THE EFFECT OF VENTURE CAPITAL NETWORKS AND INSTITUTIONS ON PORTFOLIO COMPANIES' PERFORMANCE IN SOUTHEAST ASIA

BY

MR. NATDANAI ALEENAJITPONG

A DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY (BUSINESS ADMINISTRATION)
FACULTY OF COMMERCE AND ACCOUNTANCY
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ENTITLED

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ABSTRACT

Venture capital firms (VC) have encountered with uncertainty and risk of asymmetric information due to an investment in early-to-growth stage and technology-based start-ups. Venture capital syndication network helps reduce a broad gap of information asymmetry and agency problem in a venture capital investment. Although agency and asymmetric information theory help motivate the formation of networks in emerging venture capital markets, Institutional theory is more suitable in explaining this situation, as the practice of venture capital appears to be influenced from institutional changes. As network connections are found to be the success factor for venture capitalists under a lack of fully developed institutional environment in emerging market. Venture capital industry in Southeast Asia is nascent yet in demanding and fast growing. Southeast Asia (SEA) is one of the most significant and dynamic propellers of the world economy. To clarify the role of networks and institutions on VC-backed firms in SEA VC market, we then investigate the relationship between networks and institutions and their impact on portfolio company's performance. We quantified VC networks with more tangibly and visibly quantitative approach by applying social network analysis. We further proposed a theoretical framework representing that different level of VC networking involved in different institution development offers different performance advantages of VC backed

companies. Our study initiated an empirical evidence by quantifying VC networks and institutions among SEA countries and implementing time-series pooled regressions through the performance of VC-backed companies. The result reveals that VC network could compensate for less formal institution in providing a better performance of their portfolio companies. There is joint effect in terms of the substitution and support between institutional development and VC network centrality within Southeast Asian syndication networks on shaping portfolio companies' profitability. Other interesting issues found in this study include success factors of ventures beside venture capital networks and the negative VC network effect in Singapore.

Keywords: Venture Capital, Venture Capital Networks, Institutions, Portfolio companies' performance, Southeast Asia

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Mr. Natdanai Aleenajitpong

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

Symbols/Abbreviations	Terms
VC	Venture Capital
SEA	Southeast Asia
ASEAN	Association of South East Asian Nations
BA	Business Angel
PE	Private Equity
OLS	Ordinary Least Square Regression

CHAPTER 1
INTRODUCTION

1.1 Motivation

Venture capital firms (VC) help startup companies take their first step by providing seed money with an exchange for an equity stake in the firm. VCs are looking for small companies who potentially become large and fast growing. They provide a room for small business to grow from early startup phrase with the expectation that a very small number of the startups will become success. The major role of VC commonly begins with selecting firms, structuring and monitoring to ensure an efficient and well organization, adding value to portfolio firms to keep on the desired direction and reach the achievement, and finally drawing themselves from the share before the firm goes to an initial public offering(IPO) (Ahlstrom & Bruton, 2006). As a nature of venture capital investment, most start-up companies have limited capital and resources, yet high technology orientation and high growth potential. Uncertainty and risk are highly presence and a level of information asymmetry between venture capitalists and start-ups may become more extreme. This phenomenon may induce discrepant interest between VCs and investees in business management, which aligns to classic theories in cooperate finance, an agency theory and a theory of asymmetric information. By these means, venture capital investors rarely provide funding solely, they are usually motivated to form a syndicate to invest in their common target investees (Bygrave, 1988, Lerner, 1994). This characteristic helps connect each venture capital firms as a whole network, so called “venture capital network”. The network from venture capital syndication provides an access to various advantageous resources, such as, expertise, information and capital (Brander et al., 2002). Not only does VC syndicating investment provide the opportunity of accessibility, it also helps diversify the risk of informational uncertainty and their portfolio investment (Bygrave, 1988; Lerner, 1994; Hochberg et al., 2007), and consequently help increase their backed firm’s value (Lerner, 1994; Hochberg et al., 2007).

Several documents investigated the extent to which the VC syndication network relates to a performance of VC firms, but a few studied a relation of VC networks and a performance through the lens of VC-backed companies. This issue even has a little discussion in emerging market. We would like to focus on the entrepreneur's point of view if their funder connections affect or relate to their performance. Our research provides more entrepreneurial oriented, which probably be a better approach to develop an efficiency of local (domestic) entrepreneur and SMEs, which are an important propeller to emerging economies (Kuen, 2014). Southeast Asia is regarded as the sixth-largest economy in the world and remains one of the most dynamic economies of the globe. While the current report shows that the mature venture capital market has been declining in the number of deals, the VC in South East Asia reach four year high from 2015 to 2017 (Singapore venture capital and PE association, SVCA, May 2018). However, venture capital industry in Southeast Asia is nascent yet in demanding and fast growing. By these reasons, it attracts our attention to explore venture capital networks in Southeast Asia and examine how VC networks relate to their portfolio companies' performance. Thus, the first research question is that "Is network centrality positively related to the operating performance of portfolio companies?" As majority papers revealed the positive relationship (Hsu, 2004; Hochberg et al., 2007; Tian, 2011). For instance, Hochberg et al. (2007) found that VC funds with high degree of VC networks experience significantly better performance than the lower ones, and portfolio companies of those VC firms are significantly more likely to continue being funded in subsequent financing and eventual exit. We then conjecture that more central position of VC firms in the network would in turn provides a positive result to portfolio companies' performance.

Although agency and asymmetric information theory help motivate the formation of networks in emerging venture capital markets, Institutional theory is more suitable in explaining this situation, as the practice of venture capital appears to be influenced from institutional changes (Ahlstrom & Bruton, 2006). Scott (2001) categorized institutions into three levels of formality of institution development: regulatory, normative, and cultural-cognitive, starting from the most formal to the least formal respectively. Regrading to institutional theory, it provides an extent to which social and cultural elements play an important role in different institutional contexts

and lead to different function and level of venture capital networks in emerging markets. Another interesting issue that has been discussed for a while in emerging VC studies is the differences of institutional development between mature and emerging economies. Several scholars have found different characteristics of venture capital market between developing and developed countries in many aspects including culture, government support, institution and regulation (Jeng & Wells, 2000; Groh & Wallmeroth, 2016). According to a study of venture capital across different countries with heterogenous economies, Bellavitis et al. (2014) suggested that we should consider macro-institutional factors (e.g. regulation, cultural dimensions). Further, Lingelbach (2015) revealed that country-level institutional dimensions play a pivotal role in facilitating the VC development process in emerging economies. From empirical evidence, formal institutions demonstrated a positive impact on the level of venture capital activity (Li & Zahra, 2012). The more institutional differences between VCs and ventures is, the less likely venture capital exit will become success (Li et al., 2014). Thus, we raise the second research question that "Are institutional differences related to the performance of portfolio companies in a context of emerging economies?".

Even though VC market in emerging countries is found lacking of institutional system, including lack of regulatory, poor investment protection, and proper VC legal, they prone to convey more informal institution, such as a use of networks and associations, to achieve their success in venture capital market (Ahlstrom and Bruton, 2006; Scheela et al.,2015). Networks and connections are found to be a success factor for venture capitalists under distinctive environment in emerging market. It helps gather information and replace key formal institutions such as the rule of law (Scott, 2001; Ahlstrom and Bruton, 2006; Lockett and Wright, 2002; Groh and Wallmeroth, 2016). From the survey and interviews of several papers, they confirmed a significance of network and institution in emerging VC markets. However, there is no concrete evidence on how networks and institutions interact to each other and there is no attention on how they are related to portfolio firms' performance in a more empirical explanation. This leads us to investigate the relationship between networks and institutions and their impact on portfolio company's performance. Thus, the third research question is "Does VC networks really help compensate the impact of less formal institutions on the performance of portfolio companies?".

In previous studies of VC syndication network, the scope of the VC network measures is mostly grounded by conducting survey and interview or using the number of syndication deals as a proxy of syndication measure or as a dummy variable. In our study, we quantified VC networks with more tangibly and visibly quantitative approach by applying social network tools, derived from the VC syndication deal flow. The formation of venture capital network in this study comes from a simple concept of the relationship of a connection among the firms who have their backed ventures in common. This methodology is capable to analyze and visualize how an information carried from one venture capital firm to another, as the information flow is difficult to be detected directly. This subtle technique in network analysis is calculated by Pajak program and visualized by NetDraw program. We construct a network of regional venture capital companies based on a unique hand-collected dataset on syndication deals from 136 venture capital firms in six Southeast Asian countries, consisting of Indonesia, Malaysia, Philippine, Singapore, Thailand, and Vietnam, in a period of 2010 to 2017. Another set of samples is portfolio companies, consisting of 30 firms. In our paper, most of the data are derived from Orbis database by Bureau van Dijk. We used a report of companies' balance sheet and income statement to examine two dimensions of financial performance and business potential of portfolio firms, including net profit in relation to operating revenue and Funding stage. We used VC syndicated deal as an input toward network analysis tool for constructing network and obtaining a unique primary data of network metrics. Beside the Orbis, we also collect the secondary data from the reports of VC/PE Attractive Index and World Governance Indicator (WGI) for constructing metrics of institutional factors. After we estimates all variables including network metrics, institution metrics, portfolio firms' performance measures, and all control variables, we then run an unbalanced, multi-variate, time-series panel regression through various models to answer all questions regardless to our hypotheses.

1.2 Objective and contribution

The purposes of this study are (1) to study the impact of VC network measures and institutional development on a performance of portfolio companies (2) to

study the interaction between institutional development and VC networks on portfolio companies' performance. This paper will pioneer an investigation of the venture capital network in Southeast Asia region. This study aims to provide an empirical evidence on a positive association between networks and institutions and, how they significantly have an impact on portfolio company performance. As it is suggested by Bellavitis et al. (2014), it would be interesting to take into consideration institutional factors whether they have an impact on different networks of portfolio companies in other markets. This is an interesting question that has been left unanswered. Firstly, we contribute to VC network literature in providing a unique network structure of venture capital in SEA, as well as network metrics, by using a hand-collected data from syndicated deals. Secondly, we forereach entrepreneurial finance literature by developing a theoretical framework representing that different level of VC networking involved in different institution development offers different performance advantages of VC backed companies.

This study helps clarify the significant role of networks and institutions in venture capital investment in emerging economies and provide a better understanding of how they are related to a performance of portfolio companies. Apart from academic contributions, the results also benefit to practitioners, entrepreneurs and entrepreneurial ventures who are looking for venture capital financing in emerging economies. It provides an insight of how each venture capitalist strategically invest in Southeast Asian ventures by considering a level of partners' networks and institutions of investees' country.

1.3 Structure of dissertation

This paper is organized as follows. In chapter 2, we discuss about the statistical and topological properties of the venture capital network in Southeast Asia region, by employing network analysis. In chapter 3, we further investigate the impact of VC network and institutions on a performance through the lens of portfolio companies. Hence, all data, samples, measurement of variables, methodologies, results,

discussion, and implications will be explained, respectively. Finally, in chapter 4, we summarize our study and make a conclusion.

CHAPTER 2
VENTURE CAPITAL NETWORKS IN SOUTHEAST ASIA: NETWORK CHARACTERISTICS AND COHESIVE SUBGROUPS

2.1 Introduction

As the time passed by, other alternative funding was introduced to mitigate financial limitations for the new firms. Nevertheless, one of the most commonly used financing sources for startup companies are Venture capital (VC). Venture capital firms help startup companies begin operations, exchanging seed money for an equity stake in the firm. VCs are looking for small companies who potentially become large and fast growing. Consequently, venture capitalists provide a room for small business to grow from early startup phrase with the expectation that a very small number of the startups will become success. As a nature of venture capital investment, most start-ups have limited capital and resources, yet high technology orientation and high growth potential, uncertainty and risk are highly presence and a level of information asymmetry between venture capitalists and start-ups may become more extreme. By these reasons, venture capital investors rarely provide funding solely, they are usually motivated to form a syndicate to invest in their common target startups (Bygrave, 1988, Lerner, 1994). This characteristic helps connect each venture capital firms as a whole network, so called “the venture capital network”. The network from venture capital syndication provides an access to various advantageous resources, such as, expertise, information and capital (Brander et al., 2002). For example, VC network facilitates an information flow across each VC to help support their subsidiaries in management, operation, technology, and more. Not only does VC syndicating investment provide the opportunity of accessibility, it also helps diversify the risk of informational uncertainty and their portfolio investment (Bygrave, 1988; Lerner, 1994; Hochberg et al., 2007), and consequently help increase their backed firm’s value (Lerner, 1994).

Apart from the risk of venture capital investment itself, several scholars have found different characteristics of venture capital market between developing and developed countries in many aspects including culture, government support, institution

and regulation (Ahlstrom and Bruton, 2006; Scheela et al., 2015; Groh and Wallmeroth, 2016). For instance, Ahlstrom and Bruton (2006) investigated institutions and networks in venture capital market in East Asian emerging economics and found the evidence of weak legal system, poor corporate governance, and weak protection for investors in East Asian emerging economics. Nevertheless, to survive in such challenging environment, network connections are found to be an important factor for venture capitalists. (Ahlstrom and Bruton, 2006). Recently, Alexander Peter Groh and Johannes Wallmeroth (2016) confirm that Networks and Institutions play an important role on VC success in emerging market, helping gather information and to substitute for key formal institutions such as the rule of law. Additionally, researches on alternative investments have highlighted the significance of the study on venture capital in emerging markets (Cumming and Zhang, 2016; Groh and Wallmeroth, 2016). For instance, the review paper of alternative investment (Cumming and Zhang, 2016) stated that research on alternative investments in emerging markets is in an initial stage and still growing at an accelerating rate than other similar fields during 2000 and 2015, according to the index of Google scholar. However, less attention has been paid to emerging market. Despite numerous mentions to the importance of networks and distinctiveness in venture capital industry between developed and developing countries, VC network is even less mentioned in Southeast Asia region. Whereas the report shows that the mature venture capital market has been declining in the number of deals, the VC in South East Asia reach four year high from 2015 to 2017 (Singapore venture capital and PE association, SVCA, May 2018). Furthermore, SEA is also known as one of the important regions who have an impact to the world economy. It is interesting to explore VC networks in Southeast Asia to see how VC firms in each country are connected and who has more prominent in network connections.

Previously, networks are proved to be existence by conducting survey or interview. This paper provides an empirical evidence of the network by using a more quantitative approach, Network analysis tools. This methodology is capable to analyze and visualize how an information carried from one venture capital firm to another, as the information flow is difficult to be detected directly. It also implies the relationship among venture capital firms within the network. We apply social network analysis tools to construct visualized pictures of the network with numerical measures, derived from

the VC syndication deal flow. (Mas, D. et al., 2007; Hochberg et al., 2007). Networks are calculated by Pajak and visualized by NetDraw program. This network analysis has been applied in several applications and practically used in real network, including social network, organizational network, and food webs. The network analysis technique borrows the concept from the graph theory. Two main commonly used network metrics are centrality and connectivity measure. Centrality captures how well individual node centralize and connect to one another in the network, which consists of a measure of degree, betweenness, and closeness. Connectivity, the structural cohesion of a network, captures how well the whole network are constructed. The k-cores technique is employed to identify cohesive subgroups. Venture capital firms who has higher degree centrality can be inferred to those who easier reach information (or vice versa) and become more central. Moreover, the fundamental topological properties of the network are investigated, including a proof of small world behavior and power law distribution.

The purposes of this study are to investigate (1) the statistical properties consist of network centralization and centrality measure (2) topological properties consist of a validation of small-world and scale-free model, and (3) cohesive subgroups of the venture capital network in Southeast Asia region, by employing the subtle technique in network analysis. The formation of venture capital network in this study comes from a simple concept of the relationship of a connection among the firms who have their backed ventures in common. We construct a network of regional venture capital companies based on a unique hand-collected dataset on 456 syndicated deals from 136 venture capital firms in Southeast Asia countries, consisting of Malaysia, Indonesia, Thailand, Singapore, Vietnam, in a period of 2010 to 2017. All data are derived from Orbis database by Bureau van Dijk.

This paper will pioneer an investigation of the venture capital network in Southeast Asia region. This study provides empirical evidence by quantitative methodology in measuring network centrality and examining properties of venture capital network in the region. It helps clarify the significant role of venture capital investment and provide a better understanding of networks and connections in emerging economics. Beside of academic contribution, it provides an insight of how each venture capitalist in Southeast Asia connects to one another and how the group of high networks connected. This also benefits to practitioners, policymakers,

entrepreneurs and entrepreneurial ventures that seek venture capital financing in emerging economies. Besides, we hope that this work will encourage the government to pay more attention on venture capital investment and provide a concrete projection on how they can build up and strengthen networks in Southeast Asian VC market. These would lead to an effectively increase in competitive capability and boost up the overall economic of each country in the Southeast Asia region.

2.2 Literature review

2.2.1 A study of venture capital networks

The venture capital investment generally involves with a syndication, which means that venture capitalists tend to co-invest with other VC firms to acquire their target investees. This characteristic creates a so-called the venture capital network. In finance, the study of venture capital network has been spotlighted for some decade. As in 1990s, Lerner claims a significant role of the syndication in venture capital investment among private biotechnology firms. He found that the syndication helps gather new venture capitalists in the next funding stage, which results in an increase in the firm's valuation (Lerner, 1994). One motivation of syndication is to access advantage resources, especially in CVC, they use this strategic, acquiring some departments of the backed- organization, to transfer and exploit knowledgeable resources to their mother company. VC network facilitates an information flow across each VC to help support their subsidiaries, diversifying their risk of informational uncertainty and their portfolio investment (Lerner, 1994). Moreover, if we link this to corporate financial theories, agency theory and a theory of asymmetric information, these also help reduce asymmetry of information in the company, which lowers agency cost and information cost, and then leads to diminish agency problem.

According to my literature reviews, the venture capital papers using social network analysis mostly come from the US and the European countries. The study of venture capital network currently has been spotlighted among emerging countries, especially in China, as organized belo

Table 2.1 The literature review of venture capital network

VC network analysis: Main study	Country	Author(s)
Venture capital networks in China	China	Yonghong Jin, Qi Zhanga, Sai-Ping Li (2016)
VC network and VC firm's investment performance in China		ZHIYANG LIU and ZHIQI CHEN (2014)
VC networks and Macroeconomics in regions of China (Regional level in China)		Yonghong Jin, Qi Zhang, Lifei Shan, Sai-Ping Li (2015)
VC network and VC firm's investment performance in China (measuring by exit rate)		Liu Zhiyang and Zhan Linlin (2010)
The impact of Network centrality on the investment performance of IDGVC (the first American venture capital to enter into the market of China)		Xu Mengzhou (2011)
Emergent Properties of a New Financial Market: American Venture Capital Syndication, 1960–2005	US	Bruce Kogut, Pietro Urso, Gordon Walker, (2007)
VC Syndication network, and VC investment performance in the US, Classic paper from Hoberg 2007		Hoberg et al. (2007)

Examines three rationales for the syndication capital investments, using a sample of 271 private biotechnology in the US		Joshua Lerner (1994)
Venture Capital Funds in Canada: 1988-2001	Canada	Douglas J. Cumming Jeffrey and G. MacIntosh (2002)
VC network and VC fund performance in the UK and Continental Europe	Europe	Peter Abell and Tahir M. Nisar (2007)
Research on the venture capital network value spillover base on network division model	Germany	Chen yefeng and Ma weimin (2012)
Venture Capital (VC) transactions in Germany during the period 1995 to 2005		Christian Hopp (2010)
Investigate the impact of two proxies for firm-level resources, namely maturity and status, on the relationship between network cohesion and VC performance	UK	Cristiano Bellavitis, Igor Filatotchev, and Vangelis Souitaris (2017)
A case study about the Dutch venture capital industry: Dutch VC Network	Netherlands	Niels Haars (2009)
Venture Capital Networks in Australia: Emerging Structure and Behavioral Implications	Australia	Siddiqui, A., Marinova, D., & Hossain, A. (2016)

According to Table 2.1, in previous syndication study among VC investors, the scope of the VC network is mostly grounded in using the number of syndication deals as a dummy variable or as to be represented for statistical data (Brander et al., 2002; Engel, 2004). The study of VC network become more tangible and visible when several authors start applying social network tools to study venture capital network derived from the VC syndication deal flow (Mas D. et al., 2007; Hochberg et al., 2007). Most of them investigate the extent to which the VC syndication network relates to a performance of VC firms or VC-backed ventures. For instance, Mas D. et al. (2007) show the evidence VC network around the world. By Hochberg et al. (2007) finds that better-networked VC funds experience significantly better performance, and that the portfolio companies of better-networked VC firms are significantly more likely to survive to subsequent financing and eventual exit.

2.2.2 Venture capital market in Southeast Asia

Researches on alternative investments have highlighted the significance of the study on venture capital in emerging markets (Cumming and Zhang, 2016; Groh and Wallmeroth, 2016). For instance, the review paper of alternative investment (Cumming and Zhang, 2016) stated that research on alternative investments in emerging markets is in an initial stage and still growing at an accelerating rate than other similar fields during 2000 and 2015, according to the index of Google scholar. While there are numerous studies of venture capital networks, most studies are still limited in the US and some developed countries. Less attention has been paid to emerging market, especially, the continent where significantly drives a global economy like Asia. Moreover, prior researches indicate differences of venture capital industry in the US and the Western from that in the Asia. They found that culture, weak regulation, poor political governance, informal institutions and economics play a role in characterizing VC investment in each emerging country (Bruton & Ahlstrom, 2003). Asia is a heterogenous economic region, ranging from developed economies with formal institutions to emerging economies with more informal institutions (Lockett & Wright, 2002). High formal institution can be indicated by a more concrete regulation, a better financial support and a more stable governance. According to institution theory, Scott (2001) has categorized institutions into three levels of formal development

institution: regulatory, normative, and cultural-cognitive, starting from the most formal to the least formal respectively. Firstly, the regulatory institutions represent standardized legal system and corporate governance mechanisms regulated by laws and others involved. Secondly, the normative institutions represent the roles and actions individuals expected which are developed and standardized by professional practices. lastly, the cultural-cognitive institutions are the most informal rules, which tend to be influenced by individual's behavior through social interaction and a community's culture. Whereas network connections are found to be a success factor for venture capitalists under distinctive environment in emerging market. Institutional theory (Networks and Institutions) plays an important role in VC in emerging market. It helps gather information and to substitute for key formal institutions such as the rule of law (Scott, 2001; Ahlstrom and Bruton, 2006; Lockett and Wright, 2002; Groh and Wallmeroth, 2016).

While the mature venture capital markets have been declining in the number of deals, the VC in South East Asia reach four year high from 2015 to 2017 (Singapore venture capital and PE association, SVCA, May 2018). In addition to domestic VC investment, a majority of South East Asia's VC firms also deal with out-of-region VC firms from many countries. Like in China and in the US counterparts, VC firms in SEA seem to syndicate their investment with other VC firms from both within region and out of region. South East Asia's VC firms also come from various domestic sources, consisting of the government, state-owned enterprises, and private firms (Scheela et al., 2015). Venture capital industry in Southeast Asia is nascent yet in demanding and fast growing. Despite a decline in the number of venture deals in the US, the deals keep surging in South East Asia, which is regarded as the sixth-largest economy in the world and remains one of the most dynamic economies of the globe. Despite a lack of institution in the most Southeast Asian countries, venture capital firms widely use networks and connections to fulfill such undeveloped environment, and conversely report strong investment returns and survive in the market (Ahlstrom & Bruton, 2006; Scheela et al., 2015).

2.3 Research methodology

2.3.1 Data and Sampling

This paper studies the network of VC firms in Southeast Asia region, considering six countries: Indonesia, Malaysia, Philippines, Singapore, Thailand, and Vietnam. Whereas Myanmar and Laos are eliminated from the sample due to a few deals from a couple of VC firms. The data of VC firms in South East Asia countries are derived from the Orbis data sources by Bureau van Dijk (BvD). The data include the primary information of the company, such as, type of venture capital and size of company, and lists of syndicated deals. This paper employs networking analysis to explore topological properties and network characteristics of the venture capital network in South East Asian region. Network analysis is based on graph theory, commonly used in social science's application. The tools we use to draw and analyze the network are Pajek, NetDraw, and R program. Next section, we will illustrate a process of how to conduct a network analysis, starting from collecting the data, constructing a network, visualizing and analyzing by network analysis programs.

Network construction procedure

Before we start constructing the network, all existing information of syndicated deal are gathered from each VC firms, country by country. In a network of relationship among venture capital firms, a relationship of venture capital firms defined in this study occurs when two or more VC members have co-invested the same startup companies, or they have cooperated to one another in forming a new company. Thus, the relationship is considered as non-directed tie (it means that venture capital firm A knows venture capital firm B, and vice versa, and they also share an information to each other). Since it is probably impossible to indicate whether A knows B, B knows A, or even if there is a reciprocal relationship between A and B, or A carries an information to B, or B carries an information to A, then we would treat A and B as having a relationship where the directionality of the trust are ignored. We then investigate each deal by taking into consideration merely three cases comprising of

1) Startup(s) secures funding from VC firm(s)
2) One VC firm acquires startup(s) from other VC firm(s)
3) Two VC firms establish another joint venture company.

Other cases are left out of our sample due to either insufficient information or no relevance in the sense of presenting the relation to each other, corresponding to our definition of the relationship among VC firms. In addition, only a group of venture capital firms is considered, we cross out other sorts of venture capital investors such as individuals.

The flow of the procedure is represented in Figure 2.1. Network construction procedure begins with deal arrangement. Firstly, syndicated deals are withdrawn from each venture capital firms in six countries. The title of the deal is manually transformed into a list of deal flow in a text file format. After the deal arrangement, there are 456 deals and 136 VC firms in total. Secondly, the managed text file is formatted to the ".net" file for Pajek program. Thirdly, we import the Pajek file into Pajek and draw a network. After network has been visualized, we also function Pajek to calculate centrality of the network and other properties measure. lastly, we export the result into Excel file. We then analyze and further interpret the result. To draw a graph, the similar network is also visualized by another program, called "NetDraw" for affirmation. Additionally, we use R program with the igraph package to compute the topological and statistical properties of the networks.

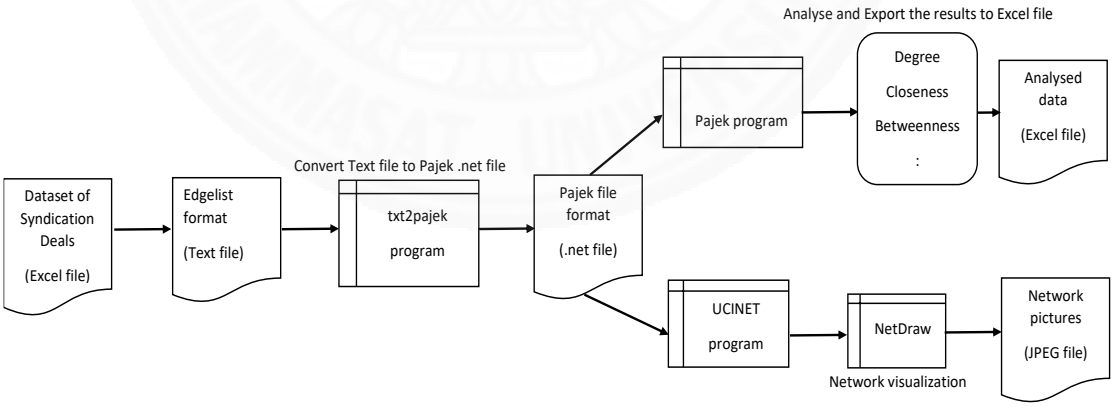


Figure 2.1: Network construction procedure and Data processing flowchart

2.3.2 Network Analysis Methodology

The main goal of social network analysis is detecting and interpreting patterns of social ties among actors. If we would like to analyze the communication structure of the network, however, we need to know who is connected to whom in the entire network and we must pay attention to indirect ties because information can flow from one person to the next and on to other people. In this study, a fundamental in statistical and topological properties of the network will be explored.

2.3.2.1 Statistical properties of the VC network

The VC network in this paper is the undirected weighted graph meaning that there is no distinction between the two nodes or vertices or actors, or VC firms in our case, associated with each link or tie, which the value on each tie depends on the number of repeating deals two VC firms have through the year. Two groups of network measurement are considered in this study: “Centrality measure” captures how well individual firm centralise and connect to one another in the network, and “Community detection” captures how the whole network separates into small communities. The details of the measurement are explained as follows.

Centrality measure

This measure gives a rough indication of the social power of a node, based on how well they "connect" in the network. "Degree", "Betweenness", and "Closeness" are all measures of centrality. The formation of venture capital network, in general, means the relationship of the firms whose shares distributed to similar investees. The one who is identified high-networked should have better access and disperse the information. Centrality measure will posit each venture capital firm according to the connection it has between one another. Simply speaking, centrality will detect who are the main players of VC industry in this region. Venture capital firms with higher degree centrality can be inferred to those who easier reach information (or vice versa) and become more central.

(1) Degree

Since, in this paper, we concentrate on the relationship of VCs, who invest in similar ventures, there is no direction between lead and follow investors. To determine the level of such indirect ties in the network, Degree is considered sufficient. Indegree and outdegree are emitted.

Degree counts the number of links to other actors in the network. Normalized degree, also called “Degree Centrality”, is defined as the number of links incident upon a node. The normalized degree vector contains the degree centrality of the vertices expressed as a proportion of the number of other vertices in the network. Degree is often interpreted in terms of the immediate risk of node for catching whatever is flowing through the network. A higher degree of VC firms means a larger number of ties, so it can be interpreted that VC firms with higher degree has more connections or high networking compared to the lower ones.

(2) Betweenness

Betweenness of one individual is the proportion of all shortest distances, alternatively known as “geodesics”, between other individuals in the network that pass through this individual. Nodes that occur on many shortest paths between other nodes have higher betweenness than those that do not. The more a firm is in between, the more central its position be in the network. A firm with high betweenness is more important as an intermediary in the communication network. This measure reflects an intensity of the transmission of information through a network, and ability to control the flow of information according to a position in the communication network. VC firms with high betweenness means that they have larger network coverage in transmitting the information to others. The betweenness is calculated by geodesic path of a node divided by all shortest paths in the network.

$$C_B(v) = \sum_{s \neq v \neq t \in V} \frac{\sigma_{st}(v)}{\sigma_{st}}$$

Where σ_{st} is the number of shortest paths from *s* to *t*, and $\sigma_{st}(v)$ the number of shortest paths from *s* to *t* that pass through a vertex *v*. This may be normalized by dividing through the number of pairs of vertices not including *v*, which is (n-1)(n-2)/2 for undirected graphs.

(3) Closeness

In network topologies, closeness is one of the basic concepts, which can be measured as the reciprocal of the sum of the shortest distances between each individual and every other person in the network. In other words, closeness of one node is the number of the rest nodes excluding this node, divided by the sum of all

possible distance between this node and all others. The closeness centrality of a node is relied on the total distance between one node and all other nodes, where longer distances reflects lower closeness centrality. Individuals that are shrunk to other individuals (that is, those that tend to have shortest-path length to other individuals within the graph) have higher closeness. The closer distance between a node and all other nodes is, the higher its centrality (Batagelj and Mrvar, 2003). The higher the value of the closeness is, the more central its position be in the network, the easier information may reach. It is usually positively associated with other measures such as degree. In the network theory, closeness is a sophisticated measure of centrality. It is defined as the mean geodesic distance (i.e., the shortest path) between a vertex v and all other vertices reachable from it.

$$C_C(v) = \frac{1}{\sum_{t \in V \setminus v} d_G(v,t)}.$$

The closeness for a vertex is the reciprocal of the sum of geodesic distances (d_G) to all other vertices of *V*.

Community measure: Cohesive Subgroups

Cohesive subgroups are sets of actors that are tied together through frequent, strong, and direct ties (Newman, 2010). The idea behind cohesive subgroup is that people who belong together tend to interact more frequently than people who do not. A higher degree of vertices yields a denser network, because vertices entertain more ties. Therefore, we can use the average degree of all vertices to measure the structural cohesion of a network. This is a better measure of overall cohesion than density because it does not depend on network size, so average degree can be compared between networks of different sizes (Batagelj and Mrvar, 2003). In this section, we use degree to identify clusters of vertices that are tightly connected because each vertex has minimum degree within the cluster. We pay no attention to the degree of one vertex but to the degree of all vertices within a cluster. These clusters are called k-cores and k indicates the minimum degree of each vertex within the core. A k-core is a maximal subnetwork in which each vertex has at least degree k within the subnetwork, for instance, a 2-core contains all vertices that are connected by degree two or more to other vertices within the core. A k-core identifies relatively dense subnetworks, so they help to find cohesive subgroups. To detect cohesive subgroups,

we first remove the lowest k-cores from the network until the network breaks down into groups of relatively dense components. Then, the components is regarded as a cohesive subgroup because they have at least k neighbors within the subnetwork. For k-cores, we recommend using simple undirected or symmetrized networks to make sure that k equals the number of neighbors to which each vertex is connected in a core. Unlike a directed network, components may be weak or strong (Batagelj and Mrvar, 2003).

2.3.2.2 Network Topology: Small-world behaviour and Scale free property

The earliest mathematical network structure, Random Graph model, was introduced and developed by Paul Erdos and Alfred Renyi in around 1950s (Erdős & Rényi, 1960). A random graph produces the network by randomly determining the number of edges and nodes, where the average degree of a random graph model is related to the size and edge probability. The larger the network is, the more diminishingly the diameter increase. However, by a nature of random graph, this model is hardly consistent to many real-world social networks. Another two well-known network models are introduced: Small-world and Scale-free model, which are more realistic and more likely to be a good representative of many real-world networks.

(1) Validation of Small-world Networks

The concept of Small-world model is an extent to which it allows the network to reconstruct regardless to the rewiring probability (0 is the original network and 1 is fully Erdos-Renyi random graph. Watts and Strogatz (and others) found out that only small proportion of rewired ties can lead to a dramatic reduce in the diameter of the network. In another word, the distance between one to another across the whole network remain impressively small as the network is getting larger. To validate the model, we can test Small-world behaviour by using The Watts-Strogatz Statistics (Watts & Strogatz, 1998).

(2) The Watts-Strogatz Statistics

While the actual social networks are observed to have a high value of clustering coefficient, Watts-Strogatz identifies Small world effect with high clustering coefficient and small diameters. The Watt Strogatz Statistic equation relies on two metrics, clustering coefficient and average shortest path length, as shown in the equation below (Humphries and Gurney, 2008).

$$S^{WS} = \frac{\gamma^{sw}}{\lambda} ,$$

where $\gamma^{sw} = \frac{Cluster\ Coefficient\ of\ Actual\ Data}{Cluster\ Coefficient\ of\ Random\ Graph}$ and $\lambda = \frac{Avg\ Shortest\ Path\ Length\ of\ Actual\ Data}{Avg\ Shortest\ Path\ Length\ of Random\ Graph}$

As Watt Strogatz Statistic suggests, S_{ws} is expected to be very much higher than 1, which means $\gamma sw >> 1.0$ and $\lambda \approx 1.00$, so that the network falls into the case of Small-world model.

(3) Scale free property

Scale-free model provides a more realistic social network by considering degree distributions, which obviously feature a long-tailed distribution in many real-world networks. It is so called a power-law characteristic as it likely follows a power functional relationship. The scale-free pattern can be explained by a network formation process of preferential attachment purposed by Barabási and Albert (1999). It stated that as networks is getting larger, newcomers are more likely to connect with the one who are more networking. The preferential attachment will be implemented to testify scale-free pattern, as well as a graph of degree value against node proportion following a power-law distribution.

2.4 Findings

We study the statistical properties, topological properties and community structure of the venture capital network in SEA. Descriptive statistics of these 136 VC firms are presented in Table 2.2. It illustrates nodes and of edges in each country, which nodes represents the number of VC firms and edges represents the number of relevant deals. Vietnam has just only three VC firms and four syndicated venture deals, while Singapore has the highest number of VC firms, at 85 firms, and 350 syndicated deals. The total deal in each country sums up to 456. All countries made a deal with the venture capital firms from outside the region, which is considered as minimum as 25 percent, and maximum as 68 percent of total deals in Malaysia and Singapore, respectively.

Country	Nodes	Total Deals	Out of region Deals	Percentage of out of region to total deals
Thailand	7	18	6	0.33
Indonesian	22	54	18	0.33
Malaysian	13	16	4	0.25
Philippines	6	14	6	0.43
Singapore	85	350	238	0.68
Vietnam	3	4	2	0.5
	= 136	= **456**		

Table 2.2 Statistical data of venture capital firms

From the histogram of degree distribution against number of nodes in Figure 2.2, this venture capital network is likely to follow power distribution. However, when we do another linearity test by taking a logarithm to degree distribution, in Figure 2.3. The result obviously reveals not to comply with power law distribution. Since a power-law characteristic was not presented, this VC network does not follow scale-free pattern.

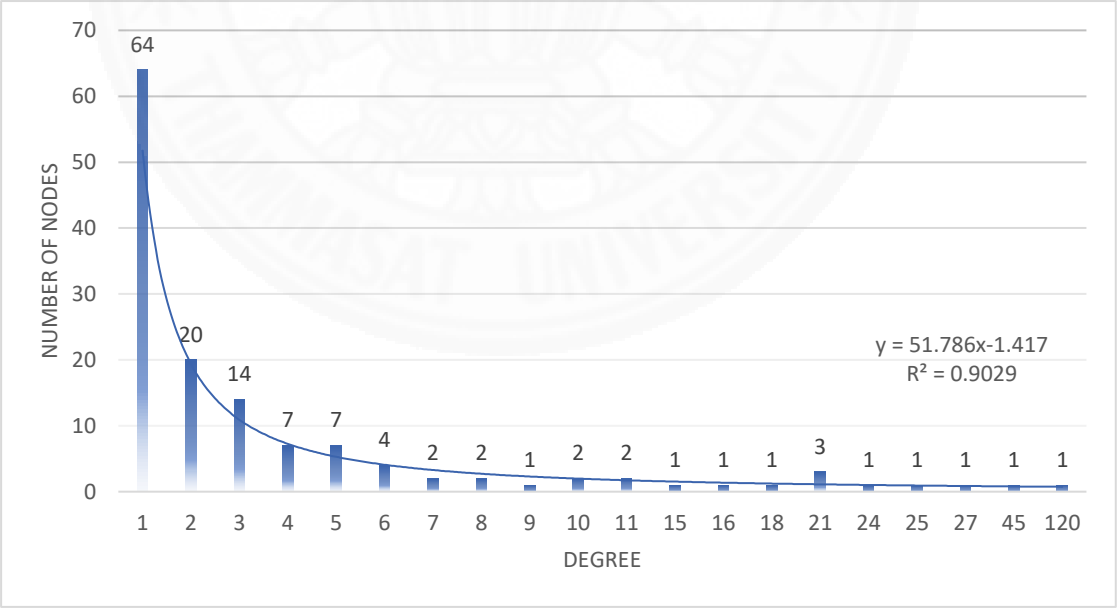


Figure 2.2 Histogram of Degree Distribution

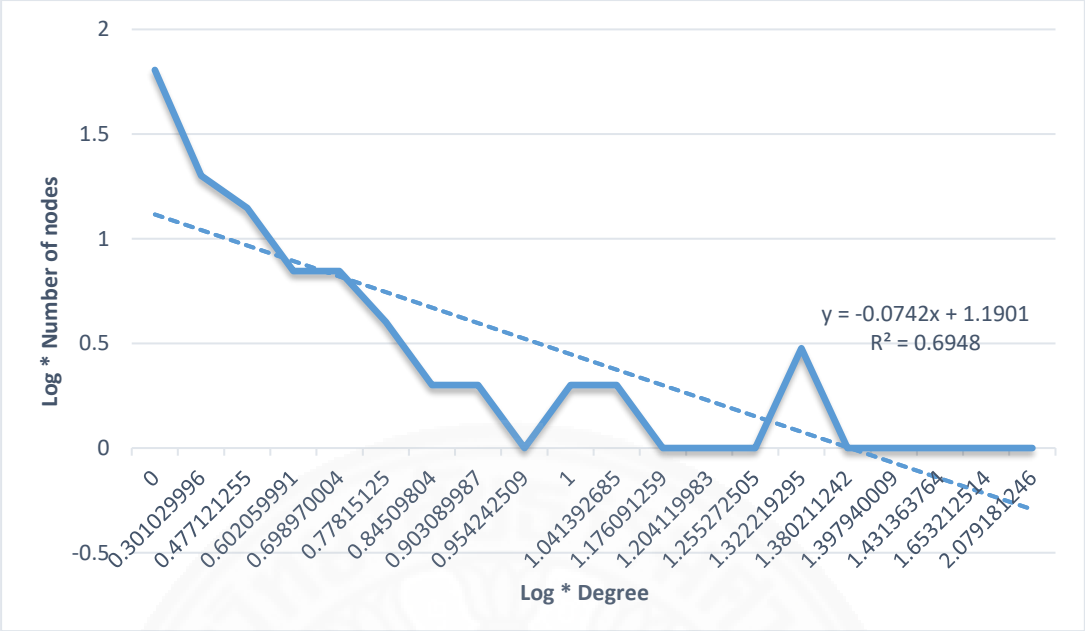


Figure 2.3 The logarithm function of Degree Distribution

Next, we will explore the topological properties of the network by conducting a comparison among three theoretical network models and actual venture capital network in this study. In addition, the small world behavior is to be assured by conducting Watts and Strogatz test. According to the comparison table in Table 2.3, the result reveals that the VC network has similar manner to Erdos-Renyi random graph model and Scale Free model, especially the value of density and average degree. However, after conducting Watts and Strogatz test, a higher value of S^{WS} and the approximate value of 1 in Lambda(λ) makes the overall value of the test is much greater than 1. This calculation leads to the case of the small-world property. All network models are plotted to the graph in Figure 2.4. In summary, this venture capital network has small world, but does not possess scale free property.

Name	Size	Density	Avg. path length	Transitivity	Avg.degree	Isolates
Erdos-Renyi	353	0.006857	6.020538	0.025023	2.413598	0
Small world	353	0.011364	4.719595	0.07781	4	0
ScaleFree	353	0.006245	5.824119	0.002357	2.1983	0
Actual Network	353	0.006631	3.999405	0.044245	2.334278	0

S^{WS}	2.661692
γ^{SW}	1.768145
λ	0.664294

Based on the model developed by Watts and Strogatz(1998), it is expected that γSW >> 1.0 and λ~1.00, leading to the case of SWS>>1.00, which falls into the small-world case.

Table 2.3 Watts and Strogatz test: a calculation of the small-world property

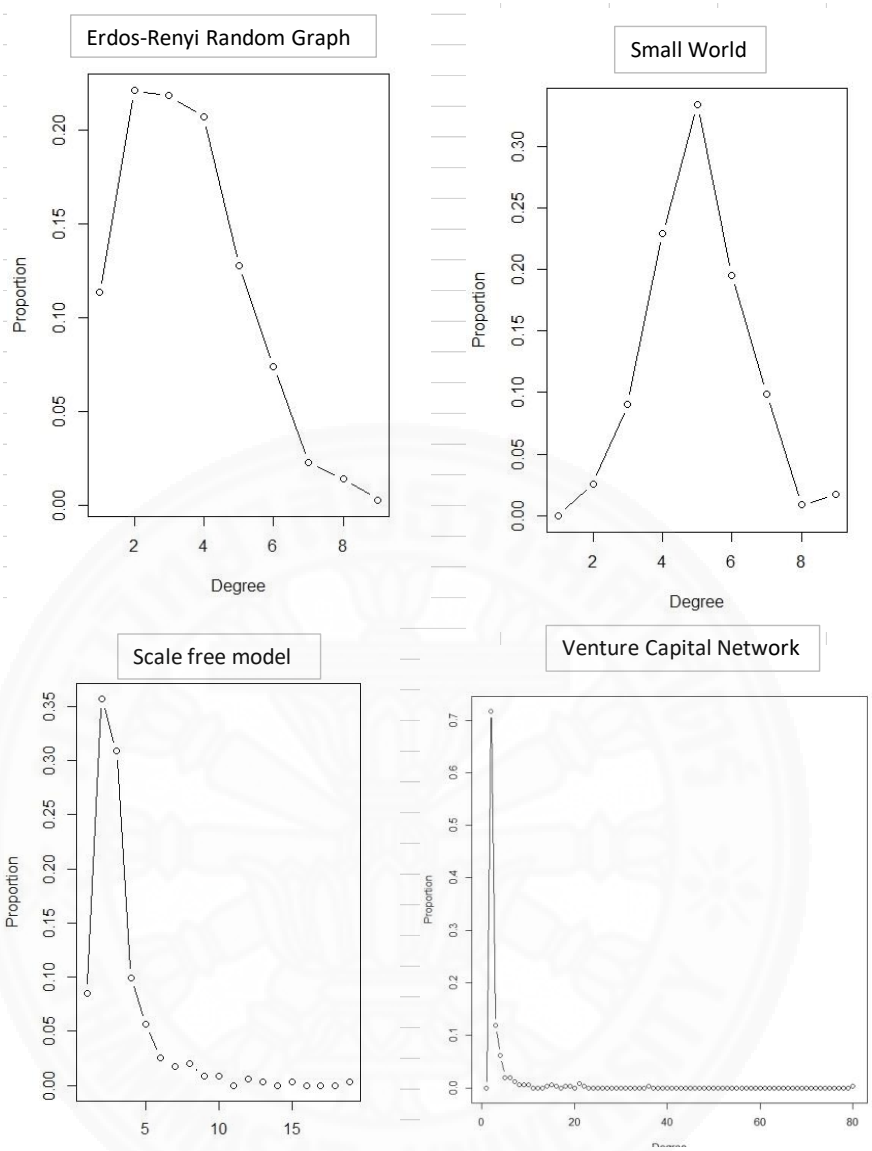


Figure 2.4 A graph comparison of three theoretical network models with the real venture capital network

Turning to the centrality measures of VC networks, the average degree centrality of the sample firms in the region is about 4.90, implying that an average VC firm in the sample has close to 5 ties of relationships. While the degree centrality has a broaden range between 1.77 and 6.20, indicating a various of VC firm relationships in Southeast Asia region (in Table 2.4). The correlation of centrality measures shows that betweenness and degree are highly correlated as shown in Table 2.5.

Country	Nodes	Degree	Closeness	Betweenness
Thailand	7	3.285714	0.173991	0.004358001
Indonesia	22	3.272727	0.133125	0.007154948
Malaysia	13	1.769231	0.086977	0.005975684
Philippines	6	2.666667	0.19535	0.010167244
Singapore	85	6.2	0.131732	0.014209391
Vietnam	3	2	0.007932	1.61875×10^{-5}
Region	136	4.904412	0.12993	0.011283

Table 2.4 Statistical Data of Centrality measure: the venture capital network in SEA

Correlation Matrix	*Degree centrality*	*closeness centrality*	*Betweenness centrality*
Degree centrality	1		
Closeness centrality	0.39259810	1	
Betweenness centrality	0.95849485	0.43249775	1

Table 2.5 Correlation of centrality measures

	Southeast Asia	China	US
Average path length	3.999405	4.83	N/A
Clustering Coefficient	0.598757	0.86	0.25(Kogut et al., 2007) 0.285(Mas et al., 2007)
Small-world model	✔	✔	N/A

Table 2.6 Centralization of VC network in Southeast Asia, China, and US.

From Table 2.6, in developed countries, Mas et al. (2007) find that the clustering coefficient of VC networks (for all industries) in the US and the West Europe are 0.285 and 0.222 respectively. Another study of VC network in the US shows that the clustering coefficient is about constant during the period under analysis and has an average value of 0.25 (Kogut et al., 2007). In developing countries, the recent study of VC networks in China unveils that the mean shortest path and mean clustering coefficient of the Chinese VC network are 4.83 and 0.86 respectively (Jin et al., 2016).

Their research provided an evidence of a more intensity in using nertwork in emerging countries, like in China, than that in the US. Whereas mean clustering coefficient of the VC network in SEA (without foreign VC firms) is 0.598, which surprisingly more superior than that in the US, even it is lower than the value in China.

Venture capital firms in Singapore have the value of degree over other top ten VCs in other countries (in Table 2.7). The highest networked venture capital company in Southeast Asia is East Ventures (coded as SG_VC42) from Singapore. Whereas the highest degree venture capitals of each country are Inspire Venture (coded as TH_VC16) of Thailand, Convergence Ventures (coded as Indo_VC54) of Indonesia, Malaysian Technology Development Corporation (coded as MY_VC2) of Malaysia, Kickstart Ventures (coded as PHL_VC17) of Philippines, IDG Ventures (coded as VIET_VC3) of Vietnam. Be noticed that the top ten venture capital firms regardless to degree and betweenness in Thailand are similar, shown in Table 2.8 and 2.9.

Table 2.7 Ranking of venture countries capital firms regardless to Weighted degree value

THAILAND		INDONESIA		MALAYSIA		PHILIPPINES		SINGAPORE		VIETNAM	
VC firm	Value	VC firm	Value	VC firm	Value	VC firm	Value	VC firm	Value	VC firm	Value
TH_VC16	10	Indo_VC54	15	MY_VC2	6	PHL_VC17	10	SG_VC42	120	VIET_VC3	3
TH_VC15	4	Indo_VC50	11	MY_VC3	4	PHL_VC15	2	SG_VC2	45	VIET_VC4	2
ArdentCapital	4	Indo_VC55	8	KhazanahNasional	2	SeawoodCapital	1	SG_VC33	27	TinhVanTechnologies	1
TrueIncube	2	Indo_VC18	6	MY_VC51	2	HatchdDigital	1	SG_VC27	25		
TH_VC17	1	Indo_VC1	5	CaptiiVenture	1	IdeaSpaceFoundation	1	SG_VC93	24		
TH_VC6	1	Indo_VC56	4	CenturySoftwareHoldings	1	VoyagerInnovations	1	SG_VC10	21		
Ookbee	1	Indo_VC57	4	MY_VC16	1			SG_VC8	21		
		Indo_VC49	3	DelloydVentures	1			SG_VC73	21		
		Indo_VC52	2	MY_VC9	1			SG_VC17	18		
		LippoDigitalVentures	2	MY_VC4	1			SG_VC32	16		

Table 2.8 Ranking of venture capital firms regardless to Closeness value

THAILAND		INDONESIA		MALAYSIA		PHILIPPINES		SINGAPORE		VIETNAM	
VC firm	Value	VC firm	Value	VC firm	Value	VC firm	Value	VC firm	Value	VC firm	Value
TrueIncube	0.236	Indo_VC54	0.283	MY_VC51	0.203	PHL_VC17	0.218	SG_VC42	0.330	VIET_VC3	0.011
TH_VC15	0.229	Indo_VC50	0.254	CIMBBank	0.187	HatchdDigital	0.210	SG_VC17	0.288	TinhVanTechnologies	0.007
ArdentCapital	0.209	Indo_VC18	0.250	KhazanahNasional	0.156	IdeaSpaceFoundation	0.210	SG_VC33	0.271	VIET_VC4	0.006
TH_VC16	0.204	Indo_VC56	0.245	MY_VC2	0.131	PHL_VC15	0.194	SG_VC93	0.270		
Ookbee	0.171	Indo_VC55	0.233	MY_VC3	0.115	VoyagerInnovations	0.171	SG_VC8	0.267		
TH_VC6	0.161	LippoDigitalVentures	0.232	XerayaCapital	0.112	SeawoodCapital	0.170	SG_VC27	0.260		
TH_VC17	0.006	Indo_VC33	0.207	CaptiiVenture	0.100			SG_VC13	0.260		
		Indo_VC52	0.201	CenturySoftwareHoldings	0.100			SG_VC32	0.258		
		Indo_VC58	0.201	MY_VC16	0.006			InfocommInvestments	0.256		
		LINEIndonesia	0.201	DelloydVentures	0.006			SG_VC59	0.254		

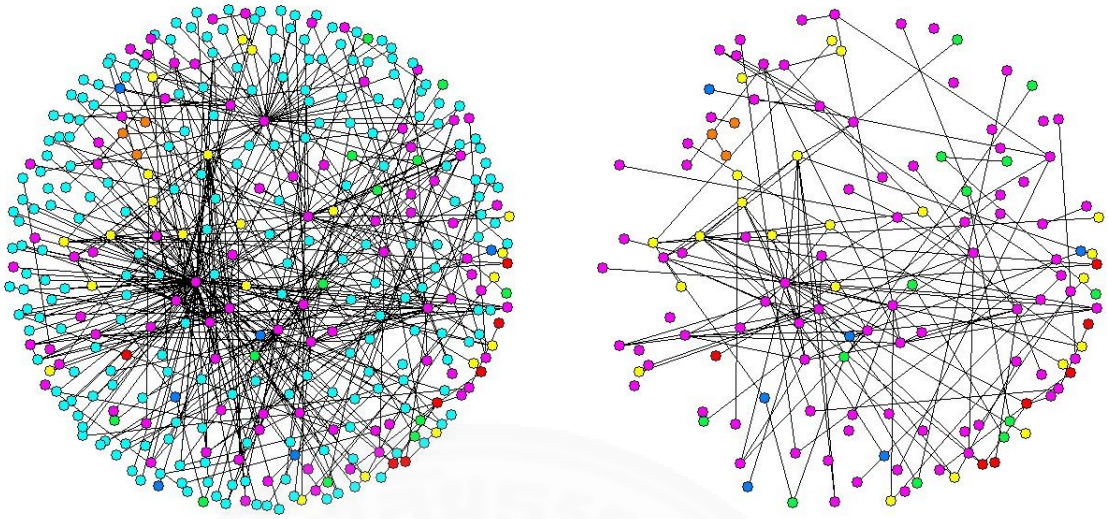
Table 2.9 Ranking of venture capital firms regardless to Betweenness value

THAILAND		INDONESIA		MALAYSIA		PHILIPPINES		SINGAPORE		VIETNAM	
VC firm	Value	VC firm	Value	VC firm	Value	VC firm	Value	VC firm	Value	VC firm	Value
TH_VC16	0.018	Indo_VC54	0.097	KhazanahNasional	0.026	PHL_VC17	0.031	SG_VC42	0.316	VIET_VC3	4.86E-05
TH_VC15	0.011	Indo_VC50	0.026	MY_VC2	0.022	PHL_VC15	0.030	SG_VC2	0.124	TinhVanTechnologies	0
ArdentCapital	0.002	Indo_VC49	0.013	MY_VC51	0.022	HatchdDigital	0.000	SG_VC93	0.109	VIET_VC4	0
TrueIncube	0.000	Indo_VC18	0.012	MY_VC3	0.009	IdeaSpaceFoundation	0.000	SG_VC10	0.071		
Ookbee	0.000	Indo_VC55	0.004	CIMBBank	0.000	VoyagerInnovations	0.000	SG_VC73	0.070		
TH_VC6	0.000	Indo_VC52	0.004	XerayaCapital	0.000	SeawoodCapital	0.000	SG_VC27	0.062		
TH_VC17	0.000	Indo_VC1	0.000	CaptiiVenture	0.000			SG_VC33	0.057		
		Indo_VC57	0.000	CenturySoftwareHoldings	0.000			SG_VC59	0.055		
		Indo_VC56	0.000	MY_VC16	0.000			SG_VC17	0.055		
		LippoDigitalVentures	0.000	DelloydVentures	0.000			SG_VC8	0.040		

To be more clarified, the network is visualized from the numerical metrics into a graphic image. Each country is defined by colours as shown in Figure 2.5. The whole VC network is originally constructed by including the deals of VC firms from other regions. Alternatively, in Figure 2.6, the VC network with internal deals is visualized to show a relationship among VC firms in South East Asia and Figure 2.7 also further illustrates its connection among the countries. The picture tells us that VC firms in the region make several deals with other VCs from outside region. Within the region, VC firms in Singapore make more deals with VC firms in other countries, especially Indonesia. Figure 2.8 shows several VC firms in Singapore are more centralized. The picture confirms that VC firms from Singapore are the main players in the market. High networked VC firms gather other VCs from both the internal and external countries.

Thailand Indonesia Malaysia Philippines Singapore Vietnam Others

Figure 2.5 Representative colour for each country



a) VC network with out-of-region firms b) VC network without out-of-region firms

Figure 2.6 Visualization of the venture capital network in South East Asia

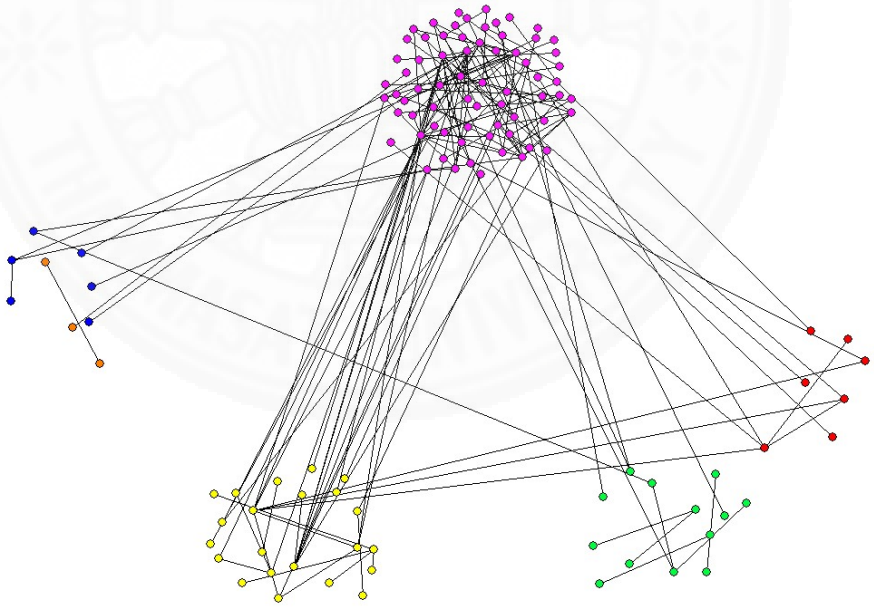


Figure 2.7 The venture capital network categorized by countries

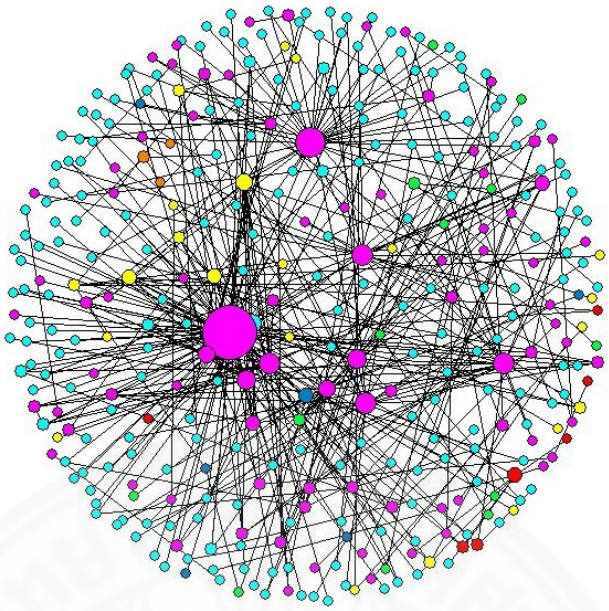


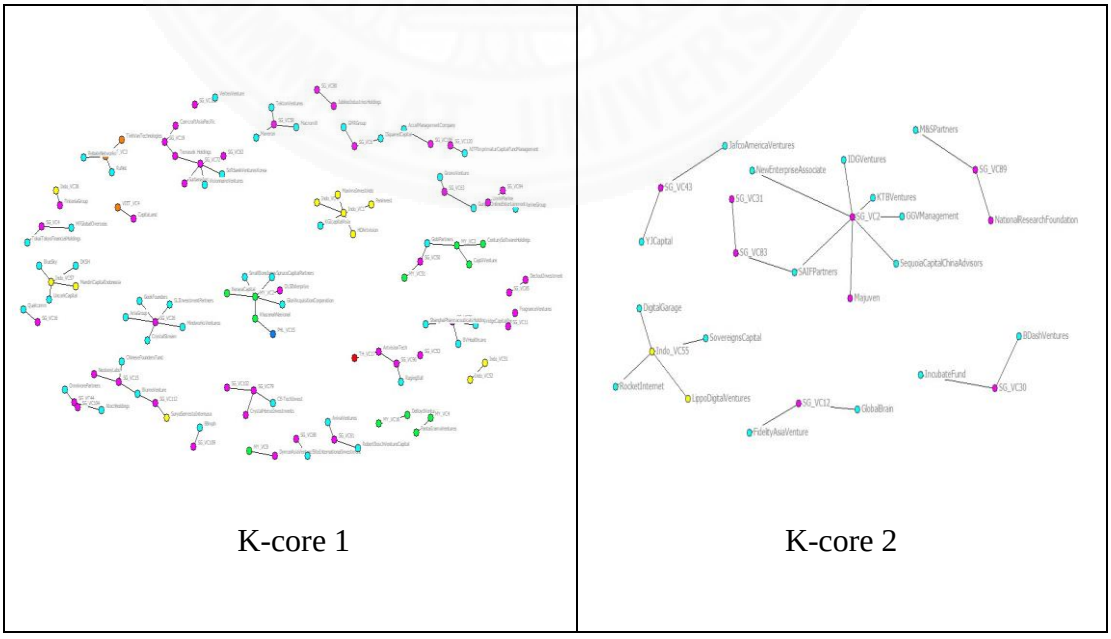
Figure 2.8 The venture capital network sizable by Degree

With the k-core technique, the network is separated into four components, from one-core to four-core component regardless to a level of degree measure (as shown in Figure 2.9). The higher number of cores identifies clusters of nodes with a higher degree. In other world, a higher core component is a subgroup of higher networked venture capital firms. Dense components are found at the highest k-core, which is considered as a cohesive subgroup who has the highest degree dominating over the entire network (regardless to Table 2.10). In 4-core subgroup, Singapore is found to be the predominant country for venture capital market in SEA, accounting for eight out of ten venture capital firms in this group. Three of them are from Indonesia, and two are 500Startups and Gree Ventures, the outside venture capital companies from Silicon Valley, the United States and Japan, respectively. In 3-core subgroup, Thailand comes to relate in this community. Singapore still be the most dominant one. Surprisingly, there is only one Indonesia venture capital firm and Malaysia does not appear in this subgroup. Again, there are three companies from other regions, comprising of CyberAgent ventures and GMO venture partners from Japan, and Fenox venture capital from the US.

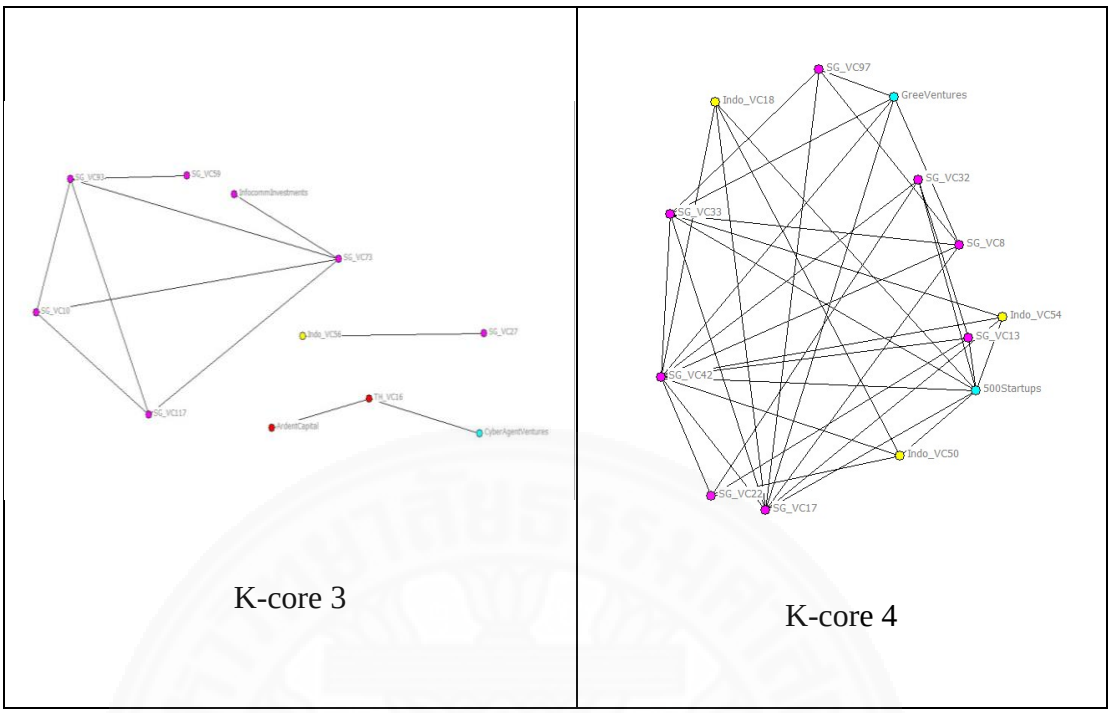
3-Core		4-Core	
Name	Country	Name	Country
TH_VC16	Thailand	500Startups	Foreign
ArdentCapital	Thailand	Indo_VC50	Indonesia
CyberAgentVentures	Foreign	Indo_VC18	Indonesia
SG_VC10	Singapore	Indo_VC54	Indonesia
Indo_VC56	Indonesia	SG_VC17	Singapore
FenoxVentureCapital	Foreign	SG_VC33	Singapore
GMOVenturePartners	Foreign	SG_VC42	Singapore
SG_VC27	Singapore	SG_VC22	Singapore
SG_VC59	Singapore	SG_VC32	Singapore
SG_VC93	Singapore	SG_VC13	Singapore
SG_VC117	Singapore	SG_VC8	Singapore
8Capital	Singapore	GreeVentures	Foreign
SG_VC73	Singapore	SG_VC97	Singapore
InfocommInvestments	Singapore		
SG_VC20	Singapore		

Table 2.10 3-Core and 4-Core partition of the network (All isolated venture capital firms are included)

Figure 2.9 K-Core components of VC networks in Southeast Asian countries, regardless to a level of degree measure



K-core 1 K-core 2



Remark: The Figure 2.9 illustrates four subgroups of K-Core components, which all isolated venture capital firms in each subgroup are removed for a simple visual image and interpretation.

2.5 Discussion

As the findings unveil, the descriptive data show that Singapore has VC deals with more than half related to out-of-region VC firms. This may relatively be affected by a massive number of VC firms in Singapore comparing to other countries. Obviously, every country in South East Asia relies on the relationship with other countries outside the region, who are more developed or mature in venture capital investment, including Japan, China, the US, and the European. This is in line with the report of venture capital investments made in ASEAN, which stated that VC companies from Japan, the US, China, and Singapore are the most active companies in the region (ASEAN Investment Report 2018).

In topological properties, the VC network in South East Asia has a small world property, but not follow the power law distribution. This finding is consistent to Chinese VC network properties, where the network has small-world, but not scale-free behavior (Jin, Y. et al., 2016). This also aligns with the previous studies of VC networks

in developed countries such as in the US (Kogut et al., 2007). Seemingly, the findings in topological properties of VC networks in both Asia emerging countries and the US probably affirm an evidence for network characteristic of venture capital industry, which differs from other prevalent social networks which normally comply with scale free structure. The outcome is also contradicting to VC investment behavior found by Lerner (1994) that new venture capitalists tend to syndicate with incumbents in the consequence funding round. This can be interpreted that the distance among SEA VC firms in the network remains short even when the network is getting bigger. It seems no difficulty in knowing one another within the network. This can be implied that one VC firm can access to the information of another VC firms across the region in just a few steps. However, this network does not belong to scale free pattern, which means that there is not necessary for the newcomer to preliminarily connect to high networked incumbent VCs inside SEA nations.

From further analysis of network measures, the findings indicate that Singapore dominates the strongest group of connection among venture capital firms in SEA. On top of that, by ranking the firms by degree in each country and degree visualization, this also highlights the importance role of connection in VC networks, which is originated from Singapore as the one who have many top-listed high networked VC firms. Whereas Jin et al. (2016) show that there are no regional dominant venture capital firms in China which act as hubs in the VC network, and multi-company syndication is not popular in China, the VC network in Southeast Asia behaves differently. Most of the high networked firms gathers in Singapore as an important VC hub of the region. Indonesia has the most relationship with Singapore. There are many multi-company syndications across the region. Again, there is an evidence that the VCs from other regions penetrated into Southeast Asia region. This is consistent with the evidence of an establishment of venture capital in emerging economies (Lockett & Wright, 2002). As a result of correlation between betweenness and degree, the correlation between these two measures is higher than that in the VC network in China (Jin et al., 2016). It means that not only do high networked VC firms in this region make a deal more than those lowers, but they also act as an intermediary to help connect one another in their network. According to the result of mean clustering coefficient of VC networks among developed country, the US, and developing

countries, China and SEA, mean clustering coefficient of the VC network in SEA (without foreign VC firms) is surprisingly more superior than the value in the US. This result provided an evidence of a more intensity in using network in SEA emerging countries, like in China, than that in the US. With these findings it provides an evidence of significant VC role in using network in VC emerging market, as networks in the developing countries have higher level of density comparing to those in the developed ones.

According to the subgroup analysis, it seems like Singapore behaves as a frontier (main gate) for other foreign VC firms to penetrate into ASEAN VC market (as you can see from the k-core 0). Singapore has both strong VC communities within and across country level, and also has a concrete relationship with VCs from other regions. As we notice that a massive links is presented between that of internal and external VC firms under the case of k core 0, which is becoming less when the core is going higher. That means most of the foreign VC firms just get to know the group of local VC firms with low connection, which mostly invest in Singapore. Interestingly, only a few players from other regions is capable to connect with the highest networked group of influential players in the region, which still most of them are a group of Singaporean VC firms. This might be one of the reasons why this network does not fall into scale-free property. Newcomers prone to connect with the local one with low connection. This is a confirmation of a nascent state in SEA that even there is more than half of contracts made with foreign firms, SEA VC market is initially supported by VC markets from other regions. Perhaps, this suspect indicates that VC investing here consider not only network and connection, but they also consider Singapore as a country to entry. Another important issue that may cause this phenomenon is institutional settings, such as, laws and regulations, regardless to the number of deal they made with more formal institutional country like Singapore (as consistent to several researches in institutional differences: Ahlstrom and Bruton, 2006; Scheela et al., 2015; Groh et al., 2016). This also aligns with Bruton et al. (2002), who mention that Singapore has different institutional environment from other Asian countries VCs, such as, fully government support in high technology entrepreneurial ventures. That’s why venture capitals in Singapore being a perfect hub to access to VC market in this region.

2.6 Conclusion

The VC network in South East Asia follows small world property, but not scale free property, like that in China (Jin et al., 2016). Singapore is the predominant country for venture capital market in SEA. As a result, high connected venture capital firms are clustering at Singapore, Indonesia, and Thailand, respectively. Surprisingly, venture capital investment in Malaysia reveals a scant attention, even less, in Vietnam and Philippines. Not only do high networked VC firms make a deal more than those lowers, but they also act as an intermediary to help connect one another in their network. Every country in South East Asia relies on the relationship with other countries out of the region, who are more developed or more mature in venture capital investment, including Japan, China, the US, and the European. Surprisingly, most foreign VC firms prone to connect with low networked VC firms instead of high networked VC firms, yet most investing in Singaporean VC firms. The results of network properties also confirm previous evidence of significance on networks in emerging market that there is a presence of a strong venture capital network in this region, even if the institution and regulation are claimed to fall behind that in the developed region. In contributions, our study benefits to those venture capital firms who are looking for potential partners in Southeast Asia region and those start-up companies who are looking for funding with high networked or influential VCs. Since the government still catches only a glimpse of venture capital market, this paper will provide them an empirical evidence and insightful implication of how significance venture capital network in Southeast Asia and how VC firms associate with each other. Hopefully, the government and relevant cooperates should pay more attention on how they can support venture capital investment, including other accelerators, and provide a concrete projection on how they can build up and strengthen networks in Southeast Asian VC market.

CHAPTER 3
THE EFFECT OF VENTURE CAPITAL NETWORKS AND INSTITUTIONS ON PORTFOLIO COMPANIES' PERFORMANCE IN SOUTHEAST ASIA

3.1 Research Questions

Venture capital firms (VC) have encountered with uncertainty and risk of asymmetric information due to an investment in early-to-growth stage start-ups with technology-based and high growing potential. This phenomenon may induce discrepant interest between VCs and investees in business management, which aligns to classic theories in cooperate finance, an agency theory and a theory of asymmetric information. By these reasons, venture capital investors rarely provide funding solely, they are usually motivated to form a syndicate to invest in their common target investees. This characteristic helps connect each venture capital firms as a whole "venture capital network". A few scholars studied a relation of VC networks and a performance through the lens of VC-backed companies. This issue even has a little discussion in Southeast Asia emerging market, which unveils a much broader information asymmetry compared to the western VC market (Bruton et al., 2002). At first, we would like to focus on the entrepreneur's point of view if their investor's connections affect or relate to their performance. Thus, the first research question is that "Is network centrality of VC positively related to a performance of portfolio companies in SEA economies?". Unless agency and asymmetric information theory emphasize on the formation of networks in emerging venture capital markets, Institutional theory is more suitable in explaining this situation, as the practice of venture capital appears to be influenced from institutional changes (Ahlstrom & Bruton, 2006). Institutional theory provides an extent to which social and cultural elements play an important role in different institutional contexts and lead to different function and level of venture capital networks in emerging markets. Thus, we raise the second research question that "Are institutional differences related to the performance of portfolio companies in a context of emerging economies?". VC market in emerging countries is found lacking of institutional system,

including lack of regulatory, poor investment protection, and proper VC legal, they prone to convey more informal institutions, such as a use of networks and associations, to achieve their success in venture capital market (Ahlstrom and Bruton, 2006; Scheela et al.,2015). From the survey and interviews of several papers, they confirmed a significance of network and institution in emerging VC markets. However, there is no concrete evidence on how networks and institutions interact to each other and there is no attention on how they are related to portfolio firms' performance in a more empirical explanation. This leads us to investigate the relationship between networks and institutions and their impact on portfolio company's performance. Thus, the third research question is "Does VC networks really help compensate the impact of less formal institutions on the performance of portfolio companies?".

3.2 Literature Review and Hypothesis Development

3.2.1 Venture Capital Syndication Networks

In venture capital industry, venture capital firms (VC) have encountered with uncertainty and risk of asymmetric information due to an investment in early-to-growth stage businesses with technology-based and high growth potential. This aligns to classic theories in cooperate finance, an agency theory and a theory of asymmetric information. Agency theory demonstrated a conflict of interest between principals and agents, while asymmetric information proposed that an inequality of information between buyers (e.g. investors) and sellers (e.g. investees or agents) can cause an inefficient outcome in a market. To alleviate these problems, venture capitalists tend to co-invest with other VC firms to acquire their target investees. This characteristic is simply called a syndication, and this enables network and connections among venture capitalists, so-called venture capital networks. The syndication network reflects the relationship among venture capital firms through syndicated agreement. In literatures, rationales behind VC syndicated deal include **(1)** an accessibility of various advantageous resources, such as, expertise, capital, and information (Brander et al., 2002; Abell & Nisar, 2007). For example, VCs can provide specific tools and skilled manager to help support their subsidiaries in management, operation, and technology (Davila et al., 2003; Baum & Silverman, 2004). **(2)** VC syndication networks facilitate

a dispersal of information flows across VC firms (Sorenson & Stuart, 2001; Hsu, 2006; Bellavitis et al., 2014). Together with VC roles of monitoring and advising (Cumming & Johan, 2007), this information sharing is intended to decline agency problem and asymmetric information in the company by lowering agency cost and information cost (Engel, 2004). For example, Hsu (2006) found that the presence of a common investor aids in reducing transaction and coordination costs through its intermediation. **(3)** VC syndication helps diversify risk of informational uncertainty and risk of their portfolio investment (Lerner, 1994; Lockett & Wright, 1999; Brander et al., 2002; Buchner et al., 2017). For example, Brander et al., 2002 assume venture capitalists are risk neutral, but they might be risk-aversion and motivated to invest in more ventures, which in turn help diversify risk of their portfolio investment**.** Buchner et al., 2017 stated that VC fund managers may look for riskier investment if their expected impact of fund diversification is negative, which in turn induces to higher performance of more diversified funds.

3.2.2 The relationship between Venture Capital Networks and Portfolio companies' performance

Additionally, numerous literatures found an empirical support for the view that VC syndication facilitates value-adding services (Lerner, 1994; Gompers and Lerner, 1999; Brander et al., 2002; Wright and Lockett, 2003). For example, syndication significantly enhances returns, consistent with an advantage of syndication in value-added investments (Gompers and Lerner, 1999; Brander et al., 2002). VC syndication is regarded as a successful strategy which is embedded in VC role in value-added service and finally results in serving benefits to portfolio companies (Engel ,2004; Abell & Nisar ,2007). For example, networking is likely to add value to firm operations (Abell & Nisar, 2007). Further, Teten et al. (2013) considered seven elements of VC's value-creation to portfolio companies and mentioned that one of the most value-added service among these elements is a network.

Table 3.1 Summary table of the relationship between Network measures and several dimensions of Performance

DV / IDV	Firm-level, Fund-level	Firm-level	Country-level
	VC firm performance	VC-backed firm performance	National performance
The number of syndications	N/A	Engel (2004)	N/A
Syndication Dummy	Brander et al. (2002) Cumming & Walz (2010) Li et al. (2014)	Tian (2011)	N/A
Social Network Analysis	Sorenson & Stuart (2001) Liu & Zhan (2010) Abell & Nisar (2007) Liu & Chen (2014) Hochberg et al. (2007) Xu (2011)	Hochberg et al. (2007). Bellavitis et al. (2014)	Jin et al. (2015)
Network Cohesion or Embeddedness	Bellavitis et al. (2017) Echols & Tsai (2005)	N/A	N/A
High Network Resources Rating	N/A	Hsu (2004)	N/A

Abbreviation: DV = Dependent variables, IDV = Independent variables, N/A = Not available

Numerous papers have studied VC syndication network and performance in many aspects. To simplify literature reviews, we tabulated them into metrics of relations between independent variable of VC syndicated network and dependent variables of performance, categorized by the measurement, as shown in Table 3.1. VC syndicated networks have been proxied by (1) the number of times in syndications (2) syndication dummy variable (3) network centrality measures (4)

network cohesion or network embeddedness (5) high network resources rating. While performance measures can be divided into three main perspectives: (1) Firm or Fund-level VC firm performance perspective (2) Firm-level VC-backed firm performance perspective (3) Country-level economic performance perspective. Each angle of performance measures provides distinctive interpretations and implications, which all depends on a purpose of the study.

In accordance with the summary table, the study of venture capital network has been spotlighted for decades. As in 1990s, Lerner claims a significant role of the syndication in venture capital investment among private biotechnology firms. He found that the syndication helps gather new venture capitalists in the next funding stage, which results in an increase in the firm's valuation (Lerner, 1994). A majority of prior works is concentrated in employing syndication dummy and social network analysis to determine VC firm performance. Some authors investigated more than one dimension of performance measures. For example, Hochberg et, al. (2007) unveiled that higher network centrality of VC firms is associated to higher level of successful exit rate (fund-level VC firm performance) and higher possibility of portfolio company's survival based on funding round (firm-level VC-backed firm performance). Another example about a study of the relation between venture capital network and a country-level performance is the paper of Jin, et al. (2015) whose findings provide an evidence of positive relationship between social network centrality and regional economic performance in China. Most of them investigate the extent to which the VC syndication network relates to a performance of VC firms. Unfortunately, a few papers have focused on the relation between venture capital networks and portfolio firms' performance, and even less on that in emerging economies. Recently, only a small group of authors has focused on this relationship in China. As Liu & Chen (2014) investigated a network of Chinese active VC firms and found that VC firm's position of networks are more essential for investment performance in China than in the US. Moreover, in previous syndication study among VC investors, the scope of the VC network is mostly grounded in using the number of syndication deals as a proxy of syndication measure or using it as a dummy variable. The study of VC network becomes more tangible and visible when several authors started applying social network tools to study venture capital network derived from the VC syndication deal flow (Sorenson & Stuart, 2001;

Hochberg et al., 2007). By these reasons, it is attractive to pay more attention to explore venture capital networks in Southeast Asia by using social network analysis technique (Wasserman S, Faust K., 1994) and examine the relation between networks and portfolio companies' performance. As majority documents resulted the positive relationship (Abell & Nisar, 2007; Hochberg et al., 2007; Liu & Zhan, 2010; Liu & Chen, 2014; Bellavitis et al., 2014). We then conjecture that more central position of VC firms in the network would in turn provides a positive result to portfolio companies' performance, the first hypothesis stated as follows,

Hypothesis 1: VC Network metrics are positively related to portfolio companies' performance in Southeast Asian emerging economy.

H1a: Degree is positively related to a performance of portfolio companies in Southeast Asian emerging economy.

H1b: Betweenness is positively related to a performance of portfolio companies in Southeast Asian emerging economy.

H1c: Closeness is positively related to a performance of portfolio companies in Southeast Asian emerging economy.

3.2.3 Institutional development of Venture Capital in Southeast Asia

Numerous researches on alternative investments have highlighted the significance of the study on venture capital in emerging markets (Cumming and Zhang, 2016; Groh and Wallmeroth, 2016). This has led many to summarize that venture capital is a crucial factor in nurturing a region's economic growth (Jeng and Wells, 2000; Groh and Wallmeroth, 2016). Recently, the review paper about alternative investment (Cumming and Zhang, 2016) stated that research on alternative investments, such as venture capital and private equity, in emerging markets is still nascent and growing at a much more rapid rate than other similar fields during 2000 and 2015, according to the index of Google scholar. Southeast Asia is one of emerging region where venture capital investment is initiate and growing. This region is regarded as the sixth-largest economy in the world and remains one of the most dynamic economies of the globe. As small and medium entrepreneurs (SMEs) play a vital role in SEA economy.

Even though traditional cooperate finance theories, agency and stewardship theory, seems emphasize the role of networks in venture capital, there are other theoretical foundations, which provide more insightful examination about venture capital activity in emerging markets. Institutional theory is more suitable in explaining this situation, as the practice of venture capital appears to be influenced from institutional changes (Ahlstrom & Bruton, 2006). Institutional theory is a theory on the deeper understand of social and culture structure which are the root of rules and norms in a society. Institutional theory incorporates social and cultural elements. Scott (2001) has provided a more refined explanation by categorizing institutions into three levels of formal development institution: regulatory, normative, and cultural-cognitive, starting from the most formal to the least formal respectively. Firstly, the regulatory institutions represent standardized legal system and corporate governance mechanisms regulated by laws and others involved. Secondly, the normative institutions represent the roles and actions individuals expected which are developed and standardized by professional practices. lastly, the cultural-cognitive institutions are the most informal rules, which tend to be influenced by individual's behaviour through social interaction and a community's culture. Institutional theory provides an extent to which social and cultural elements play an important role in different institutional contexts and lead to different function and level of venture capital networks in emerging markets. It provides a clearer explanation of why networks are more pronounced in less formal institutions, like in emerging markets. As the comparison of institution development, VC industry in emerging economics has a lack of institutional system, including lack of regulatory, investment protection, and proper VC legal. On the other words, VC institution in emerging market is still not fully and formally developed compared to those other developed economies. Scheela et al. (2015) called this as "institutional void". Scheela et al. (2015) had taken a further look at the effect of institution of venture capital industry in SEA. They conclude that amid the differences in VC environment, VC activities, and, especially, institutional factor between developed and developing countries, VCs can survive and become success by employing their networks and connections to their activities, in which to control and monitor their portfolio ventures. VC in emerging economies under incomplete institutional framework by clustering to each other or forming a group of investors reducing uncertainty. As an example, in

Thailand, where there are VC club organized by VC association of Thailand (Scheela & Jittrapanun, 2008). To survive and succeed under these challenges, there was an evidence that VCs in emerging market are more likely to use informal institution system (more cognitive), that is they tend to rely more on forming alliances, club and association.

3.2.4 The relationship between Institutional development and Portfolio companies' performance

Institutions have an impact on the setting of goals and the processes of venture capital firms (Ahlstrom & Bruton, 2006; Lingelbach, 2015). As Ahlstrom & Bruton (2006) suggested that Institutional characteristics of a country should be determined, as venture capital investment is more likely to be dominated by the local institutional settings. Institutional differences in venture capital industry modulate VC strategic decision and organizational practices, which finally augment to differences in the function and use of networks in emerging economies. Recently, Lingelbach (2015) reveal that the more formal institution changes, the more it is beneficial to the VC development process. Moreover, the paper also found that two macro-level institutional dimensions, rule of law and political stability, play a pivotal role in facilitating the process in emerging economies. Southeast Asia has heterogenous economies including both developed and developing countries According to a study of venture capital across different countries with heterogenous economies, Bellavitis et al. (2014) suggested that we should consider macro-institutional factors (e.g. regulation, cultural dimensions) otherwise, biasness may occur in the results. From our reviews, formal institutions demonstrated a positive impact on the level of venture capital activity, but this impact is milder in countries with more uncertainty avoiding and more collectivist societies (Li & Zahra, 2012). Further, Li et al. (2014) predicts found the adverse effect of institutional distance between VCs and portfolio firms on venture capital exit success. The more institutional distance is the less likely the exit will become success. Thus, the second hypothesis is posited as follows,

Hypothesis 2: Institution Development is positively related to portfolio companies' performance in Southeast Asian emerging economy. While

Institutional distance is negatively related to portfolio companies' performance in Southeast Asian emerging economy.

H2a: VCPE is positively related to a performance of portfolio companies in Southeast Asian emerging economy.

H2b: FID is positively related to a performance of portfolio companies in Southeast Asian emerging economy.

H2c: IDIST is negatively related to a performance of portfolio companies in Southeast Asian emerging economy.

3.2.5 The interaction between Venture capital networks and Institutional development on Portfolio companies' performance

Even though VC market in emerging countries is found lacking of institutional system, including lack of regulatory, poor investment protection, and proper VC legal, they prone to convey more informal institution, such as a use of networks and associations, to achieve their success in venture capital market (Ahlstrom and Bruton, 2006; Scheela et al.,2015). Networks and connections are found to be a success factor for venture capitalists under distinctive environment in emerging market. It helps gather information and replace key formal institutions such as the rule of law (Scott, 2001; Ahlstrom and Bruton, 2006; Lockett and Wright, 2002; Groh and Wallmeroth, 2016). From the survey and interviews of several papers, they confirmed a significance of network and institution in emerging VC markets. While Kuen (2014) found a sight of the substitution effect of social networks and legal systems in China, India, Japan, and Hongkong by using Pearson Chi-square test. However, there is no concrete evidence on how networks and institutions interact to each other and there is no attention on how they are related to portfolio firms' performance in a more empirical explanation. This leads us to investigate the relationship between networks and institutions and their impact on portfolio company's performance. This leads to research question that "Does VC networking really help compensate the impact of less formal institutions on the performance of portfolio companies?". We then hypothesized that,

Hypothesis 3: The interaction between VC network metrics and Institution Development metrics is positively related to enhance portfolio companies'

performance in Southeast Asian emerging economy (i.e., the extent to which VC network centrality will be more positively associated with firm performance when its funding VC's institutional metrics are low).

H3a: The interaction between VC network metrics and VCPE/FID is positively related to enhance portfolio companies' performance in Southeast Asian emerging economy

H3b: The interaction between VC network metrics and IDIST is negatively related to enhance portfolio companies' performance in Southeast Asian emerging economy

3.2.6 Theoretical framework with Hypotheses estimates

According to the introduction, the objective in this paper is to verify the impact of VC networks and institutions on portfolio firms' performance under Southeast Asia context, we then develop a research framework proposing that different level of VC networking involved in different institution development offers different performance advantages of VC backed companies (shown in Figure 3.1). Three hypotheses (H1, H2, and H3) are indicated in the model, accompanied with key measures of independent and dependent variables. Measurement and methodology in this study will determined and explained further in the next chapter.

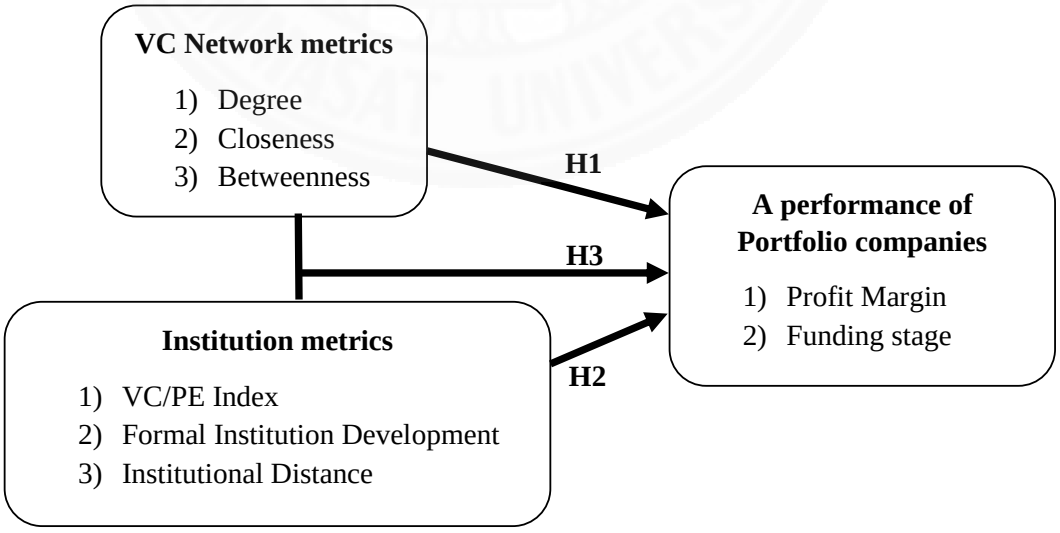


Figure 3.1 Research proposed model and Hypotheses (Source: Authors' own)

3.3 Methodology

This paper studies venture capital networks and institutions of VC and their portfolio firms in Southeast Asia region. The data of VC firms in South East Asia countries are derived from the Orbis data sources by Bureau van Dijk (BvD). The secondary data include the accounting and financial information of both VC firms and their portfolio companies, such as, year and size of the firms, and a list of syndicated deals. In addition, a status of funding round is traced back by using Crunchbase database. We created a longitudinal dataset of co-funding networks among VC firms by coding from a list of VC syndicated deal as an input toward network analysis tool for constructing network and obtaining a unique primary data of network metrics. A dataset of fundamentals in accounting and financial information from both venture capital firms, and VC-backed companies are used in measuring performance metrics, including company profile, financial report, shareholders, etc. Beside the Orbis, we also collect the secondary data from various source of reliable reports, such as, VC/PE Attractive Index and World Governance Index (WGI) for constructing metrics of institutional factors. Finally, we end up having the unbalanced and time-series panel dataset.

3.3.1 Samples and Data

Sample of Network analysis

Our study of venture capital networks is based on a sample of 136 venture capital firms over 456 deals across six countries, consisting of Indonesia, Malaysia, Philippines, Singapore, Thailand, and Vietnam. Whereas Myanmar and Laos are eliminated from the sample due to a few deals from a couple of VC firms. over a time period of eight years. We considered the period from 2010-2017, since this time frame captures almost starting point until prosperous period for venture capital industry in emerging market (NVCA's Yearbook, 2017; Cumming & Zhang, 2016). All insurance companies are excluded, due to different characteristics of performance measure. Firms that have missing data in this period will be dismissed.

Network Analysis

This paper employs networking analysis to quantify a level of VC networks in South East Asian region. Network analysis is based on graph theory, commonly used in social science's application. We run Pajek (Batagelj & Mrvar, 1998) and NetDraw program to draw and analyze the network. In this section, we will illustrate a process of how to conduct a network analysis, starting from collecting the data, constructing a network, visualizing and analyzing by network analysis programs.

Network Construction

Before we start constructing the network, all existing information of syndicated deal are gathered from each VC firms, country by country. We used syndicated deal transaction as a proxy of relationship and information sharing. To link all pairs of relationship among venture capital firms, we investigate each deal by taking into consideration merely three cases (as shown in Figure 3.2) comprising of

1) Startup(s) secures funding from VC firm(s)

2) One VC firm acquires startup(s) from other VC firm(s)

3) Two VC firms establish another joint venture company.

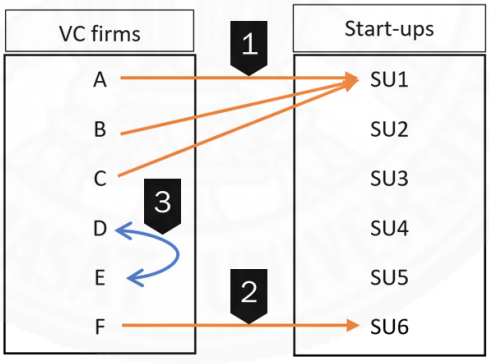


Figure 3.2 Three different syndication patterns

Since it is probably impossible to indicate whether venture capital firm A knows venture capital firm B, and vice versa, and which direction of information flow they share to each other, then we would treat them as having a relationship and neglecting the directionality of the connection. This relationship is considered as non-directed tie in graph theory. For the undirected centrality measures, we are primarily focusing on the ties among VCs occurred by co-funding for the similar portfolio company. We are less concerned about in which financing round the co-

investment occurred because we basically presume that VC relationships are built from board meetings and other activities that enhance the portfolio company success. Thus, we consider syndicates at the company level and define the syndication as the group of VC firms investing in the same portfolio company. Other cases are left out of our sample due to either insufficient information or no relevance in the sense of presenting the relation to each other. In addition, only a group of venture capital firms was considered, we crossed out other types of venture capital investors such as individuals.

Network construction procedure begins with deal arrangement. Firstly, syndicated deals are withdrawn from each venture capital firms in six countries. The title of the deal is manually transformed into a list of deal flow in a text file format, technically following a network pattern called "edge lists". After the deal arrangement, there are 456 deals and 136 VC firms in total. Secondly, the arranged text file is formatted to the ".net" file for Pajek program. Thirdly, we import the Pajek file into Pajek and draw a network. After network has been visualized, we also function Pajek to calculate centrality of the network and other properties measure. lastly, we export the result into Excel file. We then analyze and further interpret the result. The flow of the procedure is represented in Figure 2.1. To be remarked, the similar network is also visualized by another program, called "NetDraw".

Samples for hypothesis testing

We extracted and recorded portfolio companies from a set of syndicated deals of venture capital firms, so that, we can list out the name of portfolio companies and the name of their funding venture capital firms in each deal in yearly basis. At the end, we have a preliminary sample of 218 SEA portfolio companies backed with 56 venture capital firms between 2010 and 2017. However, each portfolio company was funded by different venture capital firms in each year. In some years venture capital firms are unknown or missing. Moreover, there are several cases that either dependent or independent variables is missing in each portfolio company. Econometrically, this kind of data is called an unbalanced multivariate panel data. There is no doubt why we encountered with such data, as it is challenging to collect the data in venture capital and startup industry due to an insufficiency of data sources and well-recorded data availability, especially in Southeast Asia.

We sorted out the sample, with no missing value of all independent variables, to different groups of samples regardless to each dependent variable. To be more clarified, the Figure 3.3 helps illustrate the panel data sampling in this study.

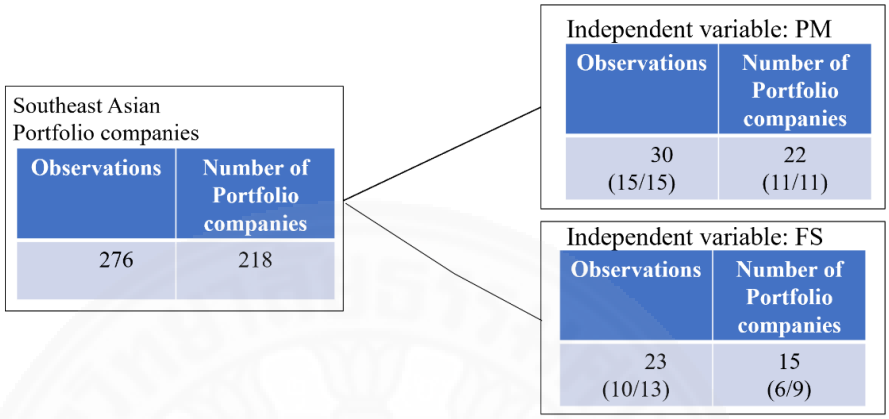


Figure 3.3 Pooled data sampling

Our primary sample is all portfolio companies derived from VC syndicated deals in Orbis database. Next, we extracted the whole sample to a set of panel data of Southeast Asian portfolio companies in yearly basis. Due to lack of data availability in multi-variate unbalanced panel data, the panel data set of all Southeast Asian portfolio companies is divided into two pooled data sets as Pooled A and B regardless to independent variables, PM and FS respectively. The observations and number of portfolio companies in each group of Pooled data are shown in Figure 8. For the Pooled data of PM, there are 30 observations in the sample with 22 portfolio companies in total. The observation consists of one half of portfolio firms from emerging countries and another half of that from Singapore. For the Pooled data of Funding stage, we bring the data set of PM and determine known information of funding round among portfolio companies. The data with missing values of funding stage are eliminated from the sample. Finally, there are 23 observations in this Pooled data with 15 portfolio companies, which include 13 Singaporean portfolio companies and 10 others from emerging countries. Still, the main data set of the whole sample in Pooled A and B reasonably delivers the reasonable result, as Park (2005-2009) suggested that in Pooled data framework if the number of firms or time period goes small it is useless to contrast one group with another.

3.3.2 Dependent and Independent variables

We have dependent variables, which indicate portfolio company's performance, and explanatory variables, which consist of Institutional metrics, Network metrics, and other significant control variables. Descriptions and measurements of all variables are shown below and summarized into Table 3.2.

Portfolio firm's performance (Firm-level vector)

Most prevalent performance indicators in VC literatures are the number of exits and successful rate of portfolio companies through either a trade sale or IPOs (Gompers and Lerner, 1999; Cumming & Johan, 2007; Abell et al., 2007; Liu & Chen, 2014; Bellavitis et al., 2017). Even though IPOs and trade sales are widely accepted, the core concept is based on an intention to assess a performance of venture capital firms, not directly reflect a performance of portfolio companies. Alternatively, other measurements, such as financial and accounting measures, are also employed. Some papers argue that the measurement from financial statement is still informative and essential for investors' firm valuation (Heughebaert & Manigart, 2012). Previous studies employed various measures of VC-backed firm performance. We could separate performance measures into three different dimensions: financial performance (e.g. Sales, Revenue generation (year-over-year revenue), and Avoidance of insolvency); operating performance (e.g. Employment growth(Davila et al.,2003; Engel, 2004), Productivity growth(Croce et al.,2013), Yearly number of patent); and value performance (e.g. The yearly total financing received by a startup, Portfolio company survival, Product and financial value creation). Performance measures could be examined from more than one dimension. For example, Baum and Silverman (2004) selected six startups' performance measures. Some of these are year-over-year revenue, R&D spending growth, year-over-year employment growth, the yearly number of patent applications by and patents granted to a startup (Baum and Silverman, 2004).

In our paper, we use the data from a report of companies' income statement to examine two dimensions of financial and operating performance of portfolio firms, including Operating revenue and Net income (Profits and Losses), for several reasons **(1)** in contrast to some literatures, IPO and exit rate of portfolio firms in Southeast Asian VC market are difficult to be observed from our data source and have just been well-recorded for a few years ago. Moreover, IPO and exit rate are

venture capital-centric, meaning that they are more likely to capture a performance of venture capitalists. While a degree of performance in our study is more concentrated into an operation of portfolio firms. Measuring startup's performance by looking at financial data like the revenue growth could be an alternative measure of success for SEA context. **(2)** Most of VC-backed firms in SEA are Small medium enterprises (SMEs). Growth is critical for an entrepreneurial firm, and it is the most widely pursued strategy for young firms. As Klonowski (2016) provided a clearer picture of the effect of acquisition on the valuation and growth of entrepreneurial firms backed by venture capital, by investigating overall financial performance thorough income statement, cash flow statement, and balance sheet. Klonowski (2016) also suggested future research could focus on achieving operating and financial synergies. One of financial indicators is the revenue growth, which proven reflecting both internal growth and acquisitions made by VC firms in the sample **(3)** According to literature reviews (in Table 3.1), not a little number of studies commonly proxied VC-backed companies' performance by using accounting and financial statement, such as, revenue, employee growth, intellectual properties. Due to the data availability, what we can access are Operating revenue and Profit/Loss. Moreover, the growth path of currently formed companies played a pivotal role to management theory. **(4)** Many literatures have confirmed the validity and reliability of using financial and accounting information. For instance, Heughebaert & Manigart (2012) that financial statement is still informative and essential for investors' firm valuation.

Nevertheless, either OR or PL alone is not enough to explain a level of performance of portfolio companies in startup industry. We decided to use Profit Margin (PM) to measure portfolio companies' performance in term of profitability. PM, also called net profit margin, is a useful tool in determining how well a company's management team generates sales while also managing expenses. PM in this study is derived from calculating PM, described as net income based on the amount of revenue generated. PM is introduced to measure a performance towards a growth potential of startup business model, since their nature is to encounter with a huge investment cost from the start, which needed money from the investors, and if the model is workable, it will gradually make profit. So, Profit and Loss value alone does not directly reflect a real potential of those kind of business. The better way is to take into

account OR, a measure of operating performance, which calculated by sales minus related expenses in the operation, not including other costs and expenses which might distort a predicting power of business competency. By dividing PL by OR, the profit or loss (Net income) the company makes will be viewed as of one unit of operating revenue the company generates. For example, if the company bears a huge initial investment cost as a nature of setting up a business setup yet its business plan is good enough to make some profits in practice, the loss due to the initial investment will be compensated by a huge amount of operating revenue the company generates. Consequently, loss per one unit of opening revenue will be reduced. This means that a company with manageable budgeting and profitable business model tends to outperform that with impracticable budgeting or unmarketable business model, even though their financial statement still shows negative at a bottom line. Speaking of, this measure truly reflects a competitive performance of startup or initial business that their business idea and business model are a key driver of their success.

As a nature of newbie business, operating revenue may go from negative to positive, and become many folds once the business reaches its breakeven. One factor that help startups run their business in order to gain the profit in the future is funding money from the investors in different funding round. However, the value of deal in the past is difficult to trace back, VC funding stage is an alternative variable which provides more pragmatic picture than operating revenue. Funding stage was manually collected by CrunchBase, worldwide database of entrepreneurial business, and calculated by rewarding the funding round portfolio firms achieves as an interval score from one to four, beginning in order from up to seed stage, series A, series B, and series C or above. Once startups get into a higher stage, they normally gain a higher value of funding money. So that they are able to make their business more profitable by reaching a turning point and having a positive revenue hereafter. We then consider VC funding stage as another dependent variables and compare the results.

We examine portfolio firm-level financial performance in term of profitability and competitive advantage in yearly basis, PM (the proportion of net income to operating revenue, ranging from negative to one) and Funding stage (the funding round portfolio firms achieves).

VC Network metrics (Firm-level vector)

We employ network centrality measures to indicate the social power of a node, based on how well they "connect" in the network. The formation of venture capital network, in general, means the relationship of the firms whose shares distributed to similar investees. The one who is identified high-networked should have better access and disperse the information. Centrality measure will posit each venture capital firm according to the connection it has between one another. Simply speaking, centrality will detect who are the main players of VC industry in this region. Venture capital firms with higher degree centrality can be inferred to those who easier reach information (or vice versa) and become more central. Hochberg et al. (2007) used five centrality measures and suggested that Degree, Indegree, Outdegree illustrate the size of a VC firm's network, which mirrors its tendency to be invited by other VCs, and Closeness (Eigenvector) means its accessibility to the large-networked VCs, while Betweenness represents ones who act as an intermediary in gathering other VCs together. Furthermore, Hochberg et al. (2007) suggest that we should consider more than one VC's centrality measure since each centrality measures captures different elements among VC's ties and results in different explanation in detail. However, their study found high correlations of five centrality measures: degree, indegree, outdegree, eigenvector, and betweenness. Since our VC networks possess indirect ties, there are no centrality measures of indegree and outdegree. Our paper then take into consideration three centrality measures "Degree", "Betweenness", and "Closeness". These centrality measures are collected from venture capital firms in portfolio firms' level and in yearly basis. In case of multiple co-investors, we will select the highest VC centrality measure from all VCs funding in each investee.

(1) Degree

Since, in this paper, we concentrate on the relationship of VCs, who invest in similar ventures, there is no direction between lead and follow investors. To determine the level of such indirect ties in the network, Degree is considered appropriate. Indegree and outdegree are emitted. Degree counts the number of links to other actors in the network. Degree is often interpreted in terms of the instantaneous risk of node for catching whatever is flowing through the network. A higher degree of

VC firms means a larger number of ties, so it can be interpreted that VC firms with higher degree has more connections or high networking compared to the lower ones.

(2) Betweenness

Betweenness of one node is the proportion of all shortest distances, alternatively known as “geodesics”, between other nodes in the network that pass through this node. Nodes that exist on many shortest paths between other nodes have higher betweenness than those that do not. The more a firm is in between, the more central its position in the network. A firm with high betweenness is more important as an intermediary in the communication network. This measure reflects an intensity of the transmission of information through a network, and ability to control the flow of information according to a position in the communication network. VC firms with high betweenness means that they have larger network coverage in transmitting the information to others. The betweenness is calculated by geodesic path of a node divided by all shortest paths in the network.

(3) Closeness

In network topologies, closeness is one of the basic concepts, which can be measured as the reciprocal of the sum of the shortest distances between each individual and every other node in the network. In other words, closeness of one person is the number of the rest persons excluding this person, divided by the sum of all possible distance between this person and all others. The closeness centrality of a node is relied on the total distance between one node and all other nodes, where longer distances reflects lower closeness centrality. Persons that are shrunk to other persons (that is, those that tend to have shortest-path length to other persons within the network) have higher closeness. The closer distance between a node and all other nodes is, the higher its centrality. The higher the value of the closeness is, the more central its position in the network, the easier information may reach it. It is usually positively associated with other measures such as degree. In the network theory, closeness is another sophisticated measure of centrality, which is defined as the mean geodesic distance (i.e., the shortest path) between an individual and all others reachable from it.

Institutional metrics (Country-level vector)

Pre-existing studies mentioned the significant of the effect of institution on venture capital activities by using a survey and in-depth interview. Less

than a decade, scholars have started to estimate and use a set of indices for measuring institutions in venture capital literatures. For instance, **(1)** Scheela et al. (2015) analyzed institutional analysis of Southeast Asian countries by initiating their own institutional score and BA/VC score by deriving the data from the Global Competitiveness Report based on five key institutional criteria: impact of business corruption, protection of property rights, trust of politicians, ease of issuing shares, and bank soundness. They compared their set of scores to VC Attractiveness Index Rank from Groh et al. (2010), the well-known VC/PE country attractiveness index based on six drivers of economic activity, depth of capital market, taxation, investor protection and corporate governance, human and social environment, and entrepreneurial culture and deal opportunities, and they found a similar pattern of significantly high correlations between the two sets of measures. Hence, we prefer using VC/PE country attractive indices as a proxy of institutional development. **(2)** Li & Zahra (2012) measure the level of formal institutional development (FID) by employing a composite index of six institutional dimensions of the Worldwide Governance Indicators (WGI), adopted from Kaufmann et al. (2007), including Rule of law, Government effectiveness, Control of corruption, Regulatory quality, Political stability, and Accountability. However, each dimension is found to be highly correlated to one another. The results remain the same with a simple method of finding the average of the six institutional dimensions. The WGI is an appropriate estimator which provides more informative about unobserved governance and possesses small margins of error. Since the index paves almost all the countries and regions and is constructed on hundreds of measures, derived from 33 data sources provided by 30 diverse organizations. These helps minimize data losses (Kaufmann et al., 2007). **(3)** Offering more precise in estimates of institutions between VC firms and their ventures, Li et al. (2014) established a use of institutional distance, which is an extent to which FID of both countries of origin between VCs and their portfolio companies are considered. A process of estimation comes into two steps. First, we calculate FID of both venture capital firms and portfolio companies. Second, we find the absolute value of differences of FID in each VC-venture pair. In case of multiple co-investors, we select the highest FID from all VCs funding in each investee.

Our study focuses on informal cultural and social constraints under institution development and how different levels of institutions interact with

networks and all together affect to venture's performance. As Lingelbach (2015) investigates the impact of formal institutional change on the venture capital development process. The results indicated that macro institutional change plays a more significant role in supporting the VC development process comparing to what micro institutional change does and found out that two macro-level institutional dimensions, rule of law and political stability, have a huge positive effect on that process. Therefore, we view the institutional development framework as a whole set of political, economic and rules of law in macro-level perspective rather than some specific institutional policies. In accordance with the review of institutional factors, we employ three dimensions of institution metrics, including VC attractiveness index rank, Formal Institution Development (FID) and Institutional distance. Firstly, since Scheela et al. (2015) found a high correlation between their generated scores (Intuitional score and BA/PE score) and VC attractiveness index rank, we would rather use VC attractiveness index rank as one measurement of institutions. The indices are derived from an annual report of The Global Venture Capital and Private Equity Country Attractiveness, which is the easy-to-access, well-known, and reliable data source. All values in each country are collected year-by-year. Secondly, we examine formal institution development (FID) to capture the level of formal institutional development by using the average index of the WGI. Lastly, we employ a more recent institution measure called institutional distance, from the work of Li et al. (2014), as another in-detail indicators to capture institutional differences between VC firms and their portfolio companies. These measurements of institution are completely taken into account all aspects of institution differences, such as, legal, regulation, CG, taxation.

Control variables (Firm-level vector)

To achieve more precise result, we need to control other factors that may affect our study of a relationship between dependent and independent variables. Jeng & Wells (2000) primarily discovered the determinants of venture capital investments (IPOs, Accounting standards, Labor market rigidities, GDP percentage growth, Market capitalization growth), which then found to be affected differently by countries, government policies and types of venture capital financing. Afterwards, Groh & Wallmeroth (2016) extended the study of the determinants of venture capital funding: evidence across countries from Jeng & Wells (2000) by taking into consideration a

large number of emerging countries. They revealed that M&A activity, innovation, legal rights and investor protection, IP protection, corruption, corporate taxes and unemployment could be a pivotal factor of venture capital investments. Moreover, they found significant differences in economic impact from several determinants between developing and developed countries. However, in our study, we consider some of these factors as institutional factors, our main explanatory variables. While some are used as control variables.

We presented firm-level control variables from VC-backed firms' perspective. They represent a fundamental factor of controlling VC-backed firms' performance comprising of VC-backed companies' size, age, and industrial categories (Hochberg et al., 2007; Croce et al., 2013). According to portfolio companies' characteristics, a larger size of firm means a more experienced and reputable company. With an advantage of economies of scale in operation, large portfolio firms are more likely to be well-prepared and positively effective to their performance. The evidence of size effect was found from Abell & Nisar (2007) that firm's size was positively and significantly related to a firm's exit rate. Besides, firm age, measured by portfolio companies' years of operation, also reflects the experience how well the company can manage its business and survive in the market. Firm's age was found to have the positive effect on entrepreneurial firm's exit outcome in the US and the UK (Tian, 2011; Bellavitis et al., 2014 respectively). However, Bellavitis et al., (2017) showing that lower network centrality and younger VC firms may perform better as they are more beneficial for using their network and connection in a cohesive network, rather than high network centrality and mature firms. In addition, since different countries with heterogenous economies taken into account, macro-institutional factors can bias the results, we also account for Singapore Dummy variable. Southeast Asia region has both developed and developing countries. Most countries in SEA are considered as developing countries except Singapore. To distinguish emerging economies from the mature, we introduce a Singapore dummy variable to control for homogenous economic environment.

Table 3.2 All variable definitions and sources

	All variables	Measures	Sources
Dependent variables	Net Profit Margin (PM)	Net Profit & Loss divided by operating revenue	Orbis
	Funding Stage (FS)	Recent funding round portfolio firms achieves, assigned in an interval score.	Crunchbase
Explanatory variables	Degree (DEGREE)	the number of links incident upon a node	Network Analysis
	Closeness (CLOSE)	the number of the rest vertices excluding this vertex, divided by the sum of all possible distance between this vertex and all others	Network Analysis
	Betweenness (BETW)	the proportion of all shortest distances (geodesics), between other vertices in the network that pass through this vertex.	Network Analysis
	VC Attractiveness Index (VCPE)	Country-level Annual VC/PE country attractiveness report from Groh et al. (2010)	Country-level Annual VC/PE country attractiveness report from Groh et al. (2010)
	Formal Institution Development (FID)	The average index of six institutional dimensions in the WGI	Worldwide Governance Indicators (WGI)[(1)]

	Institutional Distance (IDIST)	The absolute value of differences in FID between countries of VCs and portfolio companies	Worldwide Governance Indicators (WGI)(1)
	Portfolio firm's size (SIZE or Total assets)	Total assets (US Dollars)	Orbis
	Portfolio firm's year (YEAR)	numbers of year of incorporation of portfolio companies	Orbis
	Industry dummy (INDUS)	equals 1 for Information and Communication, zero for others	Orbis
	Singaporean VC dummy (SING)	equals 1 for Singaporean VC backed firm, zero otherwise	Orbis

Remarks: (1) WGI composite measure provided at www.govindicators.org (Kaufmann et al., 2010).

3.3.3 Random Effect Regression Model

This study employs Random effect regression model (REM) for testing the hypotheses. This method is more appropriate for time series pooled data than simple OLS for many reasons. This approach relaxes the assumption of OLS stating that residuals are uncorrelated, which in time series, error terms are more likely to related to each other over time. This may cause the econometric issue so called autocorrelation, which is a correlation between error term at different time period and may divert an accuracy of the result. Random Effect regression should alleviate this problem by minimizing distance relative to covariance of residuals instead of minimizing sum of squares of residual in OLS. Fixed effect is diminished by using Singapore dummy to isolate Singapore from emerging countries. Furthermore, using a more complicated model, like a fixed or Random effect model, might not be the answer if the Pooled data yet not be well-supported. Like our pooled data, which are unbalanced and short, the Hausman test is used to answer which model should be selected a simple OLS, fixed, or Random effect model. However, to avoid heteroscedasticity issue, we also employed the robustness test by obtaining the robust standards errors. Table 3.3 shows the Hausman test comparing fixed and random effects. The Hausman test returns the chi-squares score of 1.73 and small enough not to reject the null hypothesis, we may stick to the efficient random effect model.

Table 3.3 The Hausman test

	Coefficients					
Variable	*(I) Fixed Group*	*(II) Random Group*	*(I-II) Difference*	*Standard Error*	Chi2 χ^2	Prob > χ^2
Degree	1.2546	1.0348	0.2198	.	1.73	0.63
Total	0.0002	0.0002	0.0000	0.0002		
Year	0.8981	1.7339	-0.8358	1.3767		

Notes: *Test: H_o: Difference in* coefficients not *systematic*. *The Hausman test comparing fixed and random effects. The Hausman test returns the chi-squares score of 1.73 and small enough not to reject the null hypothesis. This means that the random effect model is preferable.*

Since our data are time-series panel data with unbalanced and multi-variate formation, we use time-series panel regression technique to test our hypotheses with variables including portfolio companies' and VC characteristics, portfolio companies' industrial and year fixed effects, by using STATA program. The

performance of the portfolio firm is predicted to be explained as a function of venture capital network and institutional proxies, and other controls including dummy variables.

The general form of the structural equation in this study is shown below,

$$\pi_{it} = \alpha_0 + \alpha_1(DEGREE)_{jt} + \alpha_2(CLOSE)_{jt} + \alpha_3(BETW)_{jt} + \alpha_4(VCPE)_{it} + \alpha_5(FID)_{it} + \alpha_6(IDIST)_{ijt} + \alpha_7(SIZE)_{it} + \alpha_8(YEAR)_{it} + \alpha_9(INDUS)_{it} + \alpha_{10}(SING)_{it} + \varepsilon_{it}$$

where π_{it} = Dependent variables: Portfolio firms' performance, α = coefficient, i = portfolio firm i, j= venture capital firm j, t = Year, ε = error term, other symbols are complied with the Table 3.2 in measurement of variables.

The estimated equation can be regressed into three main models. Each model is regressed to explore the answer in each hypothesis.

Models for hypothesis 1

In hypothesis 1, the goal is to find a relation between Network centrality measures and portfolio firms' performance as taking into consideration size and industrial effect. The following structural equation system, where the dependent variables are portfolio firm performance:

$$\pi_{it} = \alpha_0 + \alpha_1(DEGREE)_{jt} + \alpha_2(CLOSE)_{jt} + \alpha_3(BETW)_{jt} + \alpha_7(SIZE)_{it} + \alpha_8(YEAR)_{it} + \alpha_9(INDUS)_{it} + \alpha_{10}(SING)_{it} + \varepsilon_{it}$$

where π_{it} is a measure of the performance of firm i at year t, consists of Net income per unit of operating revenue (PM) and Funding stage (FS). Firm performance is predicted in the hypothesis by VC Network centrality measures: Degree (DEGREE), Closeness (CLOSE), and Betweenness (BETW).

Models for hypothesis 2

In hypothesis 2, the goal is to find a relation between Institutional factors and portfolio firms' performance as taking VC Attractiveness Index Rank (VCPE), Formal Institution Development (FID), Institutional Distance (IDIST) into the structural equation. The following structural equation system, where the dependent variables are portfolio firm performance:

$$\pi_{it} = \alpha_0 + \alpha_4(VCPE)_{it} + \alpha_5(FID)_{it} + \alpha_6(IDIST)_{ijt} + \alpha_7(SIZE)_{it} + \alpha_8(YEAR)_{it} + \alpha_9(INDUS)_{it} + \alpha_{10}(SING)_{it} + \varepsilon_{it}$$

where π_{it} is a measure of the performance of portfolio firm i at year t, consists of Net income per unit of operating revenue (PM) and Funding stage (FS). Firm performance is predicted in the hypothesis by Country-level Institutional factors: VC Attractiveness Index Rank (VCPE), Formal Institution Development (FID), Institutional Distance (IDIST).

Models for hypothesis 3

In hypothesis 3, the goal is to find a interrelation between Institutional factors and portfolio firms' performance as taking into account Network centrality measures. The following structural equation system, where the dependent variables are firm performance, and where there are three interaction terms of different network centrality measures:

$$\pi_{it} = \alpha_0 + \alpha_{11}(DEGREE_j \; X \; FID_i)_t + \alpha_{12}(DEGREE_j \; X \; VCPE_i)_t + \alpha_{13}(DEGREE_j \; X \; IDIST_{ij})_t + \alpha_7(SIZE)_{it} + \alpha_8(YEAR)_{it} + \alpha_9(INDUS)_{it} + \alpha_{10}(SING)_{it} + \varepsilon_{it}$$

$$\pi_{it} = \alpha_0 + \alpha_{14}(CLOSE_j \; X \; FID_i)_t + \alpha_{15}(CLOSE_j \; X \; VCPE_i)_t + \alpha_{16}(CLOSE_j \; X \; IDIST_{ij})_t + \alpha_7(SIZE)_{it} + \alpha_8(YEAR)_{it} + \alpha_9(INDUS)_{it} + \alpha_{10}(SING)_{it} + \varepsilon_{it}$$

$$\pi_{it} = \alpha_0 + \alpha_{17}(BETW_j \; X \; FID_i)_t + \alpha_{18}(BETW_j \; X \; VCPE_i)_t + \alpha_{19}(BETW_j \; X \; IDIST_{ij})_t + \alpha_7(SIZE)_{it} + \alpha_8(YEAR)_{it} + \alpha_9(INDUS)_{it} + \alpha_{10}(SING)_{it} + \varepsilon_{it}$$

where π_{it} is a measure of the performance of portfolio firm i at year t, consists of Net income per unit of operating revenue (PM) and Funding stage (FS). Firm performance is predicted in the hypothesis by the interaction between Institutional factors and VC Network centrality measures.

Model Specifications

Moreover, we extend main regression models into several models to provide more details in each relation of our study (as shown in Table 3.4). For example, we use VC network measures lagged by one year to avoid reverse causality, that is, revenue could increase network centrality in VCs. We run the regression by using the network centrality measures from syndication data for the one years prior to a year of regression. After we run all regressions, we can analyze the results of hypotheses by using the general equation as a benchmark. And we further extract an implication and make a discussion later.

		Dependent variable: Return on Revenue (ROR) and Funding Stage (FS)														
	Random Effects GLS regression.	**H1**			**H2**			**H3**								
		Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**	**Model 8**	**Model 9**	**Model 10**	**Model 11**	**Model 12**	**Model 13**	**Model 14**	**Model 15**
VC Network metrics	**Degree**															
	Closeness															
	Betweenness															
Institutional metrics	**VCPE**															
	FID															
	IDIST															
Interaction terms	**Degree X VCPE**															
	Degree X FID															
	Degree X IDIST															
	Closeness X VCPE															
	Closeness X FID															
	Closeness X IDIST															
	Betweenness X VCPE															
	Betweenness X FID															
	Betweenness X IDIST															
Control variables	**Venture's size (Total asset)**															
	Venture's age (YEAR)															
Dummy variables	**Singaporean VC dummy (SING)**															
	Singapore fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
	Industry fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Table 3.4 Designated model specifications

3.4 Empirical Results

This chapter discusses about the results from data analysis including the descriptive analysis of portfolio companies and the hypothesis testing. Two sets of pooled data were analyzed using STATA program. The analysis methods are divided into 3 main sections as follows: Initial analysis, Descriptive Statistical Analysis and Hypothesis Testing.

3.4.1 Initial Analysis

In this section preliminary diagnosis is implemented by Box & Whisker graph and t-test statistic to assure the differences between emerging countries and Singapore, and correlation matrix to avoid multicollinearity among explanatory variables. Furthermore, we adjust the interaction term by rescaling Network and Institutional metrics variable to alleviate the problem of non-identical unit and scaling.

Box & Whisker graph and z-test statistic

We do statistically confirm that we should take a consideration in dividing the sample into two groups by using two sample t statistic test of level of institutions between Singapore and other emerging countries. Although our study investigates portfolio companies in Southeast Asian countries, we intensively pay an attention on emerging economies in this region. We clearly highlighted from the introduction that their institutional system mainly differs from the developed economies'. Moreover, regardless to our research purposes, we then set Singapore into another group of study representing developed country in Southeastern Asia. As widely known that Singapore is a leading country in venture capital industry, the score of VC/PE attractive index is outstanding and positioning around the top comparing to that of other countries in SEA. According to our literature review, we expected that institution development in Singapore is more formal than those developing countries. To confirm this difference, we plotted Box & Whisker graph of VC/PE attractive index, one of institution metrics, in other countries against Singapore (shown in Figure 3.4). The graph apparently shows that the cluster of VC/PE attractive index around the mean between these two groups is easily distinguishable, as of Singapore is located higher than that of other SEA countries.

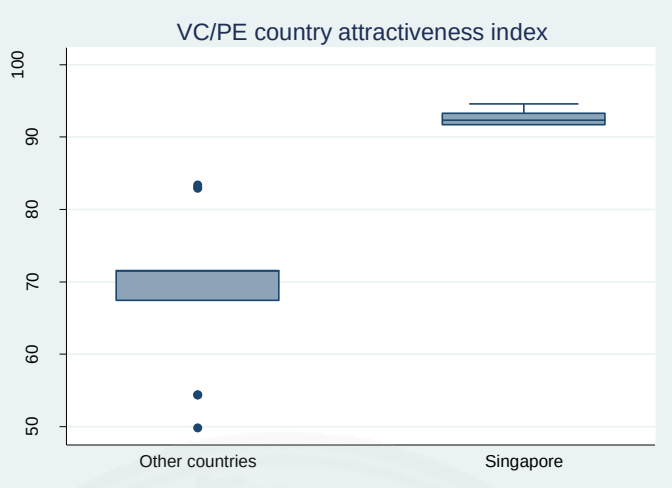


Figure 3.4 Box & Whisker graph of VCPE index between Singapore and other countries

Furthermore, we conduct two-sample t test with known covariances to statistically prove the difference of institutional measure, VCPE, between a group of emerging countries and Singapore.

Table 3.5 Two-sample t-test of VCPE

Group	*Observation*	*Mean*	*Std. Err.*	*Std. Dev.*	*t*	*P-Value*
Emerging	15	69.522	2.606	10.095	-8.854	0.000
Singapore	15	92.725	0.271	1.050		
Difference		*-23.202*	*2.620*			

Notes: *Test: H_a: two sided, H_o: Difference in means = 0*. The t statistic is -8.854 and the p-value is less than .001. The p-value indicates that a t value extremely less than -8.854 occurs less than 1 out of a thousand times under the null distribution (assuming no difference between the two groups). This means that it is highly unlikely that the two groups are equal.

As shown in Table 3.5, the null hypothesis has been rejected. VCPE country attractive index of other SEA countries is significantly lower than that of Singapore, so this affirms a significant difference of VCPE between two distinct types of economies. Hereafter in hypothesis testing, the analysis of two-group comparison will further be investigated and discussed together with the panel data of the whole sample. In a nutshell, after the test, a level of VC network centrality and Institution development among portfolio companies in emerging countries, significantly differ from portfolio companies in Singapore. This has proved that our samples reasonably maintain a good representative.

Correlation matrix

Degree and Betweenness are highly correlated in overall sample and Singapore sample (in Table 3.6 and 3.8), as we had found in our study of SEA VC network characteristics that SEA high networked VCs widely know many others yet be an intermediary between networks. So, we deal with this strong correlation by regress those measures separately. Also, VCPE has strong linkage to FID in overall sample. However, this manner has changed when the sample broke into two groups, VCPE and FID are weakly tied in emerging countries and turns negative in Singapore (in Table 3.7 and 3.8). IDIST and VC Network metrics apparently have a negative correlation in overall and Singapore sample. This pattern implies at the first glance that given a huge difference of FID between investors and investees, VCs funding those investees possibly have low level of networking. Moreover, in Singapore, VCPE and VC network metrics also have a negative correlation, which showing that given an increase of institutional development overtime, it might not be necessary for portfolio companies to be funded with an increase level of VC network over the same period of time.

Table 3.6 Correlation Matrix: Southeast Asian Countries

Variable	*DEGREE*	*CLOSE*	*BETW*	*VCPE*	*FID*	*IDIST*
DEGREE	1.0000					
CLOSE	0.6345	1.0000				
BETW	0.9267	0.6010	1.0000			
VCPE	0.3192	0.1683	0.3203	1.0000		
FID	0.2798	0.1364	0.2632	0.8646	1.0000	
IDIST	-0.2976	-0.4447	-0.2810	0.0255	0.0693	1.0000

Table 3.7 Correlation Matrix: Developing Countries

Variable	*DEGREE*	*CLOSE*	*BETW*	*VCPE*	*FID*	*IDIST*
DEGREE	1.0000					
CLOSE	0.6116	1.0000				
BETW	0.7200	0.4630	1.0000			
VCPE	0.5249	0.2379	0.5788	1.0000		
FID	0.0227	0.2119	0.2484	0.2776	1.0000	
IDIST	0.1587	-0.2767	0.1981	-0.2199	-0.3419	1.0000

Table 3.8 Correlation Matrix: Singapore

Variable	*DEGREE*	*CLOSE*	*BETW*	*VCPE*	*FID*	*IDIST*
DEGREE	1.0000					
CLOSE	0.6980	1.0000				
BETW	0.9438	0.6702	1.0000			
VCPE	0.0615	0.0900	0.1549	1.0000		
FID	-0.0358	-0.0023	-0.1262	-0.6373	1.0000	
IDIST	-0.5039	-0.5797	-0.5013	-0.2268	0.5004	1.0000

However, VC Network and Intuitional metrics in either Singapore or a group of developing countries seem to be independent of each other regardless to most of their correlations of less than 0.5. Some of high correlations are manageable and only occur within each group of predictors. Therefore, in primary observation, there is no sign of multicollinearity problem among explanatory variables.

Rescaling of Interaction terms

Each network measures and FID have its own unit. The value of network metrics starts from zero and FID score is varying from negative to positive side. With such diverse units and scales, the value of interaction between these two terms might not reflect true value when they are multiplied with each other. However, by taking logarithm is not appropriate for zero and negative value. Alternatively, we transform a value of each network measures and FID into a positive range scaling from zero to ten by setting a possible maximum and minimum value of each variables. Consequently, they all are in an identical scale which an increment implies a higher level of VC network centrality or more formal institution development. This rescaling method well answers our purpose of study in dealing with the interaction term which we are intended to determine the intensity level of Network and Institution which their multiplication results in term of score ranging from zero to ten, rather than the multiplied value of different units and scales.

3.4.2 Descriptive Analysis of variables

Descriptive statistics of variables are derived from the data of relevant explanatory variables in each group of samples, including PM, and FS. Descriptive statistics of variables, such as, maximum, minimum, and mean value, and standard deviation, are exhibited in Table 3.9-3.12. As descriptive data of the whole

sample in pooled A (shown in Table 3.9), the total number of observations is 30 with 22 portfolio companies and average time periods of 1.3636 year. PM varies from -123.199 up to 0.403 with mean value of -8.218 and standard deviation of 25.061. Since PM in this sample on average falls into negative side, this shows companies bare a hung amount of expenses including initial investments relative to the operating profit generated. In VC network centrality metrics, Degree, Closeness, and Betweenness, have its mean at 12.733, 0.154, and 0.058, respectively. The overall mean of Degree and Betweenness fall into lower side of VC network centrality with many folds of standard deviation comparing to its maximum of 90 and 0.359. In institutional metrics, the mean of VCPE posits in high score of 81.123 with standard deviation of 13.746. FID volatiles from -0.528 and 1.615 with the mean of 0.745 and standard deviation of 0.887. The overall mean of IDIST is 11.462 having a minimum at 0 and maximum at 43.1. In control variables, total asset is 7,235.276 US dollars on average with standard deviation of 15,482.48. Year of incorporation starts from 0 to 12 years with the overall mean of 3.166 and standard deviation of 2.948.

When the whole sample is divided into emerging countries and Singapore (Table 3.10 and 3.11), the total observations and the number of portfolio companies are divided into 15 with 11 portfolio companies and average time periods of 1.3636 year. PM of both groups remains negative at -8.6047 for emerging countries and -7.833 for Singapore. It is obviously seen that the overall mean of VC Network metrics from Singapore are higher than that from the group of emerging countries, especially, Degree (17.733 and 7.733) and Closeness (0.079 and 0.036). As well as the mean of institutional metrics, VCPE (92.7252) and FID (1.5876) in Singapore rank higher than that in emerging countries (69.5223 and -0.0963, respectively). This aligns with our initial analysis for a significant difference between two groups, as Singapore has further level of formal institution. FID in Singapore is in positive side starting from 1.5429 to 1.6154, whereas FID in emerging countries covers the negative side starting from -0.5284 to 0.4764. IDIST in Singapore (13.0483) is wider than that in the emerging (9.8772) due to its top positioning in FID of Singapore, and the investment from other neighbor countries in much lower FID. In control variables, the mean of total asset in emerging countries is 12,634.29 US dollars with standard deviation of 15,482.48, which

surprisingly higher than that in Singapore. Year of incorporation starts from 0 to 12 years with the overall mean of 3.6 and standard deviation of 2.995.

On another data set of funding stage in Pooled B (Table 3.12), the total number of observations is 23 with 15 portfolio companies and average time periods of 1.5333 year. Unlike Pooled A, Pooled B cannot be divided into groups due to insufficient observations and limited degree of freedom to implementing Random Effect regression. Funding stage varies from 1 up to 4 with mean value of 2.7826 and standard deviation of 0.9980. The overall mean (14.8260, 19.3594, 0.1608) and standard deviation (0.1138, 0.0655, 0.0954) of Degree, Closeness, and Betweenness are quite similar to those in the whole sample of Pooled A. Likewise, the means of VCPE (83.6596), FID (0.7951), and IDIST (12.1422) are comparable to that in the whole sample with standard deviation of 10.9853, 0.9351, and 12.6104, respectively. FID also embraces both negative to positive side starting from -0.3270 to 1.6154. In control variables, the overall mean of total asset is 3,427.054 with standard deviation of 6,091.678. Year of incorporation covers from 0 to 12 years with the overall mean of 2.7826 and standard deviation of 2.6277. To conclude, even though the number of observations has been reduced, the mean value of independent variables still be comparable with the dataset of PM in the whole sample.

Table 3.9 Pooled A: PM (Whole sample)

Unbalanced Pooled data, 2010-2017
30 Observations
22 Portfolio companies
Average time period 1.3636

Variable	*Mean*	*S.D.*	*Min*	*Max*
PM	-8.218	25.061	-123.199	0.403
Degree	12.733	17.587	1	90
Closeness	0.154	0.107	0.005	0.352
Betweenness	0.058	0.086	0	0.359
VCPE	81.123	13.746	49.8	94.554
FID	0.745	0.887	-0.528	1.615
FID2	6.491	1.775	3.943	8.230
IDIST	11.462	13.181	0	43.1
Total asset	7235.276	15482.48	25.028	67443.26
YEAR	3.166	2.948	0	12

Remarks: FID2 is the rescaled FID used for the interaction term

Table 3.10 Pooled A1: PM (Emerging countries)

Unbalanced Pooled data, 2010-2017
15 Observations
11 Portfolio companies
Average time period 1.3636

Variable	*Mean*	*S.D.*	*Min*	*Max*
PM	-8.6047	31.7069	-123.1991	0.4031
Degree	7.7333	6.4194	1	20
Closeness	0.1437	0.0929	0.0099	0.2833
Betweenness	0.0367	0.0402	0	0.0986
VCPE	69.5223	10.0950	49.8	83.3536
FID	-0.0963	0.3360	-0.5284	0.4764
FID2	4.8072	0.6721	3.9430	5.9528
IDIST	9.8772	11.8777	0	43.1
Total asset	12634.29	20709.17	26.913	67443.26
YEAR	3.6	2.995	1	12

Remarks: FID2 is the rescaled FID used for the interaction term

Table 3.11 Pooled A2: PM (Singapore)

Unbalanced Pooled data, 2013-2017
15 Observations
11 Portfolio companies
Average time period 1.3636

Variable	*Mean*	*S.D.*	*Min*	*Max*
PM	-7.833	17.1857	-68.3324	0.0203
Degree	17.7333	23.3650	1	90
Closeness	0.1662	0.1225	0.0056	0.3523
Betweenness	0.0799	0.1138	0	0.3597
VCPE	92.7252	1.0505	91.7040	94.5542
FID	1.5876	0.0251	1.5429	1.6154
FID2	8.1752	0.0502	8.0859	8.2309
IDIST	13.0483	14.6089	0	34.9
Total asset	1836.266	2281.199	25.028	6912.078
YEAR	2.7333	2.939	0	12

Remarks: FID2 is the rescaled FID used for the interaction term

Table 3.12 Pooled B: Funding Stage

Unbalanced Pooled data, 2013-2017
23 Observations
15 Portfolio companies
Average time period 1.5333

Variable	*Mean*	*S.D.*	*Min*	*Max*
Funding Stage	2.7826	0.9980	1	4
Degree	14.8260	19.3594	1	90
Closeness	0.1608	0.1138	0.0056	0.3523
Betweenness	0.0655	0.0954	0	0.3597
VCPE	83.6596	10.9853	67.4	94.5542
FID	0.7951	0.9351	-0.3270	1.6154
FID2	6.5903	1.8703	4.3459	8.2309
IDIST	12.1422	12.6104	0	34.9
Total asset	3427.054	6091.678	25.0280	26818.02
YEAR	2.7826	2.6277	0	12

Remarks: FID2 is the rescaled FID used for the interaction term

3.4.3 Hypothesis Testing

After the data is cleaned and established the goodness of measure from initial analysis, the data is ready to be analyzed and tested for the hypothesis framework (in Figure 3.1). This section investigates the results of research hypotheses. This part concerns verification of the hypotheses including the status of a relationship in each hypothesis, and further examines explanatory factors in order to determine how performance of portfolio companies can be obtained through VC network centrality, Formal institution development, and the interaction term between VC network and Institutions. Statistical techniques utilized and applicable in this part are Random Effect regression analysis techniques.

In each hypothesis testing, several statistical outcomes need to be interpreted. P-value and the regression coefficient Beta commonly are key indicators to describe the result. The p value (at 0.05, 0.01, 0.001 significant level) is used to determine significance in a relationship between independent variables and dependent variable in regression model. If P-value appears less than 0.05, it means the p-value is small enough to reject the null hypothesis, which implicitly means that independent variable is significant to dependent variable at 0.05 level. The regression coefficient (slope of the regression line), which can be expressed in words, β or parameter

estimates, or Coefficient (of the equation in each model), can help describe how dependent variable changes in units when independent variable changes by 1 percent. Moreover, plus and minus sign in front of Beta would further indicate positive or negative correlation of the hypothesis. Additionally, sign represents a positive relationship meaning that the change of both dependent and independent variable is going in the same direction. Adversely to minus sign, the change of both dependent and independent variable is going in the opposite direction. Referring to our initial analysis, we also distinguish emerging economics from mature economics among Southeast Asian countries by isolating Singapore to another group of samples (named as model .1 and .2).

Random Effect Regression of Hypothesis 1 (Pooled A: PM)

The hypothesis I is to test whether venture capital network is related to a performance of portfolio companies. In this hypothesis testing, we firstly regress each network measure to performance measure of the whole sample and secondly consider the sample into two groups of economic profile and make a comparison. The hypothesis 1 is tested by running Random Effect regression of dependent variable, portfolio companies' performance measured by PM, against independent variables, three network measures consisting of Degree, Closeness, and Betweenness. We separately regress each network metric with three different equation models (model 1-3), make a comparison with a group of emerging economies (model 1.1, 2.1, and 3.1) and Singapore economy (model 1.2, 2.2, and 3.2) and interpret the results in each model. After the test, we expected a significance outcome with a positive sign for each model in hypothesis 1.

Table 3.13: Random Effect Regression Results of Hypothesis 1
(Independent variables: all VC Network metrics)

	Model 1	Model 2	Model 3
Degree	**1.048*** **	-	-
Closeness	-	19.398	-
Betweenness	-	-	-25.978
Total asset	0.0001	0.0001	0.0001
INDUS	-1.765	-1.104	-0.797
YEAR	1.881	2.279	2.226
SING	-0.860	7.693	9.075
Const.	-14.648	-16.184	-14.196

N	30	30	30
No. group	22	22	22
Chi-Square	185.85***	2.90	12.43***

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

According to the random effect regression results shown in Table 3.13, in model 1 to 3, the dependent variable PM is predicted by explanatory variables, Degree, Closeness, Betweenness and other controls including total assets, industry, year, and Singapore dummy. The result shows that Degree is positively and significantly related to PM with coefficient of 1.048 at P-value of less than 0.001. Statistically speaking, if Degree goes up or down by 1%, PM would increase or decrease by 1.048 units in the same direction. While all control variables are insignificant to PM. In model 2, Closeness has no influence on PM (β = 19.398, and P-value = 0.329). Other predictors do not have any significant impact on dependent variable (P value > 0.05). In model 3, Betweenness is not essentially related to PM (β = -25.978 and P-value = 0.6). Similarly, control variables consisting of total asset, year of operation, and industry are not able to help explain a relationship of Betweenness to PM.

Table 3.14: Random Effect Regression Results of Hypothesis 1
(Independent variable: Degree)

	Model 1.0	Model 1.1	Model 1.2
Degree	**1.048*** **	0.002	0.121
Total asset	0.0001	**-0.00003*** **	0.003
INDUS	-1.765	-1.162	0.551
YEAR	1.881	**0.525*** **	-0.007
SING	-	0	1
Const.	-14.648	-3.478	-19.854
N	30	15	15
No. group	22	11	11
Chi-Square	185.85***	10673.70***	23.03***

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3.15: Random Effect Regression Results of Hypothesis 1 (Independent variable: Closeness)

	Model 2	Model 2.1	Model 2.2
Closeness	19.398	0.038	-52.236
Total asset	0.0001	**-0.00003*** **	0.001
INDUS	-1.104	-1.165	0.643
YEAR	2.279	**0.529*** **	1.957
SING	-	0	1
Const.	-16.184	-3.444	-11.646
N	30	15	15
No. group	22	11	11
Chi-Square	2.90	8123.55***	3.34

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3.16: Random Effect Regression Results of Hypothesis 1 (Independent variable: Betweenness)

	Model 3	Model 3.1	Model 3.2
Betweenness	-25.978	**12.544*** **	**-119.122***
Total asset	0.0001	**-0.00002*** **	0.005
INDUS	-0.797	-1.160	2.380
YEAR	2.226	**0.570*** **	-1.158
SING	-	0	1
Const.	-14.196	-4.316	-22.431
N	30	15	15
No. group	22	11	11
Chi-Square	12.43***	27379.70***	49.65***

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

By focusing on emerging countries (Table 3.14-3.16), total asset and year of incorporation turned out to be significantly connected to PM. Total asset and PM have negative relationship with coefficients of less than 0.00002. Whereas year of incorporation and PM have positive relationship with coefficient of 0.525, 0.529, and 0.570 as of Degree, Closeness, and Betweenness respectively (in model 1.1, 2.1, and 3.1). Moreover, only Betweenness is positively significantly associated to PM ($\beta = 12.544$ and P-value of less than 0.001), which means that PM would change 12.544 units by changing one percent of Betweenness in the same direction. Unlike Singapore, a relationship between Betweenness and PM interestingly shows a negative relation at 5 percent level of significance ($\beta = -119.122$ and P-value = 0.044). PM would increase by 119.122 units for each 1% decrease in Betweenness.

Overall results showed that there was a significantly positive relationship between VC Network metrics and portfolio companies' performance in major network centrality measures, Degree and Betweenness. On one hand, the relationship of Betweenness to PM was found positively significant in a sample of portfolio companies in emerging countries. On the other hand, this relationship turns negatively significant in Singapore, the one and only developing country in Southeastern Asia. Moreover, Total asset and year of cooperation are found significant to explain a variation in PM portfolio companies' performances in a group of developing countries. Total asset and PM have negative relationship whereas Year of cooperation and PM have positive relationship.

Random Effect Regression of Hypothesis 2 (Pooled A: PM)

The hypothesis 2 is to test whether Institutional Development is related to a performance of portfolio companies. In this hypothesis testing, we firstly regress each Institutional measure to performance measure of the whole sample and secondly consider other models with and without Singapore and make a comparison. The hypothesis 2 is tested by running Random Effect regression of dependent variable, portfolio companies' performance measured by PM, against independent variables, three institutional measures consisting of VC Attractiveness Index, Formal Institution Development, and Institutional Distance. We separately regress each institutional measure with three main equation models (model 4-6), make a comparison with a group of emerging economies (in model 4.1, 5.1, and 6.1) and Singapore economy (in model 4.2, 5.2, and 6.2) and interpret the results in each model. After the test, we anticipated a positive relationship for models of VCPE and FID, but negative relationship for models of IDIST.

Table 3.17: Random Effect Regression Results of Hypothesis 2
(Independent variables: all Institutional metrics)

	Model 4.0	Model 5.0	Model 6.0
VCPE	-1.975	-	-
FID	-	-34.572	-
IDIST	-	-	-0.091
Total asset	-0.0004	0.0001	0.0001
INDUS	-0.076	0.219	-1.099
YEAR	2.914	2.454	2.413

Const.	121.346	-25.169	-12.378
N	30	30	30
No. group	22	22	22
Chi-Square	3.25	3.49	2.81

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

According to the results of testing hypothesis 2 shown in Table 3.17, in the whole sample, none of institutional metrics including VC/PE attractive index, FID, and Institutional Distance has no influence on PM.

Even though the test from overall countries in Southeast Asia shows no significance in relationship, in emerging economies (Table 3.18-3.20) VCPE and FID apparently turns significantly related to PM with a positive sign ($\beta = 0.093$, P value of less than 0.001 and $\beta = 12.390$, P value of less than 0.001, respectively) shown in Model 4.1 and 5.1. This also statistically means that if once VCPE goes up or down by one percent, PM would increase or decrease by 0.093 units in the same direction. Likewise, FID goes up or down by one percent, PM would increase or decrease by 12.390 units in the same direction. Moreover, in Model 4.1, 5.1 and 6.1, such control variables as total asset and year of cooperation, are significant factors in relations of VCPE, FID, IDIST to PM. Total asset is negatively related to PM with a little small coefficient number of less than 0.00003. Whereas Year of incorporation is positively related to PM with coefficient of 0.450, 0.687, 0.524, consecutively. However, there is no significant correlation in the group of Singaporean portfolio companies.

Table 3.18: Random Effect Regression Results of Hypothesis 2
(Independent variables: VCPE)

	Model 4.0	Model 4.1	Model 4.2
VCPE	-1.975	**0.093*** **	-7.976
Total asset	-0.0004	**-0.00004*** **	-0.001
INDUS	-0.076	-1.270	-0.459
YEAR	2.914	**0.450*** **	1.624
SING DUMMY	-	0	1
Const.	121.346	-8.696	733.623
N	30	15	15
No. group	22	11	11
Chi-Square	3.25	124233.62***	3.86

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3.19: Random Effect Regression Results of Hypothesis 2 (Independent variables: FID)

	Model 5.0	Model 5.1	Model 5.2
FID	-34.572	**12.390*** **	56.696
Total asset	0.0001	**-0.00008*** **	0.004
INDUS	0.219	-1.994	0.848
YEAR	2.454	**0.687*** **	-0.734
SING DUMMY	-	0	1
Const.	-25.169	3.616	-109.308
N	30	15	15
No. group	22	11	11
Chi-Square	3.49	487743.79***	1.53

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3.20: Random Effect Regression Results of Hypothesis 2 (Independent variables: IDIST)

	Model 6.0	Model 6.1	Model 6.2
IDIST	-0.091	-0.009	0.314
Total asset	0.0001	**-0.00003*** **	0.001
INDUS	-1.099	-1.168	0.509
YEAR	2.413	**0.524*** **	1.574
SING DUMMY	-	0	1
Const.	-12.378	-3.345	-21.920
N	30	15	15
No. group	22	11	11
Chi-Square	2.81	10326.88***	2.25

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

To summarize the results of hypothesis 2, we can conclude that institutional metrics are significant to portfolio companies' performance among emerging countries, as independent variables of VCPE and FID have a positive influence on PM. Moreover, total asset and year of incorporation are considered as significant factors in most cases. Meanwhile, main explanatory variables are discovered not dominant to PM in the whole sample and in Singapore.

Random Effect Regression of Hypothesis 3 (Pooled A: PM)

The hypothesis 3 is to test whether the interaction term of VC Network and Institutional Development is related to a performance of portfolio companies. In this hypothesis testing, we firstly regress each interaction term to performance measure of the whole sample and secondly consider other models with

and without Singapore and make a comparison. The hypothesis 3 is tested by running Random Effect regression of dependent variable, portfolio companies' performance measured by PM, against independent variables, nine interaction terms consisting of the multiplication term between Degree, Closeness, and Betweenness across VC Attractiveness Index, Formal Institution Development, and Institutional Distance. We separately regress each interaction term in nine equation models (model 7-15), make a comparison with a group of emerging economies (all models of .1) and Singapore economy (all models of .2) and interpret the results in each model. After the test, we anticipated a positive relationship for each model in hypothesis 3, especially in emerging countries.

Table 3.21: Random Effect Regression Results of Hypothesis 3

(Independent variables: Interaction terms between Degree and all Institutional metrics)

	Model 7.0	Model 8.0	Model 9.0
Degree X VCPE	**1.064*** **	-	-
Degree X FID	-	**1.256*** **	-
Degree X IDIST	-	-	1.053
Total asset	0.0001	0.00005	0.0001
INDUS	-1.937	-2.019	-0.820
YEAR	1.950	2.037	2.251
Const.	-10.793	-8.140	-17.582
N	30	30	30
No. group	22	22	22
Chi-Square	196.49***	311.94***	3.28

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Remark: FID was rescaled for an accuracy of interaction terms.

According to the results of testing the relationship of the interaction term between Degree and each Institutional measure to PM shown in Table 3.21, two interaction terms are found significant in the test of the whole sample. Firstly, the interaction term between Degree and VCPE is positively and significantly related to PM with a coefficient of 1.064 and P-value of less than 0.001. Statistically meaning that if the interaction term changes by one percent, PM would change by 1.064 in the same direction. Secondly, the relationship between the interaction term of Degree and FID, and PM is positively significant with a coefficient of 1.256 and p value of less

than 0.001 (increase or decrease of 1.256 units in PM for each 1% increase or decrease of the interaction term in the same direction).

By looking upon the group of emerging countries (Table 3.22-3.24), the interaction term between Degree and Institutional Distance shows a positively significant relation to PM due to P value being less than 0.001 (β = 0.422). Moreover, total asset and year of incorporation are considered as significant factors in most cases. Total asset has negative relationship with coefficients of 0.00003 in both model 7.1 and 8.1. Whereas year of incorporation has positive relationship with coefficient of 0.515, 0.524, and 0.104 in model 7.1, 8.1, and 9.1, respectively.

Table 3.22: Random Effect Regression Results of Hypothesis 3
(Independent variable: Interaction term between Degree and VCPE)

	Model 7.0	Model 7.1	Model 7.2
Degree X VCPE	**1.064*** **	0.008	0.064
Total asset	0.0001	**-0.00003*** **	0.003
INDUS	-1.937	-1.154	0.655
YEAR	1.950	**0.515*** **	-0.120
SING DUMMY	-	0	1
Const.	-10.793	-3.565	-19.734
N	30	15	15
No. group	22	11	11
Chi-Square	196.49***	9283.36***	16.65***

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3.23: Random Effect Regression Results of Hypothesis 3
(Independent variable: Interaction term between Degree and FID)

	Model 8.0	Model 8.1	Model 8.2
Degree X FID	**1.256*** **	0.006	0.147
Total asset	0.00005	**-0.00003*** **	0.003
INDUS	-2.019	-1.162	0.526
YEAR	2.037	**0.524*** **	0.021
SING DUMMY	-	0	1
Const.	-8.140	-3.488	-19.743
N	30	15	15
No. group	22	11	11
Chi-Square	311.94***	16014.07***	24.89***

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
Remark: FID was rescaled for an accuracy of interaction terms.

Table 3.24: Random Effect Regression Results of Hypothesis 3
(Independent variable: Interaction term between Degree and IDIST)

	Model 9.0	Model 9.1	Model 9.2
Degree X IDIST	1.053	**0.422*** **	0.852
Total asset	0.0001	-0.000	0.0006
INDUS	-0.820	-0.864	-0.349
YEAR	2.251	**0.104*** **	1.374
SING DUMMY	-	0	1
Const.	-17.582	-5.564	-11.405
N	30	15	15
No. group	22	11	11
Chi-Square	3.28	0.000***	2.25

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

According to the results of testing the relationship of the interaction term between Closeness and each Institutional measure to PM shown in Table 3.25, all interaction terms were found not to be significant to PM ($p > 0.05$). However, once the emerging economies is considered, the interaction term between Closeness and Institutional Distance becomes positively and significantly related to PM with the coefficient of 0.084 and P value of less than 0.001 (see Table 3.26-3.28). Among control variables, total asset and PM have negative and significant relationship with each other in Model 10.1 and 11.1 (both have $\beta = -0.00003$ and $p < 0.001$) but positive relationship in Model 12.1 ($\beta = 0.00001$ and $p < 0.001$). Whereas year of incorporation and PM has positive and significant relationship with coefficient of 0.525 and 0.570 in model 10.1 and 11.1, respectively. These affects do not appear in a context of Singapore.

Table 3.25: Random Effect Regression Results of Hypothesis 3
(Independent variables: Interaction terms between Closeness and all Institutional metrics)

	Model 10.0	Model 11.0	Model 12.0
Closeness X VCPE	0.038	-	-
Closeness X FID	-	0.057	-
Closeness X IDIST	-	-	0.022
Total asset	0.0001	0.0001	0.0001
INDUS	-1.032	-1.046	-0.959
YEAR	2.326	2.324	2.376
Const.	-14.850	-14.751	-14.308

N	30	30	30
No. group	22	22	22
Chi-Square	3.13	3.54	2.98

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Remark: FID was rescaled for an accuracy of interaction terms.

Table 3.26: Random Effect Regression Results of Hypothesis 3

(Independent variables: Interaction terms between Closeness and VCPE)

	Model 10.0	Model 10.1	Model 10.2
Closeness X VCPE	0.038	0.001	-0.201
Total asset	0.0001	**-0.00003*** **	0.001
INDUS	-1.032	-1.158	0.687
YEAR	2.326	**0.521*** **	1.960
SING DUMMY	-	0	1
Const.	-14.850	-3.528	-12.037
N	30	15	15
No. group	22	11	11
Chi-Square	3.13	6394.42***	3.42

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3.27: Random Effect Regression Results of Hypothesis 3

(Independent variables: Interaction terms between Closeness and FID)

	Model 11.0	Model 11.1	Model 11.2
Closeness X FID	0.057	0.0005	-0.219
Total asset	0.0001	**-0.00003*** **	0.001
INDUS	-1.046	-1.164	0.627
YEAR	2.324	**0.528*** **	1.956
SING DUMMY	0	0	1
Const.	-14.751	-3.458	-11.899
N	30	15	15
No. group	22	11	11
Chi-Square	3.54	7698.69***	3.30

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Remark: FID was rescaled for an accuracy of interaction terms.

Table 3.28: Random Effect Regression Results of Hypothesis 3
(Independent variables: Interaction terms between Closeness and IDIST)

	Model 12.0	Model 12.1	Model 12.2
Closeness X IDIST	0.022	**0.084*** **	0.136
Total asset	0.0001	**0.00001*** **	0.0006
INDUS	-0.959	-0.772	-0.445
YEAR	2.376	0.038	1.386
SING DUMMY	-	0	1
Const.	-14.308	-6.133	-10.472
N	30	15	15
No. group	22	11	11
Chi-Square	2.98	0.000***	2.30

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

In dependent variable of the interaction term between Betweenness and Institutional matrices, there is no sign of significance in the whole sample (shown in Table 3.29). Separately on a group of emerging economies (Table 3.30-3.32), the terms of Betweenness across VCPE and FID reveals positively and significantly related to PM with a coefficient of 0.065 and 0.099, respectively. However, there was a negatively significant relation in the interaction term between Betweenness and IDIST ($\beta = -0.746$ and $p < 0.001$). Furthermore, PM also depends on total asset and year of incorporation in the interaction term between Betweenness and VCPE, FID, and IDIST with coefficients of -0.00002,-0.00002, and 0.00002 for total assets (in model 13.1, 14.1, and 15.1) and coefficients of 0.557 and 0.574 for year of incorporation (in model 13.1 and 14.1). In a group of Singaporean portfolio companies (in model 13.2), only the relationship of interaction term between Betweenness and VCPE appears to have a negative and significant relationship with PM at 1% level of significance ($\beta = -0.492$ and $p = 0.008$). Besides, there was no relationship of any control variables to PM.

Table 3.29: Random Effect Regression Results of Hypothesis 3

(Independent variables: Interaction terms between Betweenness and all Institutional metrics)

	Model 13.0	Model 14.0	Model 15.0
Betweenness X VCPE	-0.236	-	-
Betweenness X FID	-	-0.079	-
Betweenness X IDIST	-	-	-0.416
Total asset	0.0001	0.0001	0.00009
INDUS	-0.612	-0.823	-1.061
YEAR	2.046	2.287	2.373
Const.	-13.885	-14.961	-11.528
N	30	30	30
No. group	22	22	22
Chi-Square	27.09***	12.08***	3.08

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3.30: Random Effect Regression Results of Hypothesis 3

(Independent variables: Interaction terms between Betweenness and VCPE)

	Model 13.0	Model 13.1	Model 13.2
Betweenness X VCPE	-0.236	**0.065*** **	**-0.492** **
Total asset	0.0001	**-0.00002*** **	0.004
INDUS	-0.612	-1.152	2.275
YEAR	2.046	**0.557*** **	-0.761
SING DUMMY	-	0	1
Const.	-13.885	-4.412	-20.560
N	30	15	15
No. group	22	11	11
Chi-Square	27.09***	32316.45***	78.16***

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3.31: Random Effect Regression Results of Hypothesis 3

(Independent variables: Interaction terms between Betweenness and FID)

	Model 14.0	Model 14.1	Model 14.2
Betweenness X FID	-0.079	**0.099*** **	-0.510
Total asset	0.0001	**-0.00002*** **	0.005
INDUS	-0.823	-1.166	2.342
YEAR	2.287	**0.574*** **	-1.266
SING DUMMY	-	0	1
Const.	-14.961	-4.332	-22.387
N	30	15	15
No. group	22	11	11
Chi-Square	12.08***	27997.85***	40.72***

Table 3.32: Random Effect Regression Results of Hypothesis 3
(Independent variables: Interaction terms between Betweenness and IDIST)

	Model 15.0	Model 15.1	Model 15.2
Betweenness X IDIST	-0.416	**-0.746*** **	0.314
Total asset	0.00009	**0.00002*** **	0.0003
INDUS	-1.061	-0.721	-0.659
YEAR	2.373	0.021	1.439
SING DUMMY	-	0	1
Const.	-11.528	-3.762	-8.131
N	30	15	15
No. group	22	11	11
Chi-Square	3.08	684826.57***	2.76

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

In summary, as the results from four-ninth of models suggested that the interaction terms of VC Network and Institutional development are mainly and positively significant to portfolio companies' performance in Southeast Asian emerging economies. These interaction terms comprise of Degree and Institutional Distance, Closeness and Institutional Distance, Betweenness and VCPE, and Betweenness and FID. Aversely, the only pair of Betweenness and Institutional Distance has a negative relationship with PM. Even in the whole sample, the interaction term of Degree across VCPE and FID is able to significantly predict PM. While several models indicate the little negative effect of Total asset and the positive effect of Year of incorporation on a performance of portfolio companies.

Results of Hypotheses

In conclusion, the findings present both significant and insignificant relationship among three hypotheses. The outcome provides statistical results to investigate that VC network centrality measure and Institutional development have significant impact on portfolio companies' performance. Whereas, this kind of result is not found significantly in most cases of Singapore. All results in each hypothesis are illustrated in Table 3.33. However, the researcher has made a summary version of the results into one simple table, which is more convenient to understand and examine. The table adequately includes key indicators used for the analysis, a sign of coefficient and significance level.

Table 3.33: Results of Hypotheses (Pooled A, A1, A2)

	Hypotheses	Results Dependent variable: PM		
		Overall	Emerging	Singapore
H1	VC Network metrics are positively associated to a performance of portfolio companies in Southeast Asian emerging economy.	**Model 1** **(+)***** Degree	**Model 1.1** Degree	**Model 1.2** Degree
		Model 2 Closeness	**Model 2.1** Closeness	**Model 2.2** Closeness
		Model 3 Betweenness	**Model 3.1** **(+)***** Betweenness	**Model 3.2** **(-)***** Betweenness
H2	Institutional development metrics are positively related to a performance of portfolio companies in Southeast Asian emerging economy.	**Model 4** VCPE	**Model 4.1** **(+)***** VCPE	**Model 4.2** VCPE
		Model 5 FID	**Model 5.1** **(+)***** FID	**Model 5.2** FID
		Model 6 IDIST	**Model 6.1** IDIST	**Model 6.2** IDIST
H3	The interaction between VC network metrics and Institution Development metrics is positively related to	**Model 7** **(+)***** Degree X VCPE	**Model 7.1** Degree X VCPE	**Model 7.2** Degree X VCPE
		Model 8 **(+)***** Degree X FID	**Model 8.1** Degree X FID	**Model 8.2** Degree X FID

	enhance portfolio companies' performance in Southeast Asian emerging economy	**Model 9** Degree X IDIST	**Model 9.1 (+)***** Degree X IDIST	**Model 9.2** Degree X IDIST
		Model 10 Closeness X VCPE	**Model 10.1** Closeness X VCPE	**Model 10.2** Closeness X VCPE
		Model 11 Closeness X FID	**Model 11.1** Closeness X FID	**Model 11.2** Closeness X FID
		Model 12 Closeness X IDIST	**Model 12.1 (+)***** Closeness X IDIST	**Model 12.2** Closeness X IDIST
		Model 13 Betweenness X VCPE	**Model 13.1 (+)***** Betweenness X VCPE	**Model 13.2 (-)**** Betweenness X VCPE
		Model 14 Betweenness X FID	**Model 14.1 (+)***** Betweenness X FID	**Model 14.2** Betweenness X FID
		Model 15 Betweenness X IDIST	**Model 15.1 (-)***** Betweenness X IDIST	**Model 15.2** Betweenness X IDIST

In a big picture, the results seem to fit our expectations. While in detail, there still be implicit meaning in empirical results of each regression models. These implications will further be interpreted and discussed in the next chapter.

Random Effect Regression (Pooled B: FS)

Venture capital stage is also a key factor in determining the success of VC-backed companies, to strengthen the results, we are using funding stage as dependent variable instead of PM and run Random effect regression in every model again. Although this makes the sample smaller in number, yet outcomes remain nearly the same in most of the models. The difference is inappreciable to the major results. Since this sample is limited to a small number of observation and degree of freedom, it is insufficient to regress by groups of economies. At least we can compare the results for the whole sample of Pooled A and B.

Table 3.34: Random Effect Regression Results of Hypothesis 1 **(Pooled B: FS)** (Independent variable: VC Network metrics)

	Model 1	Model 2	Model 3
Degree	**0.018*** **	-	-
Closeness	-	1.477	-
Betweenness	-	-	**6.133*** **
Total asset	**0.00005*** **	**0.00006*** **	**0.00005*** **
INDUS	0.1812	0.0217	0.2537
YEAR	**-0.0540*** **	-0.0431	0.0017
SING	-0.4738	-0.2854	-0.4685
Cons.	1.4715***	1.4043	1.1095
N	23	23	23
No. group	15	15	15
Chi-Square	5924.38***	42.04***	278.43***

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3.35: Random Effect Regression Results of Hypothesis 2 **(Pooled B: FS)** (Independent variable: Institutional metrics)

	Model 4.0	Model 5.0	Model 6.0
VCPE	-0.060	-	-
FID	-	0.5248	-
IDIST	-	-	-0.0124
Total asset	0.00005***	0.00005***	0.00005***
INDUS	-0.1520	0.0806	0.1348
YEAR	-0.0128	-0.0475	-0.0320

SING	0.9307	-1.2499	-0.2101
Cons.	6.0836	1.7865***	1.674***
N	23	23	23
No. group	15	15	15
Chi-Square	94.00***	41.04***	55.20***

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3.36: Random Effect Regression Results of Hypothesis 3 **(Pooled B: FS)**

(Independent variable: Interaction terms between Degree and all Institutional metrics)

	Model 7.0	Model 8.0	Model 9.0
Degree X VCPE	**0.018*** **	-	-
Degree X FID	-	**0.015*** **	-
Degree X IDIST	-	-	-0.003
Total asset	**0.00004*** **	**0.00004*** **	**0.00005*** **
INDUS	0.2441	0.2086	0.0415
YEAR	-0.0375	-0.0341	-0.0361
SING	-0.5719	-0.5671	-0.2918
Cons.	1.5086***	1.549***	1.668***
N	23	23	23
No. group	15	15	15
Chi-Square	1368.60***	1863.19***	34.66***

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3.37: Random Effect Regression Results of Hypothesis 3 **(Pooled B: FS)**

(Independent variable: Interaction terms between Closeness and all Institutional metrics)

	Model 10.0	Model 11.0	Model 12.0
Closeness X VCPE	0.003	-	-
Closeness X FID	-	0.004	-
Closeness X IDIST	-	-	0.0009
Total asset	**0.00005*** **	**0.00005*** **	**0.00005*** **
INDUS	0.0894	0.0930	0.0308
YEAR	-0.0300	-0.0223	-0.0370
SING	-0.3931	-0.4608	-0.2882
Cons.	1.5541***	1.547***	1.657***
N	23	23	23
No. group	15	15	15
Chi-Square	31.84***	35.51***	33.25***

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3.38: Random Effect Regression Results of Hypothesis 3 **(Pooled B: FS)**

(Independent variable: Interaction terms between Betweenness and all Institutional metrics)

	Model 13.0	Model 14.0	Model 15.0
Betweenness X VCPE	0.0025	-	-
Betweenness X FID	-	0.012	-
Betweenness X IDIST	-	-	-0.012
Total asset	**0.00005*** **	**0.00005*** **	**0.00005*** **
INDUS	0.0718	0.2043	0.0747
YEAR	-0.0338	-0.0202	-0.0423
SING	-0.3327	-0.5305	-0.3125
Cons.	1.624***	1.485	1.708***
N	23	23	23
No. group	15	15	15
Chi-Square	38.33***	87.64***	38.99***

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

As in Table 3.34-3.38, the result in the Pooled B shows that both Degree and Betweenness have a positively significant relationship with PM. This is relied on our first hypothesis stating that VC Network centrality is positively related to portfolio companies' performance. Statistically meaning, if the Degree and Betweenness centrality increases by one unit, portfolio companies could generate more net profit margin by 0.018 and 6.133 units, respectively. The results of the relationship between Institutional development and portfolio companies' performance appear to be the same as the pooled A. VCPE, FID, and IDIST are not significantly related to PM in both the pooled A and B. To explore how VC network centrality and Institutional development are inter-related to portfolio companies' performance, we have to examine the results from all three hypotheses together at a single time, then compare and interpret what going on with the outcomes in VC Network, in Institutional development, and in the interaction terms. the evidence showing that institutional effect alone might not help portfolio companies to be success or get in further stage, but it could be compatible with Degree and these two together can enhance portfolio companies' performance. For instance, in model 1, 4, 7, even though Degree is positively and significantly related to PM yet VCPE alone has no effect, the relationship between the interaction term of Degree and VCPE, and PM still be positive and significant. It means that the strong VC network effect (Degree) on PM still be effective

and supportive to different level of institutions in enhancing a better performance of portfolio companies. For one unit increase of the interaction term between Degree centrality and VC/PE attractive index, the net profit margin of portfolio company is expected to increase by 0.018 units, holding all other variables constant ($p<.0000$). In the interaction term of Degree and FID (Model 1, 5, 8), the results apparently show that even FID is solely insignificant to PM, once it multiplied with Degree, a positively significant effect to PM, the interaction term between these two together is, overall, positively and significantly related to PM. An insignificance of FID may not change the result of its interaction with Degree. Whenever the level of the interaction term between Degree centrality and Formal institutional development increases by one unit, the net profit margin will increase by 0.015 units, holding all other variables constant ($p<.0000$). This can imply that both VC network centrality and formal institution development get along well and help portfolio companies pass though the next funding round. Whereas Total asset still be the main control factor on portfolio companies' funding achievement. A bit higher of total asset in portfolio firm is more like to allure venture capitalists in investing in that firm in the future.

These interactions between VC network and institution provide us some useful insight of how VC network and institution are inter-related to portfolio companies' performance. Apart from the consistent result of hypothesis testing in Pooled A, additional significant relation exposed in Pooled B is Betweenness and PM, which somehow complies with our anticipation in the first hypothesis. The summarized table of the results is shown below in Table 41.

Table 3.39: Results of Hypotheses (Pooled B)

	Hypotheses	Results Dependent variable: FS Overall
H1	VC Network metrics are positively associated to a performance of portfolio companies in Southeast Asian emerging economy.	**Model 1** **(+)***** Degree
		Model 2 Closeness
		Model 3 **(+)***** Betweenness
H2	Institutional development metrics are positively related to a performance of portfolio companies in Southeast Asian emerging economy.	**Model 4** VCPE
		Model 5 FID
		Model 6 IDIST
H3	The interaction between VC network metrics and Institution Development metrics is positively related to enhance portfolio companies' performance in Southeast Asian emerging economy	**Model 7** **(+)***** Degree X VCPE
		Model 8 **(+)***** Degree X FID

H3	The interaction between VC network metrics and Institution Development metrics is positively related to enhance portfolio companies' performance in Southeast Asian emerging economy	**Model 9** Degree X IDIST
		Model 10 Closeness X VCPE
		Model 11 Closeness X FID
		Model 12 Closeness X IDIST
		Model 13 Betweenness X VCPE
		Model 14 Betweenness X FID
		Model 15 Betweenness X IDIST

3.5 Discussion and Implication

3.5.1 The relationship between Venture Capital Networks and Portfolio companies' performance

From the results of testing hypothesis 1, although other two network measures, Closeness and Betweenness were found no relationship to PM, a major network centrality measure, Degree was obviously shown its positively significant relationship with PM, which represents a profitability of portfolio companies. The overall result reveals an evidence that a performance of portfolio companies in an aspect of profitability is associated to a level of network of venture capital firms investing to their subsidiaries. The higher the network of VC is, the more likely that those VC backed companies would perform better, in term of competitive potential and profitability, than those backed with lower networked VC. In other words, the more central funding VC posits in the network, the further superior portfolio companies' performance would be. However, the outcome of the insignificance provides additional implications from a slightly differences in meaning among three network measure. Venture capital firms with high level of network and connection from this result mean those who had better capture information from their multiple relationships, but do not imply that they certainly have a relationship with high networked VC or with those who can easily catch the information faster. Moreover, it is not necessary that they are better in transferring information as a bridge of sub networks. Besides, firm's internal influence on the performance of portfolio companies includes such important factors as Total asset and Year of incorporation. Total asset, used to control firm's size, obviously showed a negatively significant yet a little impact on profitability of the firm. Larger portfolio companies prone to have a slightly lower profitability since they bear a lot of expenses in relation to operating revenue during growth or expansion stage comparing to the smaller ones. Moreover, according to the result of positive and significant effect of Year of incorporation, the older portfolio companies seem to have higher net income in relation to operation revenue than the younger companies. The more years the company is in the market, the higher profitability it has.

Similarly, in emerging economies VC network centrality was found to be a significant factor inducing profitability of portfolio companies as Betweenness was positively and significantly related to PM. Thus, this implies that portfolio companies with high networked VC are more profitable than those with lower networked VC in a group of emerging countries. In addition, a level of network centrality in this case implicitly means how well venture capital firms, as a moderator, in the network help transmit the information from one sub network to another. Contradict to Singapore, the relationship between Betweenness and PM was significant yet found to be negative. The result can be interpreted that portfolio companies, whose VC network centrality is higher, are more likely to underperform comparing to those whose VC network centrality is lower. Generally speaking, a performance of portfolio company does rely on a level of VC network, yet the performance will be decreased as an increase in VC network centrality, and vice versa. This phenomenon happens in Singapore, the upper tier of VC network centrality, which may be explained from the alternative evidence by Kuen (2014) stating that in economies with high dependence on social networks, VCs make use of their networks to seek for potential ventures, but they might not necessarily invest in those ventures as networks is not the most essential factor for them . Furthermore, Kuen (2014) discovered that such a country with high level of formal institutional development, in our case, Singapore, investors would rather be more confident investing in early-stage ventures. Hence, it is possible that VC investors with lower level of networks could have more opportunity to select high potential ventures, and in turn delivers a better financial performance. Another evidence from Bellavitis et al., (2017) showing that lower network centrality and younger VC firms may perform better as they are more beneficial for using their network and connection in a cohesive network, rather than high network centrality and mature firms.

In summary of the result from the 1st hypothesis, it reveals that venture capital networks are positively and significantly associated to a performance of portfolio companies in Southeast Asian region, especially in emerging economy. Whereas there is negative yet significant relationship in Singapore. The result of the hypothesis supports the motives of venture capital syndication under the theory of agency and information asymmetry and also confirms that VC syndication network is beneficial to the subsidiaries. As the prior literatures (Sorenson & Stuart, 2001; Brander

et al., 2002; Baum & Silverman, 2004; Teten et al., 2013; Bellavitis et al., 2014) stated that VC network assists portfolio companies in providing an access to useful information and resources that might help increase competitive advantages and becoming more profitable. This finding is mainly in line with research studies of venture capital network in various parts of the world including Abell & Nisar(2007) and Bellavitis et al. (2014) in the UK and Continental Europe, Hochberg et al.(2007) in the US, and Liu & Chen (2014) in China. For instance, Hochberg et, al. (2007) discovered that higher network centrality of VC firms is associated to higher possibility of portfolio company's survival based on funding round in the US. This outcome addresses a significance of VC syndication network among portfolio companies in enhancing a better profitability in Southeast Asian emerging economies, which behave similarly to both developing and developed countries, around the world. Additionally, in a group of emerging countries, we found out that startups perform better in small base of total asset and older year of incorporation. In practice, venture capitalists should invest in their target ventures by considering a decent amount of total asset and greater age of the ventures. A success of ventures does not merely depend on a network of venture capitals but on how they manage total asset and how long they have been in the market.

3.5.2 The relationship between Institutional development and Portfolio companies' performance

From the results of testing hypothesis 2, it is obviously seen that two third of Institutional development measures, VCPE and FID, had a positively significant relationship to PM in SEA emerging economics, whereas this relationship was not significance in the overall sample and in Singapore. This can be interpreted that a level of institutional development is a key factor affecting a performance of portfolio companies in developing countries but not in the developed country, Singapore. Institution development refers to an advancement of institutions involved in VC industry in each country, such as, VC/PE attractive index, regulations, and investor protection. The more formal institutional development of that country is, the better portfolio companies in that country perform. This might be common that companies in the country with higher VC/PE attractive score, more concrete regulation, better

investor protection, and fully government support are more likely to be well-organized and expose higher growth potential ventures that can generate more profit than the country with the lower counterparts. While we cannot find this effect in Singapore, which all institutional values are already considered high and being in the top tier of VC attractive countries. Based on high level of governance and institutional system, the performance of portfolio companies may therefore depend on other factors under intensive competitiveness in venture capital industry, rather than on institutional development. Furthermore, in another institutional measure, the difference of institutional level between VC's and portfolio companies' country was not relevant in helping portfolio companies perform better. In other words, no matter how much differences of investment regulation, investor protection, government support, etc. between investors and investee countries is, the performance of investees would not be affected. Additional to the institutional effect in emerging countries, it also varies from portfolio firm size and their experience in business in the market. The Larger firms seems to slightly have an inferior in performance comparing to the smaller. However, the effect from the firm size is relatively too small to be seriously counted. Older companies that established for a longer time prone to perform better than younger firms.

In summary of the result from the 2nd hypothesis. The outcome is similar to what we hypothesized that formal institutional development has positive impact on portfolio companies' performance in other emerging countries but not in Singapore. This answers the question of how significant institution theory is in emerging economies as Ahlstrom & Bruton, 2006 argue that institutional theory is more suitable in explaining the role of network as the practice of venture capital which is influenced from institutional changes. Moreover, the significant effect of institutions in Southeast Asia region preliminary serves as an empirical evidence supporting the findings of institutional development in emerging markets from the prior studies. For example, Scheela et al. (2015) illustrate different characteristics between less formal institution development in SEA emerging economies and more formal institution development in mature economies. Also, Bruton et al. (2004) demonstrate that institutions develop the venture capital industry in East Asia and create differences from that in the West. While Ahlstrom & Bruton (2006) stated that venture capital investment is more likely to be dominated by the local institutional settings as institutional

differences in venture capital industry modulate VC strategic decision and organizational practices. Our result emphasizes these differences and further shows that level of formal institution development playing an important role in enhancing the outperform of VC-backed companies in South-Eastern Asia emerging economies. The result is in accordance with the recent findings studying about the impact of institutions on venture capital investment in China. Li & Zahra (2012) and Lingelbach (2015) revealed the positive impact of formal institutions on the level of venture capital activity and on the VC development process, respectively. This outcome affirms a consistency to a major role of institutions in enhancing portfolio companies' success yet been found in China and Southeast Asian developing countries, where we add the new finding of insignificant effect in Singapore.

3.5.3 The interaction between Venture capital networks and Institutional development on Portfolio companies' performance

From the results of testing hypothesis 3, the interaction term between VC network and Institutional development has the positively significant relationship with portfolio companies' performance in Southeast Asian countries, as apparently found in the interaction term of Degree across VCPE and FID. Moreover, after we had separated Singapore from the sample to distinguish emerging economies from mature economy, the result of several interaction terms still came out positive and significant in a group of developing countries. For instance, the interaction term of Betweenness across VCPE and FID is positively and significantly related to PM. Unlike the result in Singapore, there is only one negative and significant relationship of the interaction term between Betweenness and VCPE with PM. Afterwards, we will deep down into the implications of each interaction term to explore how VC network and institution interact with each other and how their interaction affects portfolio companies' performance.

Within the whole group (referring to regression model 1, 4, 5, 7, and 8), Degree by oneself was positively and significantly related to PM, while VCPE and FID were not significant. However, once VCPE and FID accompanied with Degree in term of their interaction, the relationship of these cross terms and PM had turned out to be significance with a positive sign. This implies that apart from promoting portfolio

companies' performance, a level of VC network centrality dominates and goes along with a level of institutional development of investee's country, which together help encourage profitability of portfolio companies. By this mean, it also points out a significance and a usefulness of using VC network for VC-backed companies in Southeast Asian region. No matter how much level of institutional development portfolio companies' country has, including a case of less formal institutional development, high level of networks and connections from funding venture capital firms provides useful resources and facilities to help elevate the performance of their backed companies. For example, portfolio companies backed by high networked venture capital firms but being in the country of less formal institutional development are still likely plausible that they would be able to generate higher net income per unit of operating revenue.

Within a group of emerging countries (referring to regression model 3.1, 4.1, 5.1, 13.1, and 14.1), Betweenness, VCPE, and FID had a positive and significant relationship with PM. When Betweenness interacted with VCPE and FID, the relationship between these interaction terms and PM reasonably continues positive and significant. It clearly shows that both Betweenness network centrality and institutional development still have a strong effect on PM. Their supportive interaction helps enhance performance of portfolio companies. In other words, portfolio companies among emerging countries, who funded by high networked VCs and whose country has high level of institutional development, have a tendency to be more profitable than the opposite kind of companies. While another interaction term between Betweenness and IDIST (in regression Model 3.1, 6.1, 15.1) has disclosed the different result. Despite the strong positive effect of Betweenness on PM and the insignificance of IDIST, the interaction term between Betweenness and IDIST has turned negatively and significantly related to PM. The positive effect of Betweenness and PM seems to be diluted when it interacts with the negative yet insignificant effect of IDIST. In the end, the interaction term instead exposes to be negative and significant. Generally speaking, it does not matter how much level of centrality venture capital firms have, as long as a gap in a level of formal institutional development between venture capitals and portfolio companies remains small, a performance of portfolio companies will become better. For instance, low networked VCs investing in portfolio companies whose level

of institutional development is closer to VCs' tend to bring more profit to their backed firms. In contrast, high networked venture capital backed firms plus an even larger gap in a level of formal institutional development between venture capitals and portfolio companies would probably bring less profit to those VC-backed companies. This shows the influential factor of institutional distance when accompanied with VC network centrality in determining the performance of portfolio companies, as institutional distance alone does not affect portfolio companies' performance. In technical explanation from social network notation, the institutional difference between investors and investees has a considerable influence on profitability of portfolio companies who backed with venture capital firms whose position in charge of transferring a vast amount of information among sub-networks. However, this behavior merely happens among portfolio companies of emerging countries, but it will disappear among that of Singapore. Also, the result provides an implicit insight suggesting that higher networked venture capital firms should be more concerned and aware of the robustness of institutions, such as investment regulation and government support, of their target investee's country in SEA emerging countries. In regression model 1.1, 6.1, 9.1 and Model 2.1, 6.1, 12.1, Degree, Closeness, and Institutional distance have no significant effect on PM. However, the interaction term of Degree and Closeness across Institutional distance remarkably showed a significant and positive relationship with PM. The synergic effect between these two factors is compensating to enhance profitability of portfolio companies. This unveils and addresses a strong linkage of the interaction between VC network and institutional differences in empowering the profitability of portfolio companies. While each factor alone does not significantly help portfolio companies. A level of VC network and a difference of institutional development between investors and investees certainly compensate to each other and together help boost up a performance of portfolio companies. One possible case provides an empirical evidence for the interrelation between VC network and Institutional distance that VC makes use of network in portfolio companies whose level of institutional development is much differ from the venture capital firms' in the context of emerging economies. By these notices, it seems that these two factors, Network centrality and Institutional development, somehow supporting each other in some way to enhance a performance of portfolio companies. When they are multiplied with each

other their interaction becomes an important factor to explain a variation of level of portfolio companies' performance.

In Singapore, the result of the relationship between Betweenness and PM was distinctive and differed from what we hypothesized. Betweenness was negatively and significantly related to PM, whereas VCPE was not significant. In case of the effect of the interaction term between Betweenness and VCPE on PM, the outcome remains negative and significant as of the relationship between Betweenness and PM. This shows the influence of negative effect of VC network centrality on institutional development that both consequently affect portfolio companies' performance. In well-organized institutions like Singapore, it seems that high networked VC does not dominate low networked VC in better providing a competitive advantage by using their network to boost up their portfolio companies' performance. Given a level of Singapore institutional development, portfolio companies backed by high networked VC perform poorer than those backed by low networked VC. This phenomenon may cause by the reason that high networked VCs make use of their networks to seek for potential ventures as networks is not the most essential factor for them (Kuen, 2014). All ventures are nurtured under high level of formal institution development including well startup ecosystem and full government support. Hence, low networked VCs are more confident investing in early stage ventures and possibly select the potential ones (Kuen, 2014). Another reason can be explained that high networked VC commonly acquire a plenty of firms into their portfolio and their return expectation and risk are more volatile than the portfolio of the low networked VC, so the performance of each portfolio firm in high networked VC may relatively low compared to that in low networked VC. Perhaps low networked VC normally come from a group of corporate venture capital who specifically focus on a few potential firms that are expected to be more profitable and beneficial to the mother company than a much larger number of investment portfolio companies from individual VC investors with high networks and connections. Also be remarkable that this effect probably happens in a country where VCs with high level of network centrality cluster together, so levels of network between two venture capitals are not much deviated. Furthermore, the difference in total asset and year of incorporation amid portfolio companies does not determine their profitability. The result told us that the size and business experience of

Singaporean ventures is not relevant to the impact of the interaction term between VC networks and institutions on their performance.

In summary of the result from the 3rd hypothesis, it shows that both VC network and institutions plays a pivot role in supporting and compensating each other, and consequently provide an extent to which level of VC network centrality and formal institutional development together being able to enhance a performance in portfolio companies in Southeast Asia, particularly in emerging economies. While we also found an evidence of the powerful influencers on portfolio companies' performance that are VC network for the overall SEA portfolio companies, and institutional distance between VCs and VC-backed firms for SEA emerging countries. It provides a clearer explanation of why networks are more pronounced in less formal institutions, like in emerging markets. As the result from the 2nd hypothesis showed that a level of institutional development is significant to portfolio companies' performance, the countries who have low level of institutional development or less formal institutions would rather make use of VC syndication network to help compensate to each other in helping their subsidiaries to survive. We found a more significantly use of VC network in developing countries, the lesser formal institutional development, than that in developed country, Singapore. The results are consistent to the discovery from the survey of the prior studies showing that in countries with less formal institution are more likely to use network and connection to assist their backed companies, especially emerging economies. For instance, networks and connections are found to be a success factor for venture capitalists under distinctive environment in emerging market. It helps gather information and replace key formal institutions such as the rule of law (Scott, 2001; Ahlstrom and Bruton, 2006; Lockett and Wright, 2002; Groh and Wallmeroth, 2016). Institutional differences in venture capital industry modulate VC strategic decision and organizational practices, which finally augment to differences in the function and use of networks in emerging economies (Ahlstrom & Bruton, 2006). Kuen (2014) found a sight of the substitution effect of social networks and legal systems in China, India, Japan, and Hongkong. Even though VC market in emerging countries is found lacking of institutional system, including lack of regulatory, poor investment protection, and proper VC legal, they prone to convey more informal institution, such as a use of networks and associations, to achieve their success in venture capital market

(Scheela et al.,2015). The results also offer the first empirical evidence of VC network effect under less formal institutions in emerging economies, and how VC network and Institutions are related and lead to impact on portfolio companies. Moreover, in most cases, the firm's total asset and age remain significant to enhance portfolio companies' performance. These significant factors provide a helpful insight related to VC investment policies and regulations.

CHAPTER 4
CONCLUSIONS AND RECOMMENDATIONS

Venture capital firms (VC) have encountered with uncertainty and risk of asymmetric information due to an investment in early-to-growth stage start-ups with technology-based and high growing potential. This phenomenon may induce discrepant interest between VCs and investees in business management, which aligns to classic theories in cooperate finance, an agency theory and a theory of asymmetric information. By these reasons, venture capital investors rarely provide funding solely, they are usually motivated to form a syndicate to invest in their common target investees. This characteristic helps connect each venture capital firms as a whole "venture capital network". A few scholars studied a relation of VC networks and a performance through the lens of VC-backed companies. This issue even has a little discussion in Southeast Asia emerging market, which unveils a much broader information asymmetry compared to the western VC market (Bruton et al., 2004). At first, we would like to focus on the entrepreneur's point of view if their investor's connections affect or relate to their performance. Thus, the first research question is that "Is network centrality of VC positively related to a performance of portfolio companies in SEA economies?". Unless agency and asymmetric information theory emphasize on the formation of networks in emerging venture capital markets, Institutional theory is more suitable in explaining this situation, as the practice of venture capital appears to be influenced from institutional changes (Ahlstrom & Bruton, 2006). Institutional theory provides an extent to which social and cultural elements play an important role in different institutional contexts and lead to different function and level of venture capital networks in emerging markets. Thus, we raise the second research question that "Are institutional differences related to the performance of portfolio companies in a context of emerging economies?". VC market in emerging countries is found lacking of institutional system, including lack of regulatory, poor investment protection, and proper VC legal, they prone to convey more informal institutions, such as a use of networks and associations, to achieve their success in venture capital market (Ahlstrom and Bruton, 2006; Scheela et al.,2015). From the survey and interviews of several papers, they confirmed a

significance of network and institution in emerging VC markets. However, there is no concrete evidence on how networks and institutions interact to each other and there is no attention on how they are related to portfolio firms' performance in a more empirical explanation. This leads us to investigate the relationship between networks and institutions and their impact on portfolio company's performance. Thus, the third research question is "Does VC networks really help compensate the impact of less formal institutions on the performance of portfolio companies?".

Even though there are some evidence from the interview showing venture capital network and institutional development play an essential role in managing VC-backed companies in emerging context, it still be sceptical about how these two factors explicitly effect VC-backed companies and how they interact with each other in an empirical way. This paper will pioneer an investigation of the venture capital network in Southeast Asia region. This study aims to provide an empirical evidence on the relationship between networks and institutions and, how they significantly have an impact on a performance of portfolio company. This study offers the first empirical evidence on the effect of venture capital network and institutions on portfolio companies' performance among Southeast Asian emerging economies. Moreover, the research primarily has an investigation on venture capital network in South-eastern Asia region. By using Social network analysis, we quantify VC network into numeric measure so called Network Centrality, so that we can apply quantitative approach to test the hypotheses and obtain the empirical results.

As the result, we found an evidence of the positive relationship between VC network centrality and performance of portfolio companies in Southeast Asian venture capital industry. This empirical evidence confirmed the significance of the positive VC network effect on portfolio firm's performance, which is consistent to the previous studies (Abell & Nisar, 2007; Hochberg et al., 2007). In contrary with interesting, among Singaporean portfolio companies the VC network effect was negative and significant on their performance. Portfolio companies with high level of VC network centrality perform worse than those with low level counterparts. This phenomenon may be explained from the consistent findings by Kuen (2014) stating that in economies with high dependence on social networks, VCs make use of their networks to seek for potential ventures, but they might not necessarily invest in those

ventures as networks is not the most essential factor for them . Furthermore, Singaporean investors would rather be more confident investing in early-stage ventures. Hence, it is possible that VC investors with lower level of networks could have more opportunity to select high potential ventures, and in turn delivers a better financial performance. Another finding from Bellavitis et al., (2017) showing that lower network centrality and younger VC firms may perform better as they are more beneficial for using their network and connection in a cohesive network, rather than high network centrality and mature firms. Moreover, in emerging economies, institutional development was found to have a positive and significant effect on portfolio companies' profitability. This provides an empirical evidence of institutional effect on portfolio companies' performance in SEA venture capital market, which is in line with the previous studies in China (Li & Zahra, 2012; Lingelbach, 2015) and reinforce with the story of venture capital in East Asia (Bruton et al., 2004; Ahlstrom & Bruton, 2006), Whereas there was no such impact in Singapore. We further investigate the interaction between VC network centrality and institutional development and its impact on portfolio companies. The study reveals that a level of VC network centrality and a level of institutional development have both supportive and compensating interrelation and together help enhance portfolio companies' performance. The results are consistent to the discovery from the survey of the prior studies showing that in countries with less formal institution are more likely to use network and connection to assist their backed companies, especially emerging economies. For instance, networks and connections are found to be a success factor for venture capitalists under distinctive environment in emerging market. It helps gather information and replace key formal institutions such as the rule of law (Scott, 2001; Ahlstrom and Bruton, 2006; Lockett and Wright, 2002; Scheela et al.,2015; Groh and Wallmeroth, 2016). Moreover, we found out that the difference of formal institutional development between investors and investees dominates the impact of VC network centrality on portfolio companies' performance. Besides, we also found the effect of VC network and institutional development on portfolio companies' performance also varies from portfolio firm size and their experience in business in the market, especially, in emerging countries.

Not only are all results of this study related and mostly consistent to previous studies in each point of the story, but also contribute several empirical

evidences of Southeast Asian venture capital industry for venture capital and entrepreneurial literature. Firstly, we pioneer in quantifying VC network centrality in SEA region and demonstrate the evidence of the positive effect of venture capital network on portfolio companies' performance in Southeast Asia emerging economies. Secondly, we initiate using a measurement of institutional development to investigate its impact on portfolio companies' performance and provide the evidence of the positive effect among emerging countries. Finally, we initiate a theoretical framework representing that different level of VC networking involved in different institution development offers different performance advantages of VC backed companies in Southeast Asia emerging economies. We implement quantitative methodology to determine how VC network and institutions are related and their impact on portfolio companies' performance, which result in providing the empirical evidence showing that VC network can compensate for less formal institution in providing a better performance of their portfolio companies. There is joint effect in terms of the substitution and support between institutional development and VC network centrality within Southeast Asian syndication networks on shaping portfolio companies' profitability.

In practice, the result helps clarify the significant role of networks and institutions in venture capital investment in emerging economies and provide a better understanding of how they are related to a performance of portfolio companies. This study also offers advantages to practitioners, entrepreneurs and entrepreneurial ventures who are looking for venture capital financing in emerging economies. In Southeast Asian economies, venture capital network plays a key role in enhancing financial performance and competitive potential of their portfolio companies. Furthermore, once we specifically pay attention to emerging countries, institutional development exposes to play another significant role in portfolio companies' performance, venture capital network and institutional development has the substitution effect on supporting and compensating to encourage portfolio companies' potential and profitability. It provides an insight of how each venture capitalist strategically invest in Southeast Asian ventures by considering a level of partners' networks and institutions of investees' country. So, it suggests that venture capital firms should realize using their network and connection in improving their portfolio companies in low level of institutional development (less

formal institution) country. For example, among the new entrants, constructing network with high-networked incumbent in countries where VC institution is low, which becomes an important strategy for cross-country investment of SEA VC industry. In addition, we found that the difference of institutional development between venture capital firm and its backed companies appears to be the dominant factor, especially for high networked venture capitals. Therefore, higher networked VCs should be more concerned and aware of the intensity of institutional system, such as investment regulation and government support, of their target investee's country. However, in case of emerging countries, VC network would have not always been important, as other studies suggested. As we found out in a group of emerging countries that a success of ventures also depends on how they manage total asset and how long they have been in the market. Startups perform better in small base of total asset and older year of incorporation. Hence, venture capitalists should invest in their target ventures by considering a decent amount of total asset and greater age of the ventures. In a part of investment in Singapore, low networked venture capital firms probably could select the potential ventures and bring out their superior performance, as they are more confident investing in early stage ventures with benefit from the supportive environment with complete facilities. While high networked VCs might not necessarily invest in the potential ventures as networks is not the most essential factor for them. Besides, we hope that this work will encourage both government and policymakers to take more action in institutional development in venture capital investment, especially laws and regulations. Furthermore, they might provide a concrete projection on how they can facilitate more open innovation practices to create a better ecosystem in the industry enhancing networks and connections among Southeast Asian VC investors, accelerators, and startup companies (including SMEs). These all together would lead to an effectively increase in competitive capability and boost up the overall economic of each country in the Southeast Asia region.

Since the research study of the venture capital industry in emerging countries is known about a difficulty in obtaining the complete data, we therefore experienced some limitations about the collection and availability of the data. In future research, we interestingly suggest, if possibly found and collected, adding a value of

syndicated deal, which can be used as a weight of each relationship in the network, and using the market value of portfolio company as another performance indicator.

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APPENDICES

APPENDIX A

Random Effect Regression Results (Pooled C: FS)

The random effect regression results from alternative sample of Funding Stage with Size dummy variable, testing Hypothesis 1 and 2 (Pooled C: FS)

	FS	FS	FS	FS	FS
DEGREE	-0.0050				
CLOSE		-1.4414			
BETW			-0.2532		
VCPE				-0.0574	
FID					-8.9188
SIZE	0.4769	0.4384	0.4544*	0.5946	0.4256
INDUS	-0.6322	-0.5331	-0.5094	-0.6582	-0.6262
SING	-0.0124	0.0074	-0.0252	1.7345	16.8473
YEAR	0.0527	0.0507	0.0470	0.0558	0.0621
cut1	0.0952	-0.0412	0.2237	-3.2774	2.9784
cut2	1.4177	1.2129	1.4730**	-1.8237	4.3671*
cut3	1.8887	1.6655*	1.9228**	-1.3160	4.8541*
sigma_u	0.2793	0.0000	0.0000	0.8684	0.4387
N	94.0000	94.0000	94.0000	94.0000	94.0000
Ng	75.0000	75.0000	75.0000	75.0000	75.0000
ll	-104.5065	-104.4571	-104.7081	-104.1594	-102.3212
Chi^2	1.7081	6.7370	3.8716	2.3887	4.3728

* p<.1, ** p<.05, *** p<.01

Note: (1) SIZE equals 0 for small size, 1 for medium size, 2 for large size, 3 for very large size. A size of company is categorized by the criteria for a company in Orbis database, which consider to be small, medium sized, large, or very large companies by relying on all constraints of operating revenue, total assets, and employees (values expressed in EURO currency). (2) N = Number of Observation, Ng = Number of groups, ll = log likelihood, sigma_u is the variance between groups.

BIOGRAPHY

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