provide evidence how change in firm value is brought about by leverage showing the mechanism beneath the theory's explanation.

About TFP, the variable measures the additional part of sales not generated by the use of tangible asset says employees and machines which can be estimated by the residual component in the production function. TFP is a better proxy comparing to those accounting ratios because, while the ratio has a narrow interpretation of firm value, TFP reflects broader aspects of firms. It implies for efficiency of both production part showing how good factors of productions are utilized and managerial part showing how good managerial people have worked for their entities. Further, the factor is found to have an important implication for corporate long

term growth and survival because it relates to the ability to control cost which means firms' competitiveness.

Next step in this study is the test of the link between the value which is represented by Tobin's Q (the q ratio) and productivity. If the change in productivity is the mechanism that link leverage to firm value, TFP should be positively associated to Tobin's Q. Further, I think that TFP is a better proxy of firm value than stock prices. Prices contain too much noise and are highly volatile. And it can be a correct measurement of firm value only if the efficient market assumption holds. Consequently, if the result is significant, it is expected to be used as an indicator instead of stock prices. The final part of this is the regression of the q ratio on leverage since the inspiration of this paper come from the trade-off theory.

Investigations are conducted at the corporate level using data of U.S. manufacturing firms during 2000-2012 which covers the period that the country is having a huge amount of debt in the corporate side. I find a positive relationship between debt financing and productivity growth showing that debt has the ability to improve firms' efficiency. Further, this improved efficiency is recognized by investors showing a positive sign when the q ratio is regressed on the productivity. Firms with higher efficiency will be valued more. Finally, I find that leverage is disadvantageous to firm value showing a negative coefficient. Therefore, apart from the benefits of debt in form of efficiency gain, debt also incurs costs. Debt has negative impacts on firm value. Leveraging creates both financial burden and increasing financial risk which put a downward pressure on firm value.

In brief, my finding shows that leverage enhances productivity growth and thus firms with higher productivity have higher value. These findings give evidence to the tradeoff theory by showing how financing can affect shareholders' wealth. Nonetheless, leveraging also increases the risk in terms of higher interest expenses and financial distressed risk.

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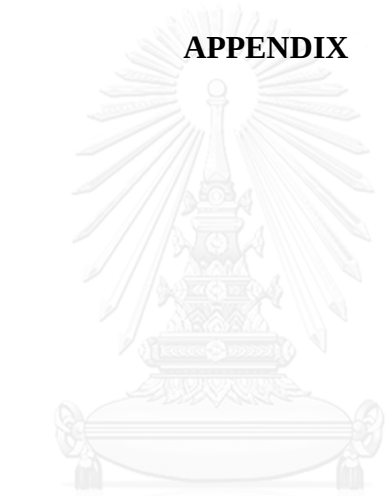
APPENDIX



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