RISK ALLOCATION IN PUBLIC-PRIVATE PARTNERSHIP INFRASTRUCTURE PROJECTS FROM THE PERSPECTIVE OF LIQUIDITY SUPPLY

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by

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ABSTRACT

Risk allocation is one of the most controversial issues regarding Public-Private Partnership (hereinafter called PPP) projects for infrastructure development. The orthodox idea of normative risk allocation can be summarized into two principles, i.e. 1) the party who can best forecast and control a risk should take it – the first principle and 2) if no party can forecast nor control it, the party who has the largest financial ability should take it – the second principle. This dominating idea is founded by rather micro-perspective since the principles are expected to minimize the cost of behavioral rent of moral hazard and risk premium of projects. However, this orthodox principles of risk allocation do not provide the idea how to allocate various risks associated with PPP projects between domestic insurance companies and international insurance companies nor between the host government and multilateral development banks in the context of developing countries.

Not all but the majority of risk events such as construction risk, operational risk, or catastrophe risk needs contingent investment which require liquidity assets. In this research, the risk event which leads to reinvestment need, sometimes resulting in a shortage of liquidity, is referred to as a "liquidity shock". Liquidity shock can bring about the project freezing (a stage where a project is unable to proceed its construction or operation), or in the worst scenario, project default or bankruptcy. Therefore, companies – special purpose companies (SPCs) in the context of PPP – rationally keep liquidity asset in hand to meet contingent liquidity shock in the future. As this thesis considers the use of a wide variety of liquid assets as risk transfer tools owning to their feature to preserve and transfer value when reinvestment is needed, risks which can be hedged through liquidity assets as well as different sources of liquidity available for PPP project investment from different markets are therefore introduced and investigated. With a corresponding usability to handle debt and redeem or reschedule liabilities when they mature, as well as its ability to quickly transform other assets into cash, insurance and securities are treated as liquidity in this research. Insurable risks related to catastrophe or big loss can be covered by various types of insurance available in the insurance market while the residual risks can be covered by other financial tools in capital market.

Even though there is an extensive literature discussing the use of risk financing instruments in PPP projects, little attention has been paid to the supply of liquidity for these projects in macro-economic level. The main purpose is to study how different types of risks in PPP projects that are conceptualized as liquidity shock should be allocated among relevant players such as the project sponsor, the lender, the insurer, and the public authority from the perspective of liquidity supply. The framework employed in this thesis owes to the Liquid Asset Pricing Model (LAPM) developed by Holmstrom and Tirole (1999) which provides theoretical mechanism of the market of liquidity. The LAPM implies that, in developing countries where available liquidity in the domestic market is not enough to meet the demand, the supply of liquidity from the outside will improve the welfare of domestic economy by achieving the optimal scale of investments. Furthermore, the LAPM also implies that the liquidity supply by the public sector is necessary when liquidity shocks are aggregate like catastrophic natural disaster risks.

This thesis comprises six chapters. Chapter 2 reviews the literature related to PPP arrangement and gives a clear scope of the study. Following the concept of privately-promoted infrastructure projects which emphasizes dominant features of risk allocation, essences of PPP such as corporate parties, types of PPP, risks in PPP, and risk management in PPP projects are described. In addition, reasons behind the insufficiency of liquidity supply in developing countries are also discussed.

Chapter 3 continues exploring the risks from chapter 2, focusing on the sources of liquidity supply. PPP projects in a closed economy always handle their risks by transferring insurable risks to the domestic insurance market and hedging residual risks to capital market (e.g. using bonds or other securities). For the insurable risks, a variety of matching insurance types in Thailand (e.g. Construction All Risks Insurance, or Catastrophe Insurance) are presented. Moreover, the roles of parties involved are explained. This chapter highlights the unique constraint in Thailand where the capacity to absorb the risks of domestic insurance market is limited, and the public sector has always pushed responsibility to purchase insurance for infrastructure projects to the private sector.

Chapter 4 presents the formulation of LAPM based on the original work of Holmstrom and Tirole (1999). This theoretical model helps project owners and investors on

investment decision making and evaluating risks of the project. This chapter devotes to solving the project's utility maximization problem and resource allocation in LAPM. Liquidity shocks can be countered when the demand of liquidity is assessed with LAPM and the supply needed is given in a timely manner. The modification of this analysis is made by considering different types of liquidity shock and different sources of liquidity supply. The modification of the model starts with liquidity supply from (i) corporate investors only, then adding supply from (ii) consumer in economy, then considering (iii) the government supply, and finally, with the additional supply from (iv)international supplies in open economy. The principle of liquidity and risk allocation is introduced at the end of this chapter.

Chapter 5 proposes an alternative principle on how to allocate different types of risks as liquidity shocks among the typical players of PPP projects from the perspective of liquidity supply. This principle aims to help the project sponsor and the government make decisions effectively. It implies that apart from the government and the project sponsor, the contribution of international participants from insurance and capital markets (which have plentiful liquidity supply and no effect from aggregate shock in one country) is indispensable, particularly in developing countries. The process to develop this principle starts with studying the role of different liquidity suppliers (i.e. project sponsor, corporate investors, insurers, the government, and multilateral development banks) and their diversified liquid assets. Then, the theoretical mechanism of the market of liquidity explains how liquidity is transferred across the market. The decision making framework is built upon the above mentioned processes. The rationale of public supply of liquidity which is implemented to alleviate aggregate liquidity crisis in the country is also investigated. The asymmetric information (soft budget problem) arising when the government intervenes the market by using taxation power to reallocate liquidity is discussed in this chapter. The result from this chapter encompasses the government's obligation to assist firms, individuals and infrastructure projects in hand.

Finally, the conclusions of this research are summarized in Chapter 6.

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Chapter 1

Introduction

1.1 Research Background and Motivation

Over the last 20 years, insufficient fund to develop several infrastructure projects at the same time and the increase of social demand in order to improve the quality and efficiency of public services for extensive economic and social development have been major concerns of the governments around the world (Auschauer, 1991; Grimsey & Lewis, 2004). It is believed that private sector's investment together with innovation, management skills, and commercial expertise should play a more prominent role in the delivery of public infrastructure and services, which are naturally undertaken by the public sector (HM Treasury, 2012; Van Herpen, 2002).

Although private finance has been considered for many major projects in both developed and developing countries, the latter generally lags behind in infrastructure development because they often lack funds from the normal sources expected in the developed countries. The main reason behind this is the inadequacy of public funds due to low tax base in these countries, caused by relatively weak domestic economies with low levels of industrial and commercial investment (Merna & Njiru, 2002). According to Hyun, et al. (2008), after recovering from the financial crisis in 1997, the high economic growth has resulted in a significant increase in need for infrastructure development and financing in Asian developing countries, as shown in Table 1.1.

Table 1.1 Total Private Investment in Infrastructure (million US$) in Asia by Country

	Cambodia	China	Indonesia	Laos	Malaysia	Myanmar	Philippines	Thailand	Vietnam
1990	0	173	116	0	870	0	98	692	0
1991	0	2,379	11	0	0	0	433	268	0
1992	13	2,414	252	0	1,794	0	814	1,902	0
1993	18	3,369	602	0	4,702	0	1,934	2,631	0
1994	0	3,165	1,954	0	6,730	0	2,218	664	10
1995	122	1,447	4,977	0	4,111	394	3,222	3,615	256
1996	8	8,093	7,488	628	4,191	50	3,260	3,749	220
1997	205	13,220	4,857	0	3,070	0	12,111	2,846	180
1998	14	4,969	1,541	1	766	0	1,807	933	39
1999	17	7,247	2,413	7	805	0	888	698	121
2000	28	8,131	642	5	5,519	0	2,153	1,377	150
2001	97	1,861	1,458	12	2,868	0	2,738	3,257	241
2002	40	5,464	1,509	20	506	0	863	1,198	1,800
2003	17	7,831	1,749	6	4,056	0	1,388	2,079	642
2004	86	3,707	1,607	34	5,261	0	1,551	1,052	70
2005	94	8,761	1,445	1,260	2,666	0	768	2,560	0
2006	250	8,287	4,622	810	1,230	0	1,815	1,149	260

Source: World Bank, *Private Participation in Infrastructure Database*

In fact, the public sector has financial instruments for solely procuring the financial capital of infrastructure investment, including tax revenue at the year (or several years of investment) and issuing public debts. However, sometimes with inefficiency and weak governance, if the public sector is credit rationed, it may not have enough ability to raise fund for potentially efficient projects. In terms of risk management, under conventional procurement, the public sector normally retains the risks associated with construction, operational performance, and services integration. On the contrary, it is often infeasible for the private sector alone to absorb all the risks as well (Issa, et al., 2012). Therefore, the Public Private Partnership (PPP) scheme which helps allocate risks to both parties has been applied as a key mechanism to provide new facilities that has advantages for both public and private sectors (Engel, et al., 2014; Dias & Ioannou, 1995).

Due to the high risk and uncertainty in PPP projects, the risk-sharing principle allows risks in PPP projects to be apportioned to the party best able to manage it (Kobayashi, et al., 2006; Van Herpen, 2002). Nevertheless, allocating risks in PPP is inherently challenging for all parties. Moreover, project risks, which are expected to arise anytime in 30-year (or more) concession contract into the future when such projects are operated, cannot be predicted with certainty since they are dynamic throughout the project life (Hovy, 2015). So far, the increased number of unsuccessful infrastructure projects has pushed researchers and practitioners to become aware of their existing risk management which is sometimes infeasible for both pre- and post-completion phases. In order to improve an ineffective risk management, recent researches have been adapting to related topic in both corporate finance theory and managerial practice (Gatti, 2008). The focus of project managers has been shifted from pure risk management to enterprise-wide risk management instead (Nocco & Stulz, 2006). Indeed, the decision on how much cash the projects are supposed to keep in hand to face unfavorable events is crucial (Holmström & Tirole, 2011). Given its ability to handle debt and redeem or reschedule liabilities when they mature, as well as its ability to quickly transform other assets into cash, the use of liquidity has been highlighted in corporate finance and business plan for many years. The integration of liquidity and risk management, which has the features as well as advantages of dynamic approach liquidity management and the familiar risk transfer widely used in the infrastructure industry, is therefore an alternative for the project sponsors and the governments to decide their investment plan.

This thesis considers the use of a wide variety of liquid assets as risk transfer tools owning to their features to preserve and transfer value when reinvestment is needed. Sources of liquidity available for PPP project investment from different markets are therefore introduced and investigated. With a corresponding usability, insurance and securities are treated as "liquidity" in this research. Wang (2004) considers that risk transfer using insurance is deemed to be one of the most prominent risk mitigation measure to the risks whether they are at country, market or project level. Insurable risks together with risks related to catastrophe or big loss can be covered by various types of insurance available in the insurance market while the residual risks can be covered by other financial tools in capital market. Recently, insurers have become more active in covering completion, operating, off-take, political and market risks (Davis, 2003). By paying a smaller amount of insurance premium, an insured project can withstand unfavorable events and their consequences such as business interruption or the claim of the third party, as mutually agreed in insurance policy.

Insurance contracts, commonly known as insurance policies, by definition of financial instrument, are legally binding obligations by a party to conditionally transfer something of value (i.e. money) as reimbursement against losses of casualties (such as fire, earthquake, and other insurable events) to the other party on a future date. Sometimes, projects need reinvestment in terms of deflect remedy and reconstruction due to damage due to contingent loss, particularly during project construction and project operation. However, if the insurance has not been anticipated and properly hedged against risks of loss (called as "liquidity shock" in this study) beforehand, the cash flow of the project will be affected leading to the project default (Zhu & Chua, 2012). This research highlights the role that insurance and securities play in procuring liquidity when additional investment is necessary to enable the projects' continuation due to contingencies.

Even though there is an extensive literature discussing the use of insurance in a certain type of infrastructure or a PPP project, little attention has been paid to the demand and supply of insurance for these projects in macro-economic level. In addition, the interaction between parties which demand and supply liquidity is very important since risks together with liquidity are transferred from investors to project sponsors (or from the host government) and insurers through various tools of insurance and securities

available in insurance and capital market. The mechanism of how project finance is managed in terms of liquidity and risk management guaranteeing the success of projects is the motivation of this research and therefore worth to be investigated. Indeed, not only do projects in developed countries like the US use insurance in infrastructure, but it is also widely used in developing countries. Looking at the reality in developing countries, even though their insurance market sizes are relatively small, the share of foreign insurance companies in the market of insurance service for PPP projects is not negligible. This phenomenon implies that the supply of insurance service in the domestic market is not enough to meet the demand. Although the participation of foreign insurance companies in PPP projects of developing countries are well recognized, there is no theoretical implication on government's decisions and the impact at the macroeconomic level of those economies. In this research, the framework for analysis is based on the integration of liquidity and risk management collaborated with the Liquidity Asset Pricing Model (LAPM), originally proposed by Holmstrom and Tirole (2011). The expected contribution of this research is to point out the importance of liquidity supplied by the public sector and international suppliers (i.e. insurers and multilateral development banks) when there is deficient liquidity supply in the infrastructure industry and the aggregate liquidity shock like natural disaster hits the country. Furthermore, the principle of how liquid assets are used to improve the project finance and transfer risks is proposed.

The result of this research will help the private investor and the government realize how national liquidity and the participation of foreign aid agencies and foreign insurance companies can positively contribute to the feasibility of PPP projects in liquidity-constrained developing countries.

1.2 Research Purpose and Objectives

The main purpose is to study how different types of risks in PPP projects that are conceptualized as liquidity shock should be allocated among relevant players such as the project sponsor, the lender, the insurer, and the public authority from the perspective of liquidity supply. The framework employed in this thesis owes to the Liquid Asset Pricing Model (LAPM) developed by Holmstrom and Tirole (2011), which provides theoretical

mechanism of the market of liquidity and the alternative principle of risk allocation by using a perspective of liquidity supply.

Therefore, the objectives of this research are the following:

1. To understand the components of PPP concession projects. Risks and responsibilities allocated among relevant parties are studied. The orthodox principle of risk allocation in PPP which most research refers to is also studied. Furthermore, the reasons behind the inadequate supply of liquidity for PPP projects in developing countries are considered.
2. To explore sources of liquidity supply and how liquidity from those sources is used in effective ways. Sources of liquidity supply is distinguished based on the insurability of risks. Features of insurance as well as its insurance acquisition process, including types available in the market and the roles of parties involved, are revealed.
3. To understand the LAPM which is the model to solve the project's utility maximization problem and resource allocation. By using this model, the demand of liquidity is determined in order to access the supply needed. The model is analyzed to comprehend a theoretical justification of the roles of the project sponsor, the government, the international insurers, and multilateral development banks.
4. To build up the risk allocation principle in PPP projects by using the perspective of liquidity. The supplementary liquidity from all liquidity suppliers in the markets are studied.

1.3 Research Outlines

This thesis comprises six chapters (including this chapter). The flow of the thesis is illustrated in Figure 1.1.

This chapter describes the broad introduction about risk allocation and liquidity provision in PPP infrastructure projects in developing countries. The general background of PPP projects, and risk sharing concept, together with the importance of liquidity provision

from different resource are explored. The research motivation for the integration of liquidity and risk management provision is introduced. It leads to the purpose and objectives of this research as listed above.

Chapter 2 reviews the literature related to PPP arrangement and gives a clear scope of the study. Following the concept of privately-promoted infrastructure projects which emphasizes dominant feature of risk allocation, essences of PPP such as corporate parties, types of PPP, risks in PPP, the orthodox principle of risk allocation in PPP and financial instruments including liquidity assets in PPP projects are described. These are important and fundamental for references in the follow chapters. In addition, reasons behind the insufficiency of liquidity supply in developing countries are also discussed.

Chapter 3 investigates fact findings related to insurance acquisition. The chapter continues exploring the risk issues from chapter 2 with the key idea of transferring insurable risks to insurers. It is found that, in normal situation, PPP projects in a closed economy always allocate their risks by transferring insurable risks to domestic insurers and transferring the uninsurable risks to financial market (e.g. using bonds or other securities). Among those insurable risks, various insurance types relating to PPP projects in Thailand such as Construction All Risks Insurance or Catastrophe Insurance, which are available in the market, are summarized. Moreover, the roles of parties involved including project sponsor, the government, the insurer and other relevant parties such as lenders or insurance brokers are explained. This chapter highlights the unique constraint in some projects in Thailand and China where the public sector has always pushed responsibility to purchase insurance for infrastructure projects to the private sector.

Chapter 4 presents the formulation of LAPM based on the work of Holmstrom and Tirole (2011). The first half of this chapter is devoted to the development of utility maximization model step-by-step. After the objective function, variables and constraints are described in details, and the model of liquidity demand and supply in closed economy is formulated. The LAPM is a main model to solve the project's utility maximization problem and resource allocation. The result of the analysis presents situations under constrains which occur when the corporate sector cannot generate enough liquidity to supply among themselves. In the second half, the analysis of the supplementary of both outside domestic liquidity and international liquidity, generated by consumers, the

government, and the international suppliers (insurance companies and multilateral development banks) are applied in the model developed in the first half of the chapter. The model determines the optimal allocation for the project's liquidity investment plan in an open economy subject to additional parties and constraints. Also, this chapter presents a discussion on the existing risk allocation problem. The principle of liquidity and risk allocation is therefore introduced at the end of this chapter.

From the theoretical mechanism of the market of liquidity, chapter 5 proposes a principle of how to allocate different types of risks as liquidity shocks among the typical players of PPP projects from the perspective of liquidity supply. The principle implies the contribution of international insurers and multilateral development banks particularly in the context of PPP projects in developing countries. The policy implementation suggests that the government, with its power of taxation, can act like a mediator to allocate liquidity on behalf of consumers to the project in need of liquidity. It should realize to increase the national liquidity-supplied capacity in advance in case the country is under the aggregate shortage of liquidity in the future. Asymmetric information (soft budget problem) arising when the government intervenes the market to reallocate liquidity itself is also discussed in this chapter. Nonetheless, there is possibility that the government might be unable to manage risks such as sovereign risk and then fails to generate adequate amounts of liquidity to finance the projects in hands. In this situation, the international financial institutions such as the World Bank should be considered to provide international liquidity to the country.

Finally, the conclusions of this research are summarized, and extensions to this research are presented in Chapter 6.

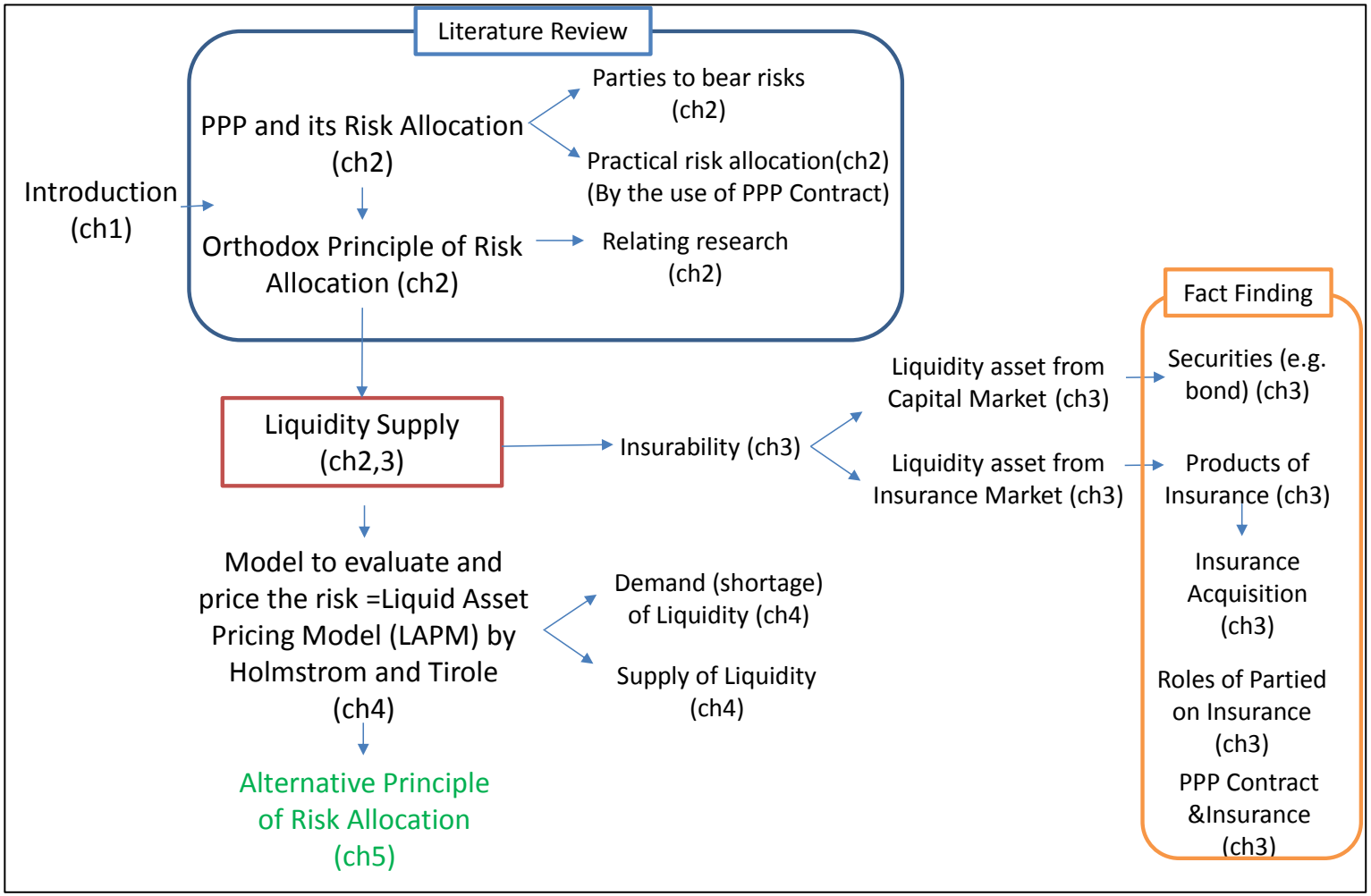

Figure 1.1 Process and Framework of Research

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Chapter 2

Public-Private Partnership (PPP) and Risk Management

2.1 Introduction

In spite of the fact that researches and articles focusing on Public-Private Partnership (PPP) have been increasing, less attention is paid to resources of project financing and its management measures. Without a comprehensive understanding regarding these issues, projects using PPP approach have not always achieved satisfactory outcomes. This study is focused on the risk management as a primary issue of PPP arrangement, particularly when projects cannot continue due to unfavorable events. However, in order to analyze a contingent liability and to formulate a theoretical model in the following chapters, the fundamentals of PPP and its risk related issues need to be clearly understood beforehand. Accordingly, the literature regarding insights of PPP is explained first in this chapter. This chapter introduces the uniqueness of PPP infrastructure projects and how it is different from other projects undertaken normally by the public sector. This includes risk allocation which is at the heart of determining whether PPP procurement best suits or not. The literature review shows how risks are allocated in practice and in theory based on the orthodox principle. It is pointed out that in order to enhance the risk allocation, the consequence on how risks are allocated to additional parties has to be concerned. Hence, the concept of using perspective of risk allocation with the liquidity supply is proposed at the end of this chapter.

The chapter is organized as follows. In section 2.2, background knowledge relevant to PPP, including literature reviews on definitions of PPP, parties involved and structures, types of PPP, advantages and disadvantages of PPP which are conditions that have affected on the success and failure of PPPs are introduced. In section 2.3, the concepts of risk management and risk allocation methods are described as a foundation for insurance and securities, which will be further explored in chapter 3. The risk allocation from existing literature is considered in this section. Finally, this chapter introduces liquidity and its use associated with risk management, and also alleges the reason why liquidity is limited particularly for PPP projects in developing countries in section 2.4.

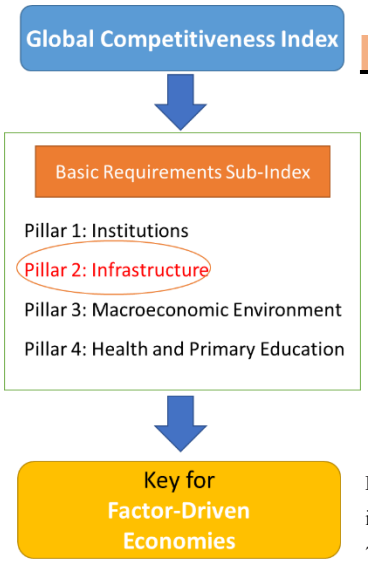
2.2 Background of Public-Private Partnership (PPP)

Infrastructure has become an influential role in economic development by enhancing the facilitating trade processes, investment climate, and increasing efficiency in daily

business activities, as well as in enrichment of living standards (World Bank, 2008). An inadequacy of infrastructure is an impediment to the development of a country (e.g. production bottlenecks for sustainable economic growth and poverty alleviation). As a result, in the last few decades, infrastructure projects in many countries have been rapidly constructed for the functioning of economy and society. The World Economic Forum 2014–2015 gives the supportive reason that the infrastructure development in a country is one of the key factors to access the competitiveness among countries around the globe (Schwab & Sala-i-Martin, 2015). They introduce a Global Competitiveness Index and infrastructure is listed under the Basic Requirements Subindex. Competent infrastructure is important to ensure the effective economic functioning, and thus becomes one of main factors to determine countries' ranking. Besides, the extensiveness and quality of infrastructure networks have a considerable effect on economic growth and also reduce the poverty and income inequality in a wide variety of ways (Aschauer, 1989; Nataraj, 2007). Countries which are able to provide better infrastructure are more attractive for foreign investors as shown in Figure 2.1. For example, transportation infrastructure, as a fundamental input in a country's development by creating transport services which benefits the market exchange of goods and labor, has positively influenced personal well-being of citizens and economic growth as a whole (International Transport Forum, 2013). According to the analysis of the US transportation cited in Dias & Ioannou (1995), in 1985, the vehicle delays on the highways were estimated to be over 722 hours and would have markedly jumped to 3,900 hours in 2005 if there were no improvements in the nation's freeway system in time. In addition, this also impacted the gasoline waste of 3 billion gallon in approximate, which was 4% of annual consumption in the US when cars and trucks sat still in traffic. The government thus try to gain a huge amount of budget for investment.

In the past, the public sector often provided infrastructure by contracting out the construction of projects to a private company and fully financing them with taxes, public debt or by borrowing from commercial banks and international financial institutions (e.g. Asian Development Bank (ADB) or World Bank) (Nataraj, 2007). The private firm was restricted to only build the projects and receive the agreed payment, thereby finalizing the construction. Thereafter, the public authority took over the facility operation and maintenance (Engel, et al., 2014). However, because the public sector has insufficient fund to develop several projects at the same time (Auschauer, 1991), whilst the demand

for improvement of quality and efficiency of public services for extensive economic and social development is increasing (Grimsey & Lewis, 2004), governments have adopted plans to encourage both investment and involvement of the private sector in infrastructure projects. These 2 major reasons lead to the Public Private Partnership (PPP) concept, which has been applied as a key mechanism to provide new facilities that has advantages for both public and private sectors (Dias & Ioannou, 1995).



Ranking by Quality of Overall Infrastructure

Rank	Country/ Economy	Value	Rank	Country/ Economy	Value
1	Switzerland	6.6	12	Portugal	6.0
2	Hong Kong SAR	6.5	13	Spain	5.9
3	United Arab Emirates	6.4	14	Luxembourg	5.9
4	Finland	6.4	15	Denmark	5.8
5	Singapore	6.3	16	United States	5.8
6	Netherlands	6.3	⋮	⋮	⋮
7	Austria	6.2	74	Russian Federation	4.1
8	Iceland	6.2	75	Ukraine	4.1
9	Japan	6.2	76	Thailand	4.1
10	France	6.1	77	Côte d'Ivoire	4.0
11	Germany	6.0	78	Swaziland	4.0

How would you assess general infrastructure (e.g., transport, telephony, and energy) in your country? [1 = extremely underdeveloped—among the worst in the world; 7 = extensive and efficient—among the best in the world] | 2013–14 weighted average

Figure 2.1 Global Competitiveness Index Framework and Ranking (Schwab & Sala-i-Martin, 2015)

In recent decades, the number of PPP infrastructure projects as well as the number of developing and developed countries adopting PPP have been increasing around the world. Even when there was a budgetary problem due to global financial crisis in many developing countries in 2008, the trend of using PPP most likely continued as the economy recovered. Table 2.1 shows the number of projects and investment from 1990 to 2011 in 4 different modes of transportation infrastructures (International Transport Forum, 2013).

Such PPP arrangements can be regarded as the approach that draws public and private sectors together by a risk-sharing principle, in particular the financial risk which might be impossible for a single party to bear (Likhitruangsilp, 2012). The provision of project finance under the PPP model has been widely applied to many types of project including hard infrastructure (large national physical networks which are necessary for the

functioning of a modern country), such as railways, highways, bridges, power stations, water and waste water plants, seaports, airports; and soft infrastructure (organizations which are fundamentally required to maintain the country's economy, health, and cultural and social standards) such as the health care system (e.g. hospitals), the educational and research system (e.g. schools, universities) (Engel, et al., 2014).

Table 2.1 Number of PPP Projects and Investment from 1990 to 2011 in 4 Different Modes of Transportation Infrastructures (International Transport Forum, 2013)

Projects from 1990 to 2011	East Asia & Pacific	Europe & Central Asia	Latin America & Caribbean	Middle East & North Africa	South Asia	Sub-Saharan Africa	TOTAL
Airports							
Number of Projects	28	30	53	11	10	13	145
Investment (US$ million)	4,536	11,829	10,138	1,913	5,045	495	33,957
Railroads							
Number of Projects	23	7	56	2	8	20	116
Investment (US$ million)	16,393	5,354	21,283	343	757	4,769	55,712
Roads							
Number of Projects	200	2	257	0	259	13	731
Investment (US$ million)	39,131	2,818	74,225	0	41,722	2,599	160,495
Seaports							
Number of Projects	109	27	126	21	46	52	381
Investment (US$ million)	19,955	2,723	16,838	4,868	10,371	5,734	60,488
TOTAL							
Number of Projects	360	66	492	34	323	98	1,373
Investment (US$ million)	80,015	22,724	122,484	349,781	64,708	508,102	310,652

Over this 25-year period since the first PPP has been introduced, many lessons have been learned from the experience of both successful and failed projects. There are many difficulties arising from a number of sources which are often cited in researches as obstacles to successful private sector involvement: (i) expensive construction, operating and maintenance costs; (ii) inadequacy of revenue (e.g., fare, service fee) resulting in the need for direct and/or indirect public subsidies such as land expropriation; (iii) the complexities of forming and sustaining cooperation and partnerships (Phang, 2007). As a result, academic research in PPP addressing a variety of key issues on how to improve PPP projects have also been established with the integration of advanced knowledge in policy, management, finance, and other related fields. Tang, et al. (2010) categorizes research on PPP into "empirical" and "non-empirical" studies. According to their idea, the empirical studies are further classified under the themes of "risks", "relationships", and "financing", whereas the non-empirical studies are under "financing", "project

success factors", "risks", and "concession periods". Tang, et al. (2010) suggest that among various aspects of research in PPPs, they can be categorized into:

- Enhanced and promote fruitful interaction between the public and private sector (e.g. Erridge & Greer, 2002; Zhang & Kunaraswamy, 2001;)
- Better risk management (e.g. Grimsey & Lewis, 2002; Li et al., 2005a)
- Clearer government policies (e.g. Ball & Maginn, 2005; Hart, 2003)
- Revealed critical success factors (e.g. Li et al., 2005b)
- Improved maturation of contract (e.g. Ho, 2006; Tranfield et al., 2005)
- More appropriate financial analysis (e.g. Akintoye et al., 2003; Norwood & Mansfield, 1999)

2.2.1 Definitions of PPP

There is no precise and commonly accepted definition of PPP, which is why a number of alternative names of PPPs are used worldwide. In addition to PPP, this following example shows names used in related terms of such cooperation between the public and private sectors (Yescombe, 2007):

- Private Participation in Infrastructure (PPI), a term expressed by the World Bank. However, it is little used outside the development-financing sector, except for the South Korean PPI program;
- Private Finance Initiative (PFI), a term which originated in Britain and now also used in Japan and Malaysia;
- P3, used in North America;
- Private Finance Projects (PFP), used in Australia

The term of "Public Private Partnership" or "PPP" was originally mentioned in the United States, co-funded by the public and private sector for educational programs and utilities in the 1950s before being wider used as joint ventures for urban renewal projects in the 1960s (Yescombe, 2007). Nevertheless, the use of private investment in public infrastructure can also be traced back to some European countries since the 18th century, such as the concession contract which supplied drinking water in Paris (Tang, et al., 2010), the construction of Suez Canal in the 1860s, before being introduced in America and Asia afterwards. Meanwhile, around 1992 the Great Britain government pioneered

the use of private funding as a substitute for public-sector investment to deliver public infrastructure and services called private finance initiatives (PFIs), originally for the transportation sector (Lobner, 2009). Since then, the PPP term was widely implemented in the late 90s. The PPP thus became an alternative to the public sector's procurement of facilities which uses funding from taxation or public borrowing. Not only the government itself, but publicly-funded provision of social services supported by non-public-sector organizations, such as voluntary or non-profit sector was also referred as PPP in the U.S. (Yescombe, 2007).

It is obvious that even though many organizations, books, and researchers refer to PPP in various uses and levels, it has still been unclear what PPP really is due to many forms and situations in different countries. There is no single universally accepted definition of Public Private Partnership (The Policy and Operations Evaluation Department, 2013; Marin, 2009; Organisation for Economic Co-operation and Development, 2008; Hemming, 2006). So far, numerous definitions of PPP have been proposed. To begin with, as expressed in the name, PPP can be seen as an organization scheme that enables the "cooperative relationship" (partnership) of the two fundamental parties: the state and the private company, aiming to achieve their mutual objective. For instance, Helming (2006) defined the Public Private Partnership in International Monetary Fund (IMF) seminar as: "arrangements where the private sector supplies infrastructure assets and infrastructure-based services that traditionally have been provided by the government." Similarly, the Canadian Council for Public-Private Partnerships (2004) simply defines PPP as: "A cooperative venture between the public and private sectors, built on the expertise of each partner that best meets clearly defined public needs through the appropriate allocation of resources, risks and rewards."

PPP can also be perceived in terms of "a contract", which satisfies the interests of the parties involved. Many researchers including Hart (2003), Guasch, et al. (2008), Hart & Moore (1998), and D'Alessandro, et al. (2013) highlight the issues of PPP contracting such as privatization, renegotiation, and incompleteness of contract. Following this idea, World Bank (2003) states that the term "public-private partnerships" is "a long-term contract between a private party and a government entity, for providing a public asset or service, in which the private party bears significant risk and management responsibility, and remuneration is linked to performance". Likewise, in the US, the National Council

for Public–Private Partnership (2000) defines PPP as a "contractual arrangement between a public sector agency and a for-profit private sector developer, whereby resources and risks are shared for the purpose of delivery of a public service or development of public infrastructure". Following the key properties of a "contract-based" PPP, Yescombe (2007) defines PPP as "a long term agreement (known as a PPP Contract) between a public and private parties which allows the private sector to design, construct, finance, and operate public infrastructure or facility. Payment over life under the PPP contract for the use of facility are paid to the private sector by either the public sector or the general public (users) with the condition that the facility remains or reverts in the ownership of the public sector at the end of the PPP contract. It should be noted that the relationship between these two parties is not a partnership in the legal sense, but is contractual, being based on the terms of the Contract".

Up to this point, there might be some argument that the definition cannot show the level of participation and might be mistaken with other forms of private finance contract. In Hong Kong, in order to clarify definitions with thorough details between PPP and outsourcing, the Efficiency Unit developed its mission of private-sector involvement (PSI) focusing on how "to assist the government in meeting its priorities, building on the clear recognition that public funds are limited". Such a PSI has 2 forms: Outsourcing and Public–Private Partnerships (PPPs). Following this concept, PPP is defined as "a contractual arrangement involving the private sector in the delivery of public services. As the name suggests, this is based on a partnership approach, where the responsibility for the delivery of services is shared between the public and private sectors, both of which bring their complementary skills to the enterprise" (Efficiency Unit, 2008). It further defines how PPPs differ from other forms of private sector involvement such as: "outsourcing, where the public sector directly procures services through shorter-term contracts; privatization where a government owned entity or asset is transferred to the private sector in perpetuity and the government's role if any is reduced to that of regulator; and private sector provision where the government has no involvement in the provision of a service as the demand is being adequately served by the market".

Lobner (2009) and Kwak, et al. (2009) argue that some organizations, such as the European Commission, do not give a clear definition of PPP on purpose, as written in its Green Paper: "The term public-private partnership (PPP) is not defined at Community

level. In general, the term refers to forms of cooperation between public authorities and the world of business which aim to ensure the funding, construction, renovation, management or maintenance of an infrastructure or the provision of a service" (European Commission, 2004).

Even though there are many aspects and discrepancies among the definitions of PPP proposed by various different sources mentioned above, it is clear that most of those sources contain and focus on a crucial idea of "risk sharing". With this key concept, the objective of this research is built upon the fundamental idea: how to tie the public and private sector successfully and enhance their capacity for managing risks. Therefore, the applicable definition of PPP concerning the scope of this research is "a long-term financial and contractual arrangement which bundles design, construction, operation and project finance between the public and private sectors using the latter's resource, technology and skills in order to improve the efficiency in delivering the infrastructure project with rationale allocation of responsibilities and risks among the parties involved".

From this definition emphasizing the important of effective resource and risk allocation, the next section will explain the roles and responsibilities of relevant parties allocated under the PPP agreement. It is necessary to track back and comprehend the source of risks arising when PPP is formed and also the current policy and measures used by all parties involves.

In this research, it has to be noted that the authors emphasize the bundling features of investment in the proposed definition as well. Among wide use of PPP with a wide variety of meanings, the PPP projects in this study need investment and management of the private sector to achieve benefits of value added, greater competency and efficiency until the project completion. Even though some textbooks and organizations such as the National Council for Public-Private Partnerships (1999) distinguish PPP project into different types by degree of participation, this study considers some types which have no construction and operation investment from the private partner out of scope of PPP in accordance with the definition given by Burger, et al. (2009). For example, under conventional Design-Build (DB) (or sometimes referred to as Build-Transfer (BT)), after

completing the facility, the government takes responsibility for operating and maintaining the facility itself.

2.2.2 Parties Involved and Structures of PPP

Under the definitions of PPP mentioned above, a PPP infrastructure project needs at least 2 parties: the public sector (government agencies) and private enterprises to constitute a sustained collaborative effort together on the implementation of projects. They collaborate on the basis of a clearly defined sharing of tasks and risks to achieve benefits of added value and increased efficiency (Nataraj, 2007). However, especially in the complex infrastructure projects, it is impossible that the PPP project organization consists of only 2 parties. This section will broadly introduce 4 main parties: the principal (government), the promoter, the lender and others private participants; and will describe their identities and responsibilities with different major goals and reciprocal relationships.

Principal

According to the concept of PPP, principals are public organizations or government agencies, which have agreement with private sector to finance, construct, operate and own an infrastructure facility. In a PPP project, risks are mostly transferred to the private party. The government therefore focuses on strategy and policy making through bureaucratic governance, sustaining a performance monitoring role of all agencies involved through contracts and penalties rather than service delivery (Nataraj, 2007; Merna & Njiru, 2002). Lobner (2009) states that the pivotal roles of the government throughout the life of the contract include authorizing and launching specific legislation to regulate the project, providing stable political environment and necessary project guarantees, assisting private promoters to obtain necessary information for evaluating the project's viability, elaborating the agreement, and making decisions at the appropriate timing.

As the objective of the host government and its agencies is to run the project successfully, they have to be able to obtain trust from the private companies by providing political stability. United Nations Development Programme (1999) demands that the government

should state clearly the key-related policy which includes the amount of public support given to the private sector to use in its delivery of public services; the support for independent regulation and PPP review to protect consumers and the private operator, especially in cases of monopolies where the government fixes tariffs; and the public sector's contribution and capability to share the commercial risks of the PPP.

Major concerns from the public governance regarding political issues always arise when the government changes the substantial terms of the contract, cancels a project or fails to meet its obligations, or when there are changes in government resulting in the new government withdrawing promised support to a PPP. Akintoye et al. (2003) propose the efficiency rule for allocating risk which, cited in Marques & Berg (2011), states that "the public sector should not transfer risks that are under its control to the private partner, nor should it assume the risks that are beyond its control" (p.3). In this sense, the government ought to offer a guarantee or retain political risks itself. In the case where it is beyond the government's control, it should share such political risks which can be mitigated by regulatory and other policy supports to the private sector.

In a PPP, for the purpose of public accounts, the private sector is invited to support the government. Not only the political risks, but the host government should also consider sharing some other project risks with the private sector because they cannot solely bear all. A high level of risk stems from large capital outlay, lengthy construction periods, slow buildup of revenue over time, slow asset depreciation, and also small value in alternative use of the facility.

Apart from the above, risk sharing perspective when the government sees and treats the force majeure risks, including the use of insurance, is taken into account as well as the government's commitment of co-financing. Such government co-financing can be done by many mechanisms such as the purchase of bonds of the owing company, the offer of subordinated loans, the support for advance payment (e.g., power supply project), allowing owning companies to increase prices for service, obtaining the lender's agreement to defer the debt, and limiting competitors (Lobner, 2009)

When a partnership is simply not feasible from an economic or financial point of view, the only solution is to share risks and cost with the private sector. Sometimes support and subsidy have to be offered in order to attract private investment by facilitating access to

finance and improving the risk-return balance. The measures that the government can take to support or to compensate the private sector in PPP projects can be categorized into 9 groups as following (Burger, et al., 2009; Fisher & Babbar, 1996):

(1) Equity guarantees: Under this guarantee, the government granted the private partner an option to be bought out with a guaranteed minimum return on equity (the private partner can sell its equity stake to the government at an agreed price) or other measures to ensure equity. Although under this arrangement, there is no public cost as long as the project can generate the minimum return on equity, the government essentially assumes all of the project risk, and private sector performance incentives are severely reduced.

(2) Debt guarantees: With a debt guarantee, the government provides a full or part guarantee or a cash-deficiency guarantee for repayment of loans. As with an equity guarantee, this type of guarantee entails no cost on the public side as long as the project generates sufficient cash flow to service debt. However, it can create extremely high government exposure and also reduce incentives of the private partner. In China the government provided a cash-deficiency guarantee for the $800 million in senior project debt.

(3) Exchange rate guarantees: Under an exchange rate guarantee the government provides protection to a private partner when there is increases in the local cost of debt service due to exchange rate movements. Because currency fluctuations can constitute a significant project risk when foreign capital is involved, government guarantees can have a substantial impact on a project's ability to raise financing. Although not on the same scale as debt or equity guarantees, exchange rate guarantees can still expose the government to substantial risk.

(4) Grants and Subordinated loans: Grants are considered the most direct and efficient means of supporting projects which require a significant boost to become feasible. The government can alternatively furnish grants at project startup as cash or in-kind contributions. With the subordinated loan, the government provides a standing loan facility on which the private partner can

draw if necessary. These may reduce the cash-flow risks that the servicing of senior debt may cause and provide a critical boost to project economics.

(5) Shadow tolls: Shadow toll is an alternative upfront government payment widely used in PPP transportation projects, whereby the government contributes a specific annual payment per vehicle recorded on the road. The advantages of shadow tolls are that they are paid over time and therefore may be less of a burden to the government than an up-front grant. Furthermore, they greatly enhance the private partner's incentive to attract users to the facility. However, the drawback of shadow tolls is that they may not use government funds efficiently to protect investors from revenue risk. Under a shadow toll arrangement, the government contributions are higher when traffic is high and lower when traffic is low. Thus government support may inadequately protect investors when traffic falls below expectations. On the other hand government support may be unnecessarily high when traffic exceeds expectations. In addition, the payment of contributions over time creates a credit risk for the private partner that is avoided with upfront grants.

(6) Minimum revenue (or traffic) guarantees: A compensate, in which the government agrees to pay the project company a specific amount if revenue (or in terms of user numbers) falls below an agreed minimum level in order to ensure that the private partners can cover the repayment and servicing of their debt liabilities. The private sector satisfies this condition regardless of whether the project service is used or not but some contracts might also specify revenue sharing agreement in case the private sector gains greater revenue as shown in Figure 2.2.

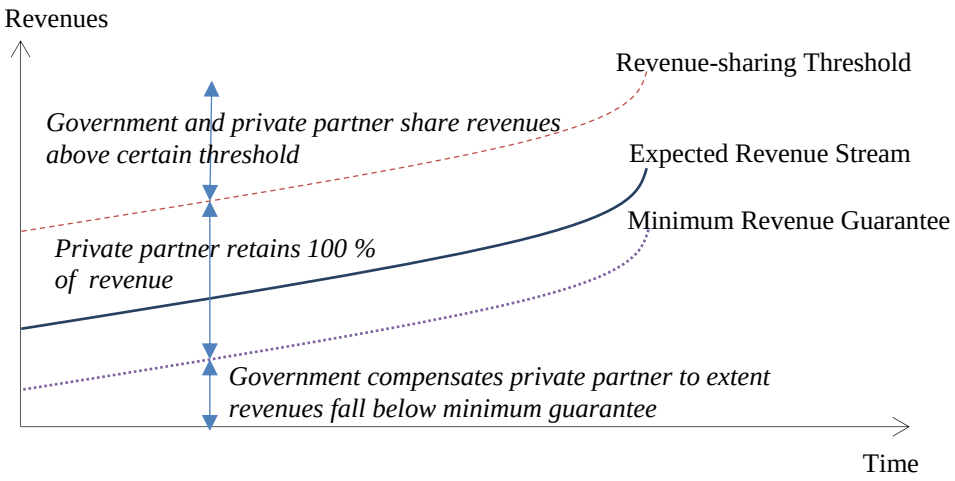


Figure 2.2 Example of Public-private Revenue Sharing (Fisher & Babbar, 1996)

The approach which seeks to share any higher than expected revenues between the two parties, known as "upside revenue sharing" is used to avoid excessive returns for the concessionaire, resulting in the burden of the users (Verdouw, 2015). This approach allows concessionaire to share some level of revenues with the government, the risk of excessive returns can be eliminated.

(7) Concession extensions: financial support involves very limited public sector risk (but it also limits the government ability to support financing). In case the revenue falls below a minimum amount, the government extends the tenure of the agreement to allow the private partner to generate the return needed to ensure the viability of the project.

Out of the various mechanisms available to government, its risk exposure is highest for equity guarantee, debt guarantee, and exchange rate guarantee as shown in Figure 2.3. Fishbein & Babbar (1996) concludes the significant impact on a project's ability to raise financing from different subsidizing methods. Each alternative trades off between project attractiveness for private investors and degree of risks that the government has to bear. The changed distribution of risks can shift the cost burden between the parties but weaken the attractiveness of PPPs. Therefore, to limit their contingent liabilities and write down conditions (e.g. when revenue below projection) in PPP contract is challenging. The idea

of this government's responsibilities and supports are further developed in detail with the context of liquidity in chapter 4 and 5.

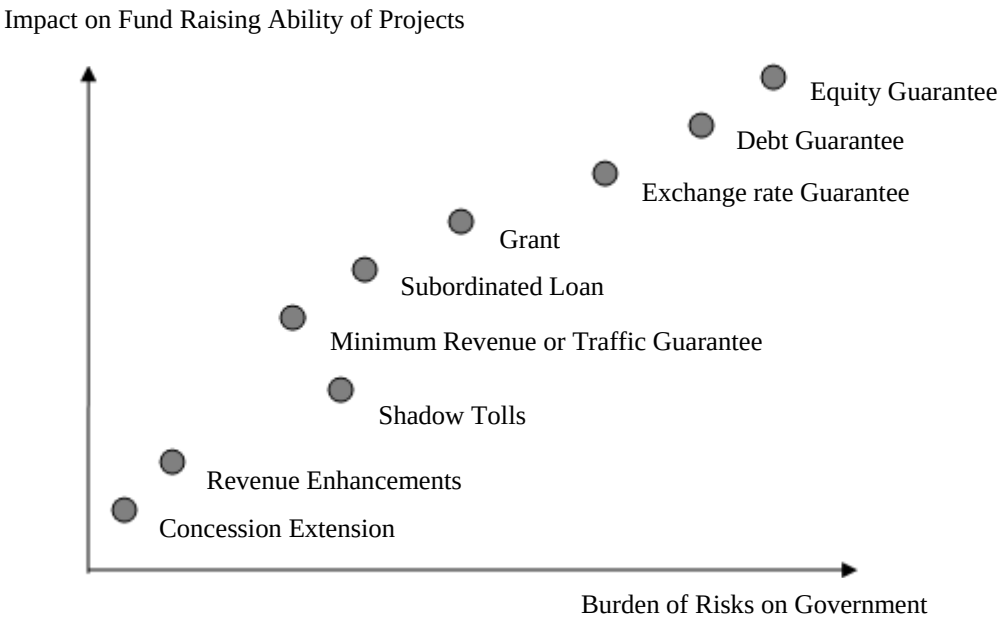


Figure 2.3 Range of Options for Government Support (Fisher & Babbar, 1996)

Promoters

The term promoters (also commonly referred as concessionaire, sponsor, or private consortium) is used to describe the private sector entity with which government contracts. The role of promoters is to use their private fund and management to collaborate with the government and other various parties by setting up a single purpose entity known as a Special Purpose Vehicle (SPV) in order to launch the efficient infrastructure services through different phrases of the project. This limits the private company from involvement in any non-project activities, ensuring that the lenders are not exposed to any additional risks unrelated to the project. It can also be set up under a number of structures including in a form of a joint venture, or a subsidiary of an existing company (Partnerships Victoria, 2001). In accordance with the project agreement and objectives, the private company creates a new entity as owning company to perform feasibility study, makes an agreement contract with the government, arranges the financing with investors and lenders, studies environment impact leading to community acceptance, designs a project and construct, operates and maintains facility (including to find subcontractor to undertake the obligation), makes loan payment, and distributes dividends to shareholders (Dias & Ioannou, 1995).

Basically, the main objective of the private sector to take part in PPP is related to profit acquisition. Every for-profit firm is motivated to make use of its capital, time, and effort based on the opportunity to generate revenue and to seek profit over the contract life (Lobner, 2009). The decision to invest is also considered by the level of coordination and commitment of the local government as being explain in the previous section.

Vining and Boardman (2008) give reasons why the role of private entities helps infrastructure obtain more cost-efficiency through a PPP. First, private partners are more specialized and have more experience in construction and management of businesses. Hence, better economies of scale can be realized. The second reason is that the private entities have stronger incentive to minimize investment costs. This incentive subsequently motivates the private partner to use new technologies in order to reduce costs. Additionally, this research is in accord with the idea of Lobner (2009) that apart from the above reasons, another importance of the private sector in the partnership is that it has more proficiency in using financial instruments and that it can better access to markets that provide a more efficient risk-allocation (e.g. transferring the risks to a third party by way of insurance to insurance market) (Partnerships Victoria, 2001). The utilization of liquidity from different markets will be explained thoroughly in the following chapters.

Lenders

To enhance the shortage of investment capital, the lender is invited and responsible for granting capital to projects through loans, guarantees or equity to privately financed infrastructure projects. In general, lenders can be any financial institution such as international project finance banks, local financial institutions for infrastructure or commercial banks, however, a solution which the developing countries always seek for is to find other resource or party to mitigate financial risks. In many projects financed through project finance techniques, the involvement of foreign governments or multi-lateral financial agencies, such as the World Bank, the International Finance Corporation, and the Asian Development Bank becomes important. Such involvement of these parties is complementary also provides confidence to other lenders and investors in the project (Merna & Njiru, 2002). For instance, guarantees from international organization such as the World Bank are viewed as a key financial instrument to support the flow of private investments for development. Guarantees provide support to lenders or project

companies against a government's (or government entity's) failure to meet specific contractual obligations to a private project.

In infrastructure project financing, lenders should be satisfied as long as the projects are able to manage to generate the expected cash flow and obtain their repayment. On the other hand, lenders need to monitor and control the activities of the project to make sure that the basis on which they originally assessed risks of the project is not breached (Yescombe, 2007). In some case, the lenders obligate the project company to reserve funds as security against short-term cash flow problems for its operation or to make a request to demonstrate that it can still meet the debt obligation in each and every year over the contract period (Boussabaine, 2013). Apart from financial roles to provide loans and monitor investment, some lenders (such as the World Bank or Asian Development Bank) provide aid services to the host government since the project planning or preliminary design stage (e.g. consulting, conducting feasibility study, or technical cooperation) for sustainable collaboration and improving the business environment for investment.

Others Private Participants

Not only does the primary sponsor of the project mentioned above plays the central role, but other private participants (both domestic and foreign) are also crucial for the success of projects finance. Regardless of the type of private sector participation (see section 2.2.3), rights and responsibilities for the private participants (and public sector) along with the risks are normally established in a written PPP contract. According to Merna & Smith (1996), a contract-based interrelation among different parties in PPP projects is illustrated as shown in Figure 2.4. Besides the lenders who naturally take responsibility of project funding share financial risk, diverse parties have to share other risks corresponding to their contracts (e.g. a license (for the operator), a concession or the shareholder agreement document) (Marques & Berg, 2011). Since PPPs use the financial vehicle project finance to raise funding for the projects, contribution from both institutional and individual investors is complementary and important for the promotion of PPP. This will be highlighted again in terms of liquidity supply in following parts of this research.

Even though numbers of literature have given roles and guidelines to the authority to follow, none of them consider the reason behind and timing why and when the government has to take "contingent claim". The mechanisms for assigning of risks to the contractual party is challenging and hence a novelty to study in order to fulfil this gap.

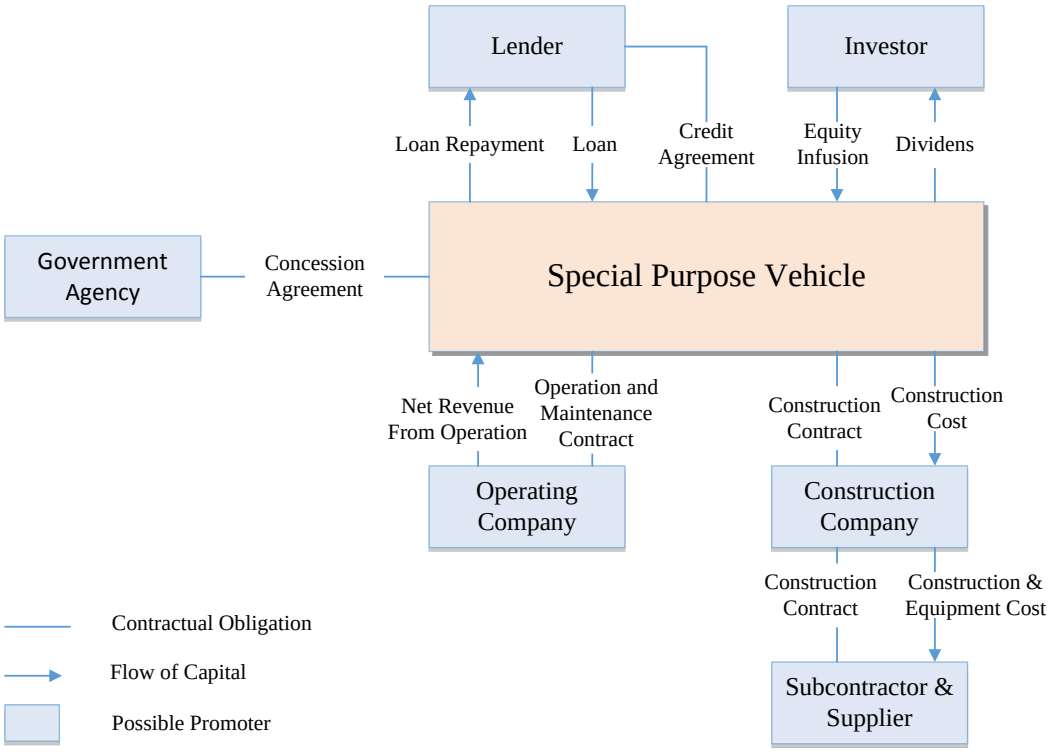


Figure 2.4 Project Financing Structure (Modified from Merna & Smith (1996))

2.2.3 Types of PPP

Among different reasons in establishment, there are various types of private participation, from management contracts to various forms of concessions, or even full privatization, reflecting the different objectives and requirement of governments for investing in infrastructure services. Although the types vary, United Nations, (2008) proposes that two broad categories of PPPs can be identified: the institutionalized kind that refers to all forms of joint ventures between public and private stakeholders; and contractual PPPs. Yescombe (2007) basically classified types of PPP by the legal nature of private sector involvement using expressions such as BOT, BTO, DBFO and other variants as shown in Table 2.2.

Table 2.2 Public and Private Provision of Infrastructure (Yescombe, 2007)

	Public Project ←					→ **Private Project**
			← **Public-Private Partnership** →			
Contract Type	**Public-Sector Procurement**	**Franchise (*Affermage*)**	**Design-Build Finance-Operate (DBFO)***	**Build-Transfer—operate (BTO)****	**Build- operate — Transfer (BTO)****	**Build-Own-Operate (BOO)**
Construction	Public Sector (2)	Public Sector (2)	Private Sector	Private Sector	Private Sector	Private Sector
Operation	Public Sector (3)	Private Sector	Private Sector	Private Sector	Private Sector	Private Sector
Ownership (1)	Public Sector (4)	Public Sector	Public Sector	Private Sector during Construction and then Public Sector	Private Sector during Contract, then Public Sector	Private Sector
Who Pays?	Public Sector	Users	Public Sector or Users	Public Sector or Users	Public Sector or Users	Public-Sector offtaker public sector (5) or Users
Who is paid?	n/a	Private Sector	Private Sector	Private Sector	Multiple	Private Sector

* in all cases, ownership may be in form of a joint-venture between the public and the private partner

(1) Also known as Design-Construct-Manage-Finance (DCMF) or Design-Build-Finance-Maintain (DBFM).

(2) Also known as Build-Transfer-Lease (BTL), Build-Lease-Operate-Transfer (BLOT) of Build-Lease Transfer (BLT).

(3) Also known as Build-Own-Operate-Transfer (BOOT)

The Asian Development Bank Institute classifies Types of PPP models into (Nataraj, 2007):

1) Design-Build (DB): Under this model, the government contracts with a private partner to design and build a facility in accordance with the requirements set by the government. After completing the facility, the government assumes responsibility for operating and maintaining the facility. This method of procurement is also sometimes referred to as Build-Transfer (BT)

2) Design-Build-Maintain (DBM): This model is similar to DB except that the private sector also maintains the facility. The public sector retains the responsibility for operations.

3) Design-Build-Operate (DBO): Under this model, the private sector designs and builds a facility. Once the facility is completed, the title for the new facility is transferred to the public sector, while the private sector operates the facility for a specified period. This procurement model is also referred to as Build-Transfer-Operate (BTO).

4) Design-Build-Operate-Maintain (DBOM): This method of procurement (also referred to as Build- Operate Transfer or BOT) combines the responsibilities of design-build procurements with the operations and maintenance of a facility for a specified period by a private sector partner. At the end of that period, the operation of the facility is transferred back to the public sector.

5) Build-Own-Operate-Transfer (BOOT): The government grants a franchise to a private sector to finance, design, build, and operate a facility for a specific period of time. Ownership of the facility is transferred back to the public sector at the end of that period.

6) Build-Own-Operate (BOO): The government grants the right to finance, design, build, operate, and maintain a project to a private entity, which retains ownership of the project. The private entity is not required to transfer the facility back to the government.

7) Design-Build-Finance-Operate/Maintain (DBFO, DBFM, or DBFO/M): Under this model, the private sector designs, builds, finances, operates, and/or maintains a new facility under a long-term lease. At the end of the lease term, the facility is transferred to the public sector. In some countries, DBFO/M covers both BOO and BOOT.

Responsibilities and risks in each type of contract are different for PPP partners. For example, under Design-Build (DB) scheme, the private sector involvement is at the lowest level. Under DB, the private firm is responsible for both design as well as construction of the facility, whereas a greater amount of risk is transferred to the private sector entity with the additional roles to operate and provide services under Design-Build-Operate (DBO) structure, or under the conventional Design-Bid-Build (DBB) approach, separate firms are responsible for design and construction. Each type of PPP model above has its own characteristic as well as risks hidden inside. The allocation of risk is often seen as the defining quality of a PPP arrangement. The general rule regarding risk allocation is that risks should be allocated to the party which is best able to manage them at the least cost. Young (2007) and Van Herpen (2002) shows the degree of participations and their responsibility that the public and private party have to bear as shown in Figure 2.5.

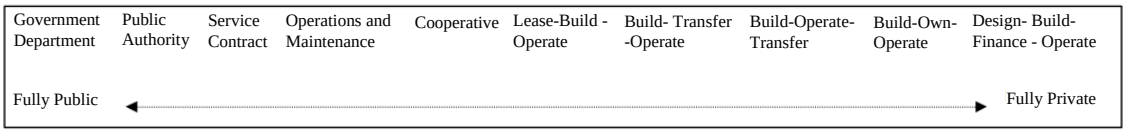


Figure 2.5 Responsibility of Project Private Partnership (Van Herpen, 2002)

For more precise PPP classification, the National Council for Public-Private Partnerships (1999) further identifies 18 types of partnership. In this study, the situation when the liquidity shock which will be introduced in chapter 4 hits an infrastructure project under PPP scheme is focused. However, as mentioned in the definition (section 2.2.1), the model analyzed in the latter part of thesis based on the assumption that the project needs the private sponsor to manage the project and share risks until the project completion.

Therefore the private participation without management such as the facility sale/leaseback[1] is out of scope of this research.

2.2.4 Advantages and Disadvantages of PPP

This section summarizes the advantages and disadvantages of PPP from existing literature. The limitations of PPP arrangement have to be understood first in order to structure the conceptual model in the following chapters.

Miller (1999) concluded that neither a purely public nor a purely private infrastructure development approach is likely to be sustainable in the long-term. A purely public approach may cause problems such as slow and ineffective decision-making, inefficient organizational and institutional frameworks, and lack of competition and efficiency, which are collectively known as government failure. On the other hand, a purely private approach may causes problems such as inequalities in the distribution of infrastructure services, an example of what is known as market failure. To overcome both government failure and market failure, a Public-Private Partnership approach can incorporate the strengths of both the public and private sector. (Kwak, et al., 2009)

The growing experience in Public Private Partnerships (PPPs) for the provision of public infrastructure shows that, in a significant number of cases, the private partner reaches a situation where it is unable to meet its financial obligations. There are examples of major contracts where the project could not be completed due to an inadequate cost control; which was the case of the Metronet PPP project launched in 2002 for the modernization of the London Underground. This project was suspended causing the termination of the contract and was returned to public management (National Audit Office, 2009).

According to various studies, the summary of positives and drawbacks gained when PPP is applied to projects as shown in the Table 2.3 (Yescombe, 2007; International Bank for

[1] Sale/Leaseback (The National Council for Public-Private Partnership, 1999): "a financial arrangement in which the owner of a facility sells it to another entity, and subsequently leases it back from the new owner. Both public and private entities may enter into sale/leaseback arrangements for a variety of reasons. An innovative application of the sale/leaseback technique is the sale of a public facility to a public or private holding company for the purposes of limiting governmental liability under certain statues. Under this arrangement, the government that sold the facility leases it back and continues to operate it."

Reconstruction and Development, 2014; Public Accounts Committee, 2003; HM Treasury, 2012).

Table 2.3 Potential Advantages and Disadvantages of Private Finance Initiative Deals

Advantages	Disadvantages
Spread out the government spending throughout the lifetime of the project which enables the launching of otherwise financially impossible projects.	The public sector is tied into a long-term contract (often over 30 years). Business needs change over time so there is the risk that the contract may become unsuitable for these changing needs during the contract life.
Responsibility for assets is transferred to the contractor. The public sector is relieved from providing services which may not be part of its core business.	Infrastructure or services delivered could be more expensive. One of main reasons is PPP service procurement procedure is longer and more costly in comparison with traditional public procurement
PPP brings the scope for innovation in service delivery. The private sector has incentives to introduce innovative ways to meet the public sector's needs since the design stage.	.On the other hand, private sector may have no incentive to use efficient technologies as long as the service is still meets requirement under the contract.
In many cases, the unitary payment will not start until, for example, the building is operational, and therefore the contractor has incentives to encourage timely delivery of quality service.	The unitary payment will include charges for the contractor's acceptance of risks, such as construction and service delivery risks, which may not materialize.
PPP provides greater incentives to manage risks over the life of the contract than under traditional procurement. A reduced level or quality of service would lead to compensation paid to the public sector.	There is the possibility that the contractor may not manage transferred risks well or public sector may believe they have transferred core business risks, which ultimately remain with them.

A long-term PPP contract encourages the contractor and the public sector to consider costs over the whole life of the contract, rather than considering the construction and operational periods separately. This will lead to efficiencies through cooperation between design, construction, operation and maintenance.	There is no unlimited risk bearing. Private firms (and their lenders) will be cautious about accepting major risks beyond their control, such as exchange rate risks or risk of existing assets.

The disadvantages of PPP are mainly related to the specific ownership, risk transfer and the consequences of information asymmetry. Without the good governance and comprehensive risk management from participants, the PPP projects cannot successfully reach their goals. The next section will introduce the risks and its existing management in PPP projects.

2.3 Risk Management in PPP Projects

Risks in PPP relate to uncertain outcomes which negatively affect either the provision of services (e.g. the delay to deliver facility), or the fiscal status of the project (e.g. additional costs or decreases in revenue). Either case results in a loss which has to be borne by some parties, and the key elements of PPP risk management is to decide the proper parties where this cost will go to (Yescombe, 2007).

This section serves to remind about the important role of risk allocation in PPP. However, before going into details of the risk-allocating mechanism offered by PPP arrangements, it should be first explained what kinds of risk are taken into consideration.

2.3.1 Risks in PPP Projects

It is obvious that investments in infrastructure projects always carry higher levels of risk than other types of investment because they are intuitively concerned with high capital outlays, large sunk cost, long lead time, and permanent assets which have small value in alternative use (Dias & Ioannou, 1995). All PPPs inevitably involve a wide variety of

risks emerging anytime during the contract. To form effective and sustainable partnership, each party (as mentioned in section 2.2.2) must not only share responsibilities but also must accept to share and be able to bear some risks. With prudent planning, probability and impact of risks can be lowered to the level which become no longer a severe threat and can eventually be handled within the PPP arrangement (United Nations Development Programme, 1999). In order to do so, the identification of risks which can potentially prevent the PPP projects from achieving their objectives is necessary. All participants have to recognize the existing sources of risks before moving on to analyze their impacts and consider appropriate strategies to mitigate their effects. Methods like risk exposure checklist or risk breakdown structure are typically applied to infrastructure projects delivered through PPP.

It is difficult to identify and list every risk in a PPP project because risks vary based on different types and complexity of projects (Fisher & Babbar, 1996). In addition, risks in PPP infrastructure projects involved in each country may differ because each country has its own economic, social and regulatory environment leading to different methods to allocate risks (Lemos, et al., 2004). Hence, many scholars have classified risks into broad categories instead. This research shows some results of the risk classification based on literature conducted from cases in different countries:

- Grimsey & Lewis (2004) develop risk matrix to identify major categories of risks categorized into 10 groups: site risks, technical risks, construction risks, operating risks, revenue risks, financial risks, force majeure risk, regulatory/political risks, project default risks and asset risks.
- Wang et al. (2000) classify over 50 risks associated with BOT/PPP power projects in China based on literature review, interview, survey via questionnaires and case studies on numerous BOT projects in 1990s into 6 categories: political risks, construction risks, operating risks, market and revenue risks, financial risks, and legal risks.

After the risks in PPP project are identified, the next stage, in order to manage them to minimize threats to the project, the parties involved have to be able to access the likelihood of identified risks materializing and the magnitude of their consequences if they do materialize (Partnerships Victoria, 2001). Sources of risks, their likelihood to

occur, and their significant impacts along with the measures to minimize risks are of mutual concern to decide how the risks identified above can be best managed by the relevant parties. The next section will explain the risk management used after the risk identification and risk assessment process.

2.3.2 Risks Management and Risks Allocation in PPP Projects

Risk management is an essential tool designed to deal with risks by using managerial knowhow in order to eliminate or mitigate their negative consequences in projects. In general, risk management focuses on how the adverse consequences of risk should be managed. Risk management can be defined as "a structured process in which decisions are made to reduce the likelihood and/or impact of risk occurrence" (Bunni, 2003).

What is the difference between risk allocations of PPP projects compared with other model of public infrastructure procurement? Basically in traditional public procurement projects, most risks are borne by the public sector and a small part is transferred to the private sector. In privatization, on the other hand, the greater part of risks is allocated to the private sector. A PPP approach is therefore rational for transferring risks to parties best able to manage them. The optimal risk allocation is the key feature of Value for Money (VfM) to be achieved. To consider whether a project should adopt the PFI (PPP) approach, one of the evaluating criteria is VfM. It has to satisfy the condition that additional cost of private capital for public sector is outweighed by saving through private sector enterprise, innovation, and competitive efficiency, at the same time appropriately transferring certain risks (particularly financial risk) to private sector (Froud, 2003; D'Alessandro, et al., 2013).

Before the PPP contract is awarded, the public and private sectors need to reach a mutually acceptable agreement on risk allocation (D'Alessandro, et al., 2013). A contract which fails to address and assign risks to the contractual parties in a comprehensive manner increases the costs of infrastructure services (Marques & Berg, 2011). Risk events have been of interest to scholars working on PPP projects (Tang, et al., 2010). The different results of risk identification and classification are presented by several researchers (Treasury Taskforce 1997, Tinsley 2000, Kumaraswamy & Zhang 2001,

Grimsey & Lewis 2002, 2004, Li 2003, Thomas et al. 2003, Shen et al. 2006, Estache et al. 2007, Ng & Loosemore 2007, Medda 2007, Zou et al. 2008, Xu et al. 2010, Marques & Berg 2011, Martins, Marques & Cruz 2011). D'Alessandro et al. (2013) compare risk category and the allocation of risks made by different researchers. The risks identified by each author are grouped into eleven categories: default risk, demand risk, design risk, financial risk, force majeure risk, legal risk, operating risk, political risk, regulatory risk, services risk, and technological risk as shown in Table 2.4.

Table 2.4 Comparative Analysis of Risk Allocation Preferences from Different Literature

Risk Categories	**Risks**	**A**	**B**	**C**	**D**	**E**	**F**
Default	Project Completion Risk	Private	Private	Private		Private	Share
Demand	Operating Revenue		Private	Private		Private	
Design	Design and construction	Private	Private	Private	Private	Private	
	Different working methods	Private	Private	Private	Private	Private	
	Late design change			Private	Private	Public	
	Responsibilities and risk distribution			Share			
Financial	Interest Rate Risk			Private			
	Foreign Exchange Exposure Risk		Public				
	Inflation Risk			Private			
	Credit Risk	Private	Private	Private	Private		
	Residual value	Private					
	Availability of finance	Private		Private			
	Financial attraction of projects to investors			Private			
	Influential economic events			Private			
	Lack of tradition of private provision of public services			Private			
	Higher maintenance cost	Private		Private			
Force Majeure	Environmental Risk	Share		Share	Share	Share	Share
	Geotechnical conditions	Share		Private	Private	Private	Share
Legal	Authority distribution between partners			Share			Share
	Excessive contract variation			Share	Public		Share
	Project approvals and permits	Share		Share	Private		Share
Operating	Land acquisition/site availability	Share			Public	Private	Share
	Supply Risk		Public	Private	Private		Share
	Product Risk	Private	Private	Private	Private	Private	
	Operations & Maintenance Risk	Private		Private			
	Construction time delay			Private	Private	Public	Share
	Operation cost overrun	Private		Private		Private	Share
	Unproven engineering techniques	Private	Private	Private			

Political	Nationalization/expropriation		Public	Public		Private	Public
	Political opposition			Public			Share
	Unstable government			Public	Public		
Regulatory	Industrial regulation change			Private			
	Tax regulation change			Private			Share
	Legislation change	Share	Share	Share	Share	Private	Share
Services	Low operating productivity	Private	Private	Private			
	Poor quality of workmanship	Private	Private	Private			
	Staff crises		Private	Private	Private		
	Third party tort liability			Private	Public		
	Lack of commitment from public/private partner			Share			Share
	Lack of experience in PPP/PFI arrangement			Share			
Technological	Technology Risk						Share
	Obsolescence Risk						Share

Source: modified from D'Alessandro et al. (2013) and Ke et al., (2010) (note: letters A to F refer to the following references: [A] Arndt (1998), [B] Wang and Tiong (2000), [C] Li (2003), [D] Lam et al. (2007), [E] Ng and Loosemore (2007), [F] Ke et al. 2010)

Even though the authors mentioned above use different methods to allocate risks, there is a consensus in the literature regarding the orthodox principle of optimal risk allocation which is to seeks to minimize both project costs and the risks to the project following these two criteria: first, the agent that should bear the risk is in the best position to influence and control the risky outcome; and second, the risk should be borne by the agent able to bear the risk at the lowest cost (Partnerships Victoria, 2001; Ng & Loosemore, 2007; Bing, et al., 2005; Yescombe, 2007; Marques & Berg, 2011).

Table 2.4 shows that despite using the same orthodox principle, the parties which are supposed to bear the risks in PPP projects from those authors' perspectives are still somehow different and thus difficult to apply to different projects. It is understandable because there is diversity of project types and environment of investment in different countries. However, another important reason is because these researchers limit the parties which are liable to risks only to few choices: the government and the private company, while risks which neither the public nor the private sector alone is able to deal with should be equally shared. For example, Ke et al (2010) identify the preferred risk allocation in PPP projects in China and Hong Kong. The result shows that the public sector prefers to allocate most of mesolevel risks (risks occurring within the system boundaries of the project and directly concerned with the nature of each project) to the

private sector, to share most of microlevel risks (risks associated with the relationships between the parties involved within projects) and force majeure risk, and to retain the majority of macrolevel risks (risks external to the project itself), including political, legal, and social risks.

Nevertheless, Medda (2007) claims that the two criteria of the orthodox principle mentioned above often have contrasting results in the risk allocation context. It is possible that the party from which the risk emanates and therefore is best able to control it may not be able to control the risk in the most efficient way and at the lowest cost. Wang & Tiong (2000) share this idea and hence consider responsibilities of additional parties: lender, bank and insurance in the risk mitigation of BOT projects in China (with a case study of Laibin B Power Plant project) besides the government and the private company as shown in table 2.5. For example, the insurers are in charge to provide insurance coverage under (a) cargo transportation insurance; (b) contractor's all risks insurance; (c) third party liability insurance; (d) miscellaneous insurance until the project completion, and (e) property all risks insurance; (f) consequential loss following all risks insurance; (g) machinery breakdown insurance; (h) third party liability insurance; (i) miscellaneous insurance until the transfer date.

Table 2.5 Risk Allocation of the Laibin B Power Plant Project (Wang & Tiong, 2000)

Categories	**Risks**	**Government**	**The Consortium** (as Sponsor, Contractor and O&M Contractor)	**Lender**	**Insurer**	**Bond, Bank or Insurer**
Political risks	Revoke, expropriation, sequestration	X				
	Exclusivity, i.e. not second facility		X			
	Changes in law	X				
	Development approvals	X	X			
	Adverse Government action or inaction	X	X			
	Provision of utilities	X	X			
	Increase in taxes (general)	X				
	Increase in taxes (specific)	X				
	Political force majeure events	X				
	Termination of concession by Government	X				
	Payment failure by Government	X	X			
	Land acquisition and compensation	X				

Construction completion risks	Restriction on import equipment/materials	X				
	Cost overruns		X	X		X
	Increases in financing costs		X	X		
	Time and quality risk		X			X
	Contractor default		X			X
	Default by Concession Company	X	X			X
	Time, cost and scope of identified but related work and variations					
	Environmental damage-subsisting	X			X	
	Environmental damage-ongoing		X			
	Environmental damage-ongoing	X	X		X	X
	Protection of geological and historical objects	X				
	Force majeure	X	X		X	X
Operating risks	Government department default	X				
	Concession company default		X			
	Operator inability		X			
	Termination of concession by Concession Company	X	X	X	X	
	Environmental damage-ongoing		X			
	Force majeure event	X	X		X	
	Labor risk	X	X			
	Technology risk		X			
	Prolonged downtime during operation		X		X	
	Condition of facility (maintenance)		X		X	
Market and revenue risks	Insufficient fare income	X	X			
	Fluctuating demand of power generated	X				
	Transmission failure	X				
	Problem in bill collection	X				
	Insufficient other income	X	X	X		
	Power theft	X				
	Fluctuation of material cost (by private sector)	X	X			
	Government restriction on profit and tariff	X	X	X		
Financial risks	Inflation risk	X	X	X		
	Interest rate		X	X		
	Foreign currency exchange rate	X	X			
	Foreign currency convertibility	X				
Legal risks	Title/lease property	X	X			
	Ownership assets		X			
	Security structure				X	
	Insolvency of Concession company		X		X	
	Breach of financing documents		X		X	
	Enforceability of security				X	

	Documentation/contractual risk (conflict and arbitration, applied laws)		X		X	
Competition risk (before bid award)	Competition risk		X			

If risk allocation can be improved, it reduces not only economic costs but also the chance to enter a renegotiation process, and provides incentives for a rigorous management of the PPP (Marques & Berg, 2011; Nisar, 2007). This research also corresponds to this idea and argues that the orthodox risk allocation principle does not provide the idea of how to allocate various risks when additional agent takes part in PPP projects (for example, what are the consequences when force majeure risks in Table 2.4 are "shared"). The question is how such risk allocation principle can be enhanced to achieve more efficiency. Apart from the government and the private partner, the alternative of shifting some risks to a third party (e.g. professional agent whose core business is risk insurance and who adopts them against payment of insurance premiums) has to be considered.

By adapting the concept of risk management into PPP projects, effective risk control reduces exposure to risk and mitigates loss (Burger, et al., 2009). Risk can be managed in several ways (Organisation for Economic Co-operation and Development, 2008), including:

- Risk avoidance: the risky activity is not undertaken (e.g. when a public body opts for public procurement);
- Risk prevention: action is taken to reduce vulnerabilities. (e.g. when a PPP consortium borrows in domestic currency to avoid exchange rate risk);
- Risk transfer: risk is transferred to another party through a contractual arrangement (such as minimum traffic guarantees mentioned in section 2.2.2) but can remain within the partnership or sub-contracting to the third party.
- Risk retention: risk is retained by a specific party who, in theory, should have the incentive to reduce its cost implications. For example, a construction company can manage effectively to reduce the probability of design risks, while a government can reduce the likelihood of policy/ regulatory changes; and
- Risk insurance: financial coverage for the loss from a negative outcome

The next section will explain the instruments of insurances and securities with the introduction of liquidity in the financial flows which play an important role to allocate risks and resources for the investment of infrastructure projects, particularly when the projects encounter unexpected incidents.

2.4 Financial Instruments and Liquidity in PPP Projects

All projects require financing in order to progress. They nonetheless differ in nature and phase, and require different amount of financial resources. According to Merna & Njiru (2002), the expenditure of projects changes dramatically as the phase changes from study stages to evaluation stages. In general, a project can be seen as having 3 phases: project appraisal, project implementation/construction, and project operation. Although the shape of cash flow curve of projects may differ due to various factors, a cumulative cash flow curve in each project can be typically illustrated in Figure 2.6. This shape starts with negative cash flow in the initial phase (e.g. design stage, obtaining statutory approvals, contracting, etc.), increases considerably in financial requirements when it moves through the implementation phase (e.g. construction, operation, and maintenance), and peaks at the completion stage. Until the project breaks even, it is clear that financing from outside the project is essential. This sudden increase sometimes causes the situation that the concession projects cannot continue and eventually go into default.

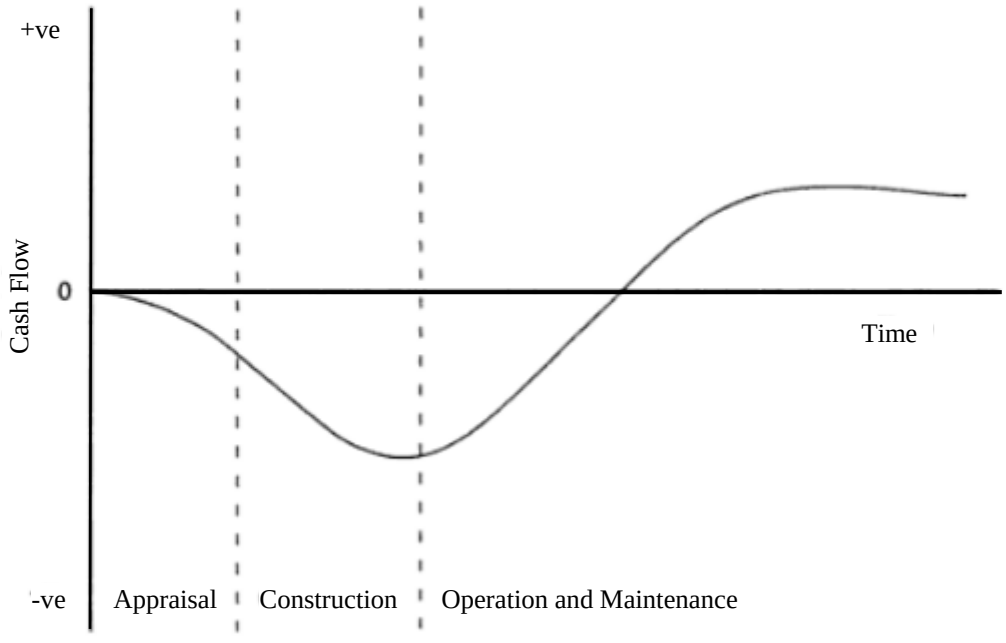


Figure 2.6. Project Cumulative Cash Flow Diagram (Merna & Njiru, 2002)

In project financing, the future cash flow plays a pivotal role to increase resources for the investment of the projects. In this sense, the use of insurance and securities, which are widely considered as financial instruments as well as a risk management tool, is studied in close and open economy with engagement of foreign market. Sometimes, projects need reinvestment (e.g., deflect remedy and reconstruction due to damage) due to force majeure, particularly during project construction and project operation. Insurance and securities enable the projects' continuation.

2.4.1 Definitions of Liquidity

Same as definitions of PPP which were discussed in 2.2.1, liquidity is a concept with a wide range of definitions, facets, and uses. In some economic literature, liquidity refers to the economic agent's ability to exchange his existing wealth for goods and services or for other assets (Williamson, 2008). Basically, as liquidity concept relates to trading, Warsh (2007) gives a definition of liquidity in the sense of traditional "trading liquidity", which relates to the ability of rapid transact, allowing financial institutions to perform their intermediation functions without exerting a material effect on prices. For example, some assets, such as money, can trade goods and services without diminution in value, therefore are highly liquid. On the other hand, liquidity can be easily understood in terms of flows (as opposed to stocks) due to the fact that an entity is liquid as long as inflows are larger or at least equal to outflows (Nikolaou, 2008). This flow is referred to as "monetary flow" from the central bank to financial systems as well as the national liquidity injected by the government to reinforce the economy.

Correspondingly, Crockett (2008) gives 3 basic definitions of liquidity which are commonly used. First is the liquidity of financial instruments, which can be exchanged for money with ease and without any loss of value. Such value can be realized by using creditworthiness to obtain external funding or by selling owned assets in the marketplace. Second, the market liquidity, is defined as the ability of the market to trade a given quantity of assets or securities, including adjusting portfolios and risk profiles, without considerably affecting their prices. Third, the monetary liquidity, which is the amount of fully liquid assets circulating in the economy. It is often measured by a broad or narrow monetary aggregate, or its ratio to nominal GDP.

According to European Central Bank (ECB), liquidity is classified into 3 types: central bank liquidity, market liquidity, and funding liquidity (Nikolaou, 2008). To begin with, central bank liquidity, typically discussed in the context of monetary policy implementation, relates to the liquidity provided by the central bank to the financial system. Market liquidity, as mentioned by Crockett (2008), is usually seen in the asset pricing literature. In line with the IMF definition, it refers to the ease with which value can be realized from assets, be bought and sold at approximately the same price determined largely by market making activities (International Monetary Fund, 2014). This definition clearly explains the liquid feature of liquidity, in which wealth is easily transferred from one agent to another. Lastly, funding liquidity, usually discussed in the context of liquidity management, is defined as the ability to settle obligations immediately when due (Nikolaou & Drehmann, 2009). For instance, a bank is illiquid if it cannot settle obligations on time. Likewise, International Monetary Fund (2008) defines the term of funding liquidity as "the ability of a solvent institution to make agreed-upon payments in a timely fashion". Borio (2000), Strahan (2008), and Brunnermeier & Pedersen (2007) define funding liquidity as the ability to raise cash within a short period of time via either selling assets or new borrowing.

With regard to the global economy, liquidity on behalf of the flow of wealth has become considerably more important. Managing liquidity is essential for undertaking desirable projects and avoiding credit rationing (Tirole, 2002a). For example, liquidity generally used in capital mobility promotes effective allocations of investment and consumption. More importantly, it creates insurance opportunities, which will be discussed later in this study. With liquidity flow contributed by the assistance of banks and insurers, the agents in economy can allocate savings into investment capital and therefore increase economic growth (Webb, et al., 2002). On the other hand, capital mobility facilitates households and firms to insure against country-specific shocks in worldwide markets while households can smooth their consumption and firms can manage their risks better (Tirole, 2002b).

This section will show features of liquidity within the context of PPP projects. With regard to PPP context, liquidity in this research has derived its importance and utilization from the definitions of both market liquidity and funding liquidity as follows. In infrastructure industry where risks and complexity of projects are concerned, liquidity

can be visualized as an "ability" to temporarily transform an asset without losing its value which subsequently allows the project sponsor to meet the obligation to launch reinvestment (e.g., remedy of defects arising from accident or catastrophe risks), enabling project continuity under the agreed terms and designated timing. This ability might support the sponsor to avoid project default, solvency problem, and hold-up problem by private party which have been serious problems for public-private involvement. On the other hand, by considering the definition of liquidity of financial instruments, liquidity referred in this research also means the "wealth" that is preservable and transferable from one party to another as "liquid asset" in forms of insurance products or securities to meet financial liabilities and thus able to withstand shocks (when cash is difficult to acquire) in an efficient and timely manner.

2.4.2 Integration of Liquidity and Risk Management in PPP Projects

When a risk event occurs, it brings negative impact of a certain degree to the project finance. In this research, the risk event which impacts project continuity (project production) and leads to reinvestment need, sometimes resulting in a shortage of liquidity, is referred to as a "liquidity shock". If the liquidity shock is substantially high, it can bring about the project freezing (a stage where a project is unable to proceed its construction or operation) or, in the worst scenario, project default or bankruptcy. By integrating conceptual ideas of liquidity management together with risk management, the project's investment decision needs to assure the sufficient liquidity throughout the planning horizon in the most cost effective way. This section will explain how the provision of liquidity has a significant impact on PPP project continuity and risk events which relate to liquidity shock.

In this section, risks related to financing arrangement of a project are highlighted. A financial manager in a PPP project is in charge of any plans regarding the project financing. Risks which can obstruct the continuation of PPP projects are grouped into two categories: risks which affect the productivity of the project and those which do not. Risks of the former category are mostly related to the construction and operation, since the productivity of concession projects depends on the revenue of user charge. However, some risks emerging during other phrase are not negligible. For example, when the

project has to be shut down due to huge accident or the instruction from the government policy. The latter category indirectly suffers the project cash flow (e.g., some legal changes which may have influence on unexpected shortfall of income or unexpected necessary expenditure) but does not substantially affect the operational capability. Some accidents can also fall into this category such as the physical damage of projects when the user' claims of bodily injury or loss related to the projects. The thorough explanation of how different sources of liquidity are supplied will be explain in the following chapters.

Since this research focuses on project financing and liquidity particularly in developing countries, the author highlights the reason why liquidity is scarce in these countries. Many countries have been suffering from underdeveloped managerial accountability, especially the project finance which inextricably links to the government's risks which may arise (e.g., political risk, legal and contractual risks).

Regarding the project finance in form of PPP, liquidity can come from 2 main sources: the government and the private investors' investment. The widespread of private investment in infrastructure projects was introduced not only in developed countries, but also in developing countries since the 1990's. By the end of 2001, developing countries had seen over $755 billion of investment flows in nearly 2500 private infrastructure projects. However, investment flows peaked in 1997 and have since dropped by more than half (Harris, 2003). The statistics proved that the demand of infrastructure is still high as well as the demand of liquidity. The government with many projects in hands are nevertheless incapable to support all projects without the supply of capital and liquidity from both domestic and international sources.

Although private finance was considered for many major projects in both developed and developing countries, developing countries generally lag behind in infrastructure development because they often lack funds from the normal sources expected in the developed countries. The main reason behind this is the lack of public funds due to the low tax base in developing countries caused by the relatively weak domestic economies with low levels of industrial and commercial investment (Merna & Njiru, 2002). Besides, in these countries where such projects are often of tremendous strategic importance, local authorities that are unfamiliar with the complexities and do not have the expertise may

be better off relying on private consortiums that have worked on similar projects (Hart, 2003). On the other hand, it is also obvious that the risks facing private investors are particularly high during the construction and operation phase. In developing countries, there is always a lack of capital and liquidity from domestic investors.

A sound financial structure of PPP requires that the debt is denominated in the same currency as the revenues of the debtor (that is, the private partner or SPV). The APMG Public-Private Partnerships Certification Program (2016) proposes that debt had better be provided by local lenders when the project revenues are denominated in local currency (unless the currency of a country is a supranational currency, as in the case of the Euro). Otherwise the project will be affected by one of the more severe and difficult to manage risks, which is foreign exchange risk (if the project is financed using a foreign currency and there is a devaluation of the local currency, this results in an increase in the amount of debt in local currency terms, which has to be returned from the devalued revenues).

However, a country without a relatively developed financial system (i.e., countries which are able to lend significant amounts for long terms), will have to rely on cross-border financing in hard currency, such as US dollars or Euros. This research shares the same idea and the hypothesis rests on the assumption that it is quite difficult for developing countries to seek for only domestic finance. The international insurers and multilateral financial institutions thus play a relevant role by providing mitigation against liquidity shock as they are not affected by domestic liquidity shortage.

In the next chapter, the liquidity provision will be further studied and distinguished by its sources. Two major acknowledged sources of liquidity are from insurance market and securities market. Even though many researchers present the risks allocated to contract parties, what kinds of risks can be transferred to the third party (e.g. insurance and securities) are still in question.

2.5 Conclusion

This chapter reviews the relevant PPP studies published in the past from fundamental theory and findings to lessons learnt and discussion. The objective of the review in this

chapter is to provide a concrete knowledge of PPP and its risk management which will become crucial to analyze and develop the model throughout the dissertation.

Development of infrastructure is the essential presumption for development of a country. Particularly in developing countries, despite lacking public funding and technology, these countries have been making efforts to improve infrastructure capacities to boost economic activities and investment as well as to raise the overall living standard and reduce poverty. Traditionally, infrastructure projects and public utilities have been established, owned, and managed by the state. Public-Private Partnership (PPP) is an alternative solution for project financing instead of the conventional sources of funding through the use of public debt, taxation or by borrowing from commercial banks and international financial institutions to deliver large scale, long term facilities and services. It can help the government overcome fiscal challenges by mobilizing private sector sources, helping improve project management on-time and on-budget.

Even though the definitions of PPP are different among countries which implement for their projects, the idea generated from the unique structure where the government utilizes the private sector's resource conceptually shares some characteristics, particularly risk sharing. To release fiscal pressure and risks borne by the government, the principal of PPP is to allocate risks to appropriate parties. The type of PPP projects is an important factor to allocate responsibilities and risks. PPP encompass a variety of contractual structures, with various degrees of risk transfer to the private sector. Even though PPP is believed to benefit from the investment, it is also found that the drawbacks of PPP, mainly coming from the consequences of risks and information asymmetry, are significant. Without the good governance and comprehensive risk management from participants, the PPP projects cannot reach their goals. It is therefore challenging for all participants to foresee and evaluate the risks in advance, especially with a long term contract like PPP.

There is a consensus in the literature regarding PPP risk allocation. They usually refer to the orthodox risk allocation principle: (1) the agent that should bear the risk is in the best position to influence and control the risky outcome; and (2), the risk should be borne by the agent able to bear the risk at the lowest cost. However, among various methods proposed by many researchers, some focus only on risks taken by either the government

or private partner. The subsequence where risks are allocated to, is out of their scope. Whereas, some authors consider the additional parties that the risks should be allocated but none of them make clear of the process when and how those additional parties should participate, and what happens if they do not. Hence, there is a gap in the academic literature regarding how risks should be subsequently handled. With the perspective of liquidity supplied from various parties involved in PPP projects, risk allocation can be explained by theoretical mechanism of liquidity supplied from markets.

Last but not least, the chapter introduces liquidity and its usage with respect to risk management. Some risks in PPP projects which affect project continuation (project productivity) leading to reinvestment need, can result in the situation called the "liquidity shock". If the project doesn't prepare sufficient liquidity, these kind of risks make the project stop (it cannot continue activity to generate income) or sometimes go bankruptcy. With the budget constraints in developing countries (e.g. limited tax power of the government and inadequate domestic finance), the study hypothesizes that international insurers and multilateral financial institutions can provide liquidity against liquidity shock as a complement to domestic liquidity shortage.

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Chapter 3

Insurance and Securities Used in PPP Infrastructure Projects

3.1 Introduction

In chapter 2, risk identification and risk sharing principle in PPP infrastructure projects are introduced and discussed. A better understanding of PPP and its risks enables not only the project sponsors, but also all concerned parties to design risk allocation programs successfully. This chapter is devoted to build up foundation of insurance and securities used in infrastructure projects when insurance becomes the important tool for risk sharing to insurers who have risk pooling capacity, whereas securities helps the project sponsor hedge financial risks that cannot be transferred via insurance. However, the thorough understanding of insurance usage is still limited among practitioners in PPP projects. The focus of this chapter is mainly the fact finding which demonstrates a general overview of insurance market. It will generate idea on how insurance, from the perspective of liquidity, allocates risks.

Section 3.2 gives the general idea on how importance of insurance in infrastructure and modern economics. Section 3.3 provides the fundamental ideas which need to be declared in 2 key areas. It starts with the insurance market and risk insurability. It is an important question to be answered: what kind of risks can be insured. Next, the products of insurance are introduced. The finding in section 3.4 exposes the extensive review of regulation relating to insurance acquisition including the case studies using the expert interview conducted in a developing country, Thailand. Lastly, roles to procure and to manage insurance from parties concerned are explored in section 3.5. These are the crucial questions to be answered to prevent misleading before developing the model in the next chapter.

3.2 Infrastructure Insurance and Economics

The importance of insurance in modern economies is undoubted and has been recognized in the past centuries (The Council of Insurance Agents & Brokers, 2010). In the infrastructure industry, the construction and operation of an infrastructure project have some substantial risks, including faulty design and construction, performance deficiencies, on-site injuries of workers, property damage, and environmental incidents (Percopo & Haller, 1999). Therefore, in many cases, sophisticated risk financing

alternatives are utilized to handle these different risks. Insurance which is a method of risk response in the form of risk transfer on a par with other key contracts has become a critical role in risk management in many countries. The integration of insurance and project financing techniques to access capital markets is gaining acceptance as investment trend.

The challenge of infrastructure project managers and policy makers often lies in designing consistent insurance programs that covers not only construction exposures, but also risks related to the operation and maintenance after the completion of constructions, by taking project financing into consideration. If the risks have not been anticipated and properly hedged, the cash flow of the project will be affected, which eventually leads to project default. Adding to the complexity is the capacity shortage of local insurance (which will be the major part of discussion in the next chapter) and risk management experience (Percopo & Haller, 1999), especially in developing countries.

Moving on to social economics' point of view, insurance is an essential element in the operation of national economies in the world today. A well-functioning insurance market plays a significant role in ensuring social and economic continuity, particularly when large-scale disasters occur (Auerswald, et al., 2005). Although insurance is valuable to the society in different ways, there is a low general awareness of the contributions of insurance to the overall economy and society. Only when a loss has occurred and compensation is expected do policymakers and the general public start valuing insurance. In fact, the provision of risk pooling, risk sharing, and risk transfer abilities as well as loss prevention actions are the most significant contributions of insurance to society, but remain largely unseen by the public (Hoppe, 2012). The council of Insurance Agents & Brokers (2010) claims that insurance can actually further serve a broad public interest beyond its prime role in business affairs and also its protection of a large part of the country's wealth. It is the necessary means by which the "disaster to an individual is shared by many, the disaster to a community shared by other communities; great catastrophes are thereby lessened, and, it may be, repaired" (Mashayekhi & Fernandes, 2007).

Hoppe (2012) raises the question of how insurance help consumers, companies and society overall. Apart from the commercial world, insurance is also vital to individuals.

He further claims that insurers insure individuals as well as commercial entities. Private individuals choose an insurance product to avoid being confronted with a financial burden when incurring damage resulting from a certain event (in the case of non-life insurance) or when they want to build up a financial reserve for a certain project and/or seek to mitigate mortality, disability and longevity risks (life and pension insurance). Lack of insurance coverage would leave individuals and firms without protection from the uncertainties of everyday life. Life, property, and other insurance coverages are essential to the financial stability, well-being and peace of mind of the average person (The Council of Insurance Agents & Brokers, 2010).

In addition, insurance can be an outstanding tool in inducing infrastructure investments to enhance prevention and response. For decades, insurance has been a key mechanism not only for aiding in recovery after damage but also for inducing infrastructure investments to make damages less likely to happen for individuals and organizations in most developed countries (Auerswald, et al., 2005). The reason behind this is, as written in all insurance policies, when accident occurs, the insurer cautiously investigates whether the insured has taken a sufficient level of care to protect his own property. Hence, the insured party has to be aware of these conditions written in the policy and be responsible to maintain the level of safety throughout the insured period, otherwise the insurer might reject the claim.

Webb et al. (2002) treat insurance as one of financial intermediaries broadly acknowledged with improving resource allocation. They claim that insurers as well as banks not only help mobilize and allocate savings, but also mitigate the negative consequences that random shocks can have on capital investment. This research takes advantage of insurance as liquidity. By reducing frictions, financial markets and intermediaries allow agents and economies to more efficiently allocate income for consumption and savings and to allocate savings across investments. If financial intermediaries can achieve these allocation goals, they increase the effective level of capital in an economy. They also enable entrepreneurs and individual savers to invest in riskier but potentially more productive technologies. The liquidity, risk pooling, and project monitoring provided by banks and insurers, consequently, may all contribute to more efficient capital allocation.

3.3 Fundamental of Insurance in PPP projects

Dickson (1983) defines insurance as a risk transfer mechanism that a party, called the insured, transfer from a state of uncertainty to a state of certainty by paying the certain cost of the insurance premium to the other party, called the insurer. Infrastructure projects generally require several types of insurance coverage, including construction all risks, operation all risks, surety and fidelity bonds, environmental liability, business interruption, workers' compensation, and political risk. In chapter 2, the general ideas of risk analysis in infrastructure project management are reviewed. Initially, risk analysis can assist the infrastructure project managers to address these diverse risk exposures in order to approve or reject any decisions since the beginning and throughout the project design, construction, operation, and maintenance of completed projects subsequently, as well as to develop risk response strategies, particularly related to project financing. Because a project involves various parties, risk analysis can help to determine the appropriate allocation of project risks. Gatti (2008) points out 3 basic strategies that the special purpose vehicle (SPV) established by the private sector to run the project, can use to mitigate the impact of risk. Level of risk is then lessen through the risk allocation via contracts to the counterparties such as concession and sub contracts. As a result, risks retained by the project sponsors shall then be minimized by sharing to insurance companies as shown in Figure 3.1. Nevertheless, Gatti (2008) suggests that insurance is supposed to be used only if it is most cost-effective to achieve risk mitigation, for example when the risk mitigation’s cost of the project using insurance is less than the risk premium expressed in interbank interest rates (the rate of interest charged on short-term loans between banks).

An infrastructure project has a number of identifiable risks. Some are reasonably within the control of one or more of the parties of the project. Others may not be within any party's reasonable control, but may be insurable, at a cost. Still others may not be insurable. The conventional wisdom in project financing is that each risk should be assumed by the party within whose control the risk most lies. Usually a party will insist on some reward equal to the risk undertaken. The characters to classify insurable risks explained in section 3.3.1 (Augenblick & Custer, 1990).

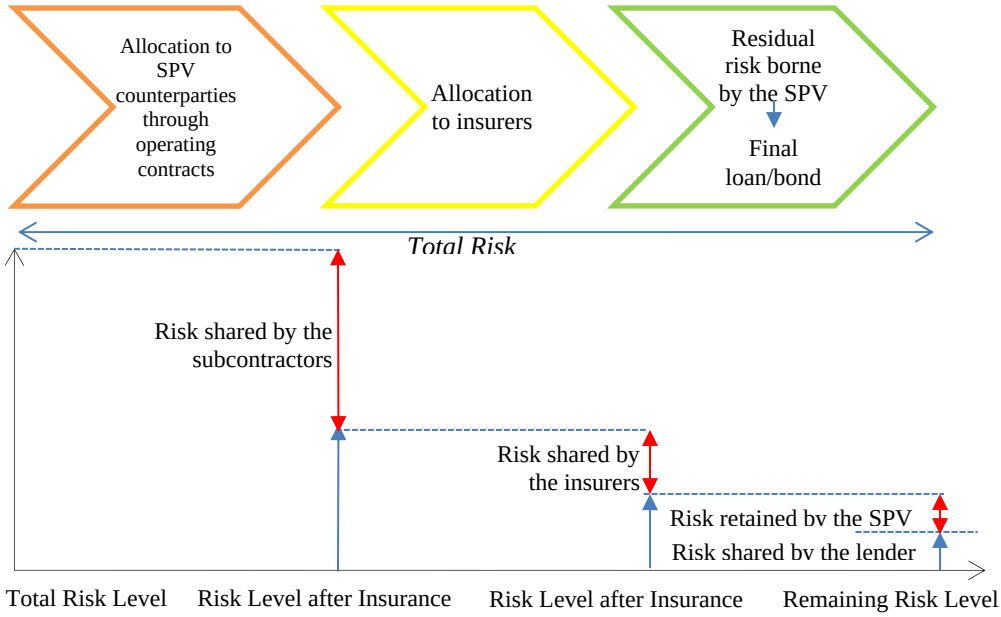

Figure 3.1. Risk Level and Risk Mitigation Strategies in PPP Projects (Zhu & Chua, 2012)

3.3.1 Insurable/ Uninsurable Risks

In order to make a right decision on selecting appropriate tools to allocate risks, according to the principle of risk identification and risk transfer element of PPP in Chapter 2, the first question to be answered before purchasing insurance is what kind of risks can be insured by insurers. There are various essential conditions that need to be considered to distinguish insurable risks from uninsurable ones. A risk can be insured only if it is not excluded by one (or more) of the following conditions (Gollier, 2003; Liu, et al., 2004):

1. *Risk Characteristics*: a risk that does not randomly occur cannot be insured because it is, for instance, an unavoidable consequence of events that have already occurred or because it depends entirely upon the choice of the insured party. For example, a manager cannot take out insurance against possible failure of his business but he can insure the interruption of the business under the agreed condition from an insurer. In other words, the risk must be "non-speculative" (occurrence of the risk will not benefit the insured party (unlike bets or speculation).

2. *Obligation of the insurer*: a risk is uninsurable if no insurer agrees to cover it under conditions considered acceptable by at least one insured party. One of the

most common reasons when the insurer consider a risk uninsurable is that the insurer cannot calculate the probability nor the impact of the risk, and therefore cannot work out a premium that the insured has to pay. Moreover, a risk is also said to be uninsurable in case of a scenario where the loss is expected too huge that no insurer want to take that risk, or the premium would be so high as to make purchasing the insurance infeasible.

3. *Affiliation of the insured party*: a risk is uninsurable if nobody accepts the conditions at least one insurer considers acceptable.

4. *Social utility of the contract*: a risk is uninsurable if its coverage is forbidden by law, if such insurance does not improve social welfare, or if it contributes to its deterioration.

Regarding the second and third conditions, to put it simple, when risks can be seen from different perspectives of insurers and insured, only risks which are mutually accepted can then be taken into further consideration as insurable risks.

In practice, the infrastructure manager is confronted with enormous challenges. It is quite difficult to identify insurability of risk since it not only relates to the mutual consent of contracting party (i.e. insurer) as listed in 4 conditions above, but also the business opportunity of insurers. For instance, from the first condition, an insurable risk has to be a “pure risk” which means it has the downside of the effect only, while “speculative risks” which provide opportunity for loss only are not covered by traditional insurance. Moreover, it has to be sudden and accidental, with statistics available for insurers to simulate historical events and calculate an insurance premium. Therefore, in the past, financial risks were typically not covered by standard hazard insurance policies as they are ones of the speculative risks. However, there is always misunderstanding because nowadays insurance companies have started to produce many programs that cover different financial risks. The business interruption insurance, for example, allows the beneficiaries of insurance (entrepreneur, government, and lenders) to allocate some risks of revenue loss due to consequences of accident.

Similar to catastrophic risks, the risks were traditionally uninsurable. Even though by definition, catastrophic risks are parts of pure risks owing to unpredictability, by considering the second condition above, their uniqueness of low probability but high magnitude makes the insurers reluctant to insure and generally put them in the exclusion condition since insurers can neither forecast the losses using the law of large numbers (which is how insurable risk is generally determined), nor calculate insurance premiums. However, catastrophic insurance program can still be separately launched by either some insurers besides the standard hazard insurance policies using financial models instead of the law of large numbers (thought such models are far less accurate than using the law of large numbers), or by some government programs. This is an example of how business opportunity of insurers make a change to the practical use of insurability from the orthodox approach.

Therefore, some insurable risks in one country might become uninsurable in other countries. However, by theoretical context, insurability can be judged according to the "technology" of each country. On the contrary, some risks which are uninsurable risks by theory, can be acceptably insured instead.

From figure 3.1, it is clear that risks can be minimized after the project allocates risks to subcontractors and insurers. The subsequent question is how residual risks left of the earlier processes can be managed. With perspective of liquidity supply, insurance is deemed to be liquidity asset in the situation that insurable risks are allocated. On the other hand, for the case of uninsurable risks, the general idea is to turn back to the risk sharing principle - risks have to be shared by the parties best able to bear and manage them. Therefore, those which cannot be transferred are borne by either public or private sector. According to Zhu & Chua (2012), residual risks borne by the SPV are recommended to be hedged by financial instruments provided from capital market. Asian Development Bank Institute summarizes the investment vehicles on private finance as shown in Table 3.1 (Inderst, 2016).

Table 3.1 Infrastructure Investment Vehicles (Inderst, 2016)

		Direct	Indirect
Equity	Listed	Shares of transport, energy, water, utility companies, etc.	Listed infrastructure fund
		MLPs, YieldCos	Investment trust
			Indices, ETFs, derivatives
	Unlisted	Direct investment in private companies/projects	Unlisted infrastructure fund, closed-end, open-end
		Co-investment	PPP fund
		Investor platforms, alliances	Fund-of-fund
Debt	Bonds	Corporate bond	Infrastructure bond fund
		Project bond, PPP bond	Trust structure
		Government infra bond	Bond indices
		Sub-sovereign, municipal bond	
	Loans	Private infrastructure debt	Infrastructure debt fund
		Project loan, PPP loan	Hybrid/ mezzanine fund
		Syndicated loan	

It has to be noted that the range of vehicles in Table 3.1 is different due to economies. The range is larger in developed markets, so the choices in some developing countries might be missing compared with the above list. The use of some securities will be explained again in chapter 5.

3.3.2 Products of Insurance

In general, infrastructure projects require diversified types of insurance coverage. In order to gain adequate coverage, consultants, insurance advisors or brokers specialized in the insurance sector are normally assigned to prepare this specific document owing to its complexity and contractual uniqueness. With different views from different professions, risk exposure in insurance involving insurability and capacity to absorb risks needs to be considered jointly. In this chapter, 3 major risks which need to be transferred regarding insurable aspects in the insurance market for PPP projects are defined as follows:

- Pure Risks
- Catastrophic Risks
- Financial Risks

Insurance policies, by definition of financial instrument, are contracts legally binding obligations by a party to conditionally transfer something of value (i.e. money) as reimbursement against losses of casualties from insurable events to the other parties on a future date. This definition accords with the transferability in the definition of liquidity mentioned above. Various types of infrastructure-related insurance products in the market are listed as follows.

Construction All Risks Insurance (CAR)/ Operation All Risks (OAR) Insurance

Sometimes, projects need reinvestment in terms of defect remedy and reconstruction due to accidental damage or force majeure, particularly during project construction and project operation. The 2 following different insurance policies enable the project's continuation when the project gets its claim due to physical loss in different stages. In construction period (often including machinery erection process), construction (or contractors) all risks insurance (CAR) covers all loss of on-site accidents which are not written in the exclusion clauses. Once the completion test has been passed, another type of insurance (with a different set of policy wordings and conditions) comes into effect when the infrastructure project operates. The loss from accidents and mistaken operations are covered under the operation all risks insurance (OAR), sometimes known as industrial all risks insurance (IAR). It has to be emphasized that the above-mentioned insurances pay for only physical claim due to accidents but do not cover consequences of revenue loss. The coverage under these policies applies not only to physical damage of the project itself but also to property damage and bodily injury occurred to the third party who uses the services.

Delay in Startup (DSU)/ Advanced Loss of Profit (ALOP) Insurance

Due to their large scale and complexity, infrastructure projects are sometimes not able to avoid the delay in construction or maintenance causing a loss in anticipated revenue. As a result, stringent conditions regarding delays in scheduled project completion (such as liquidate damages) are usually added to contracts between the financiers and principals, and particularly to those between principals and contractors. This insurance therefore offers the protection against delays arising from accidental physical damage which affect the "critical path" of the project schedule (Chengwing, 2008). Even though the loss from physical damage can be covered by purchasing CAR, the consequential loss (loss of anticipated revenue) resulting from such physical damage is always excluded. DSU and

ALOP thus benefit both principals and contractors by reducing disputes, especially when the parties liable for the accident are not clear.

Political Risk Insurance

Political risk insurance is now more available for emerging markets in many countries. Its coverage has become an alternative in PPP project development which covers the sponsor's failure on contract obligations when the failure is caused by one of the specifically defined political risk events, even though the premium rate is usually high (Chengwing, 2008). It is used to protect against selective and discriminatory acts by the host government (i.e., confiscation, expropriation, and nationalization of an investor's permanent or mobile assets, deprivation (CEND)); physical damage to assets caused by war, riot, or political violence; forced divestiture of a shareholding; and forced abandonment of a foreign enterprise from a deteriorating security (Percopo & Haller, 1999). This type of insurance also covers trade-related risks such as exchange transfer risk, currency inconvertibility, wrongful/ unfair calling of guarantee, contract repudiation or cancellation by a government buyer or supplier, non-payment by a government obligor or guarantor (Galvao, 2001).

Business interruption (BI) Insurance

This type of insurance, also known as business income insurance (BI), covers loss of gross profit (sales – variable costs – savings (net profit + fixed costs)) if during the insurance period the business is interrupted or interfered with "consequence" of loss or damage which is indemnifiable under property damage section of operation all risks insurance.

In order to purchase this insurance, the essential condition is that the project either has to have operation all risks insurance as prerequisite, or needs to extend its optional cover before the contract is signed. After the physical loss due to accident is indemnified by the operation all risks insurance, the consequential loss of income that a business suffers due to disaster-related closing of the business facility or due to the rebuilding process after a disaster is then reimbursed by this BI policy. Seen from project lenders or investors' standpoint, this insurance program can mitigate significant risks associated with a business venture and provide liquidity to secure the project from bankruptcy.

Catastrophe Insurance

Catastrophe insurance is a type of insurance which both business firms and individual residences can transfer risks against natural disasters such as floods, earthquakes, or even man-made disasters such as terrorism to insurers. In general insurance policy, the catastrophe risk is always excluded because of its uniqueness of low probability but extremely high cost resulting in difficulty to estimate the total potential loss. The insured who wants to extend the coverage needs to purchase this catastrophe insurance instead.

Unfortunately, the use of this insurance in developing countries has not been prevalent. According to the report from Munich Re (2005), low-and- middle- income countries have suffered the most in the last few decades with a number of over 95% deaths from natural disaster with the direct economic loss of US$54 billion per annum on average. The statistics also indicates that around 30% of losses (3.7% of GNP in total) in those years were covered by insurance while only 1% of losses (12.9% of GNP) in low-income countries were insured. As a consequence of this significant fatalities' numbers arising from the lack of insurance, lower-middle-income countries with exhausted tax bases, limited support from donor, and high indebtedness cannot raise enough capital to repair damage. According to the concept of liquidity, it is clear that post-disaster expense is more costly than getting prepared before the unfavorable events occur. This also became clear to the Mexican authorities after the 1985 earthquake in Mexico City, which increased the fiscal deficit of $1.9 billion over the next 4 years with the colossal expenses on rehabilitation and reconstruction (Cardenas, et al., 2007).

Owing to the great flood in Thailand in 2011, catastrophe insurance as a pre-disaster financial instrument has become more attractive not only for firms and individuals but also the infrastructure managers. Normally in concession or construction contract, there is always a clause mentioned about the force majeure or catastrophe risk. For example in the FIDIC general contract, such risks are identified but no clear mitigation method is given. The contract parties have to decide whether they want to transfer the risks via insurance or to retain it themselves.

However, it has to be noted that, as a result of the great flood, the insurance premium at that moment was considerably risen because the domestic supply of catastrophe insurance fell short as insurers and reinsurers became essentially unavailable in the Thai

market. As a result of this problem, some foreign reinsurance companies denied to reinsure properties whereas some charge significantly increased premiums. The unfavored situation pressured the government to create the "Government (or National) Catastrophe Insurance Policy" providing cover for floods, storm winds and earthquakes instead of foreign reinsurers. Such an insurance policy is further explained in detail in section 5.4.3.

Recently, the increasing trend of financial insurance has been promoted because of the feed from insurance market. From the interview conducted with insurers, the common approach usually found in the PPP projects in Thailand is that sponsors buy CAR/ OAR (these also always cover the third party liability as a substantial clause), BI, and DSU, whereas policy insurance is not prevalent in Thailand.

Modified from Zhu & Chua (2012) and Chengwing (2008), Table 3.2 distinguishes the insurance products and securities into traditional and financial insurances typically used in Thailand. The traditional insurances, such as the contractors' all risks insurance, operation all risks insurance, and the third party liability insurance are focused on only physical damages, not their consequential loss resulted from such damages. However, financial risks which are major impediments of the continuation of PPP projects are grouped into two categories: unexpected necessary expenditure, and unexpected shortfall of income. In the former category, even though it includes the physical damage of projects, the users' claims of bodily injury or loss related to the assets as well as the third party's loss are covered by the traditional insurances, whereas in the latter category, risks mostly related to revenue of concession projects are the major concern of participants, especially the project sponsors and lenders. When traditional insurance and financial insurance are fed into the PPP project, the economical results or the bankability of the project could be improved.

Table 3.2 Available Insurances and Securities in the Thai Market Modified from Zhu & Chua (2012) and Chengwing (2008) [1]

Traditional insurance	Financial insurance
Constructors' All Risks Erection All Risks	Business Interruption
Third Party Liability	Residual Value Insurance
Catastrophe Insurance / Named Peril Insurance	Revenue Risk Mitigation
Property All Risks Insurance	Contingent Capital
Physical Damage Operating All Risks	Credit Delivery Guarantees (For Renewable Energy Projects)
Political Violence Insurance	Derivatives (Futures, Forwards, Options and Swaps)
Catastrophe Insurance	Delay in Startup Advanced Loss of Profit

3.4 Regulations Relating to Insurance Acquisition: The Case Study of PPP Projects in Thailand

Some parts of law and regulation related to PPP projects in developing countries are reviewed in this section. It also explains the risks and insurance provisions related. The case of legal issue in developing country like Thailand shows the significance of insurance acquisition in risk management of infrastructure projects.

Since 1992, all infrastructure projects in Thailand has been launched under the enactment of the Private Participation in State Undertakings Act B.E. 2535 (1992) (PPSUA). However, the law, originally deemed to ensure transparency in the undertaking of large-scale PPP projects, appears to be an obstacle rather than a promoter of PPP implementation in Thailand (Likhitruangsilp, 2012). More importantly, the law does not provide any methodology for identifying, analyzing, allocating, and mitigating risks in PPP infrastructure project development, even though this is one of the most important considerations in developing PPP projects (Valentine, 2008). Risk management and its risk transfer element which are given less attention than they deserve, have also become a weakness and a major concern to be criticized because it contains insufficient measure regarding risks (Likhitruangsilp, 2012).

[1] The original table does not include Catastrophe Insurance but Political Risk Insurance. However, nowadays such a political risk insurance is not available in every country, like Thailand due to the political instability. Instead, the special product established in Thai market is the Political Violence Insurance which covers only loss due to riot (This risk is explicitly excluded in other insurance policies).

Replacement of the PPSUA was requested because the law had a complicated project approval procedure that discouraged the private investment. As a result, the new act, namely the Private Investment in State Undertaking Act B.E. 2556 (2013) (PISUA), come into effect 2 years ago. Overall, such legislation provides more sophisticated ways to better identify and allocate projects risks for both the government and private sector. The substantial improvement of the new act is to be more concerned on the fiscal purpose in order to attract more private funding into infrastructure projects. Insurance acquisition is therefore imperative for any new infrastructure project as it becomes one condition in concession to allocate insurable risks. However, the author could access neither the up-to-date PPP contract nor the provision related to insurance under the new PPP act at the time of research, so the following examples are cases before 2013. The insurance related responsibility is shown as follows.

Liability Provision in Concession contract

In the past, without the standard from the 1992 PPP Act, the state authorities in Thailand which supervises the PPP infrastructure project, such as the Mass Rapid Transit Authority (MRTA) have full right to draft and impose their own concession contract. Risk sharing therefore depends on the agreement and negotiation project by project. For example, under the highway concession contract between the Expressway and Rapid Transit Authority of Thailand (ETA) and Bangkok Expressway Public Company Limited (BECL) [2], even though there is no specific clause explicitly written for liability in infrastructure projects, the Thai government also push almost all responsibilities to as follows:

Insurance Provision in Concession Contract: Agreement for the Expressway Project

> "Except as otherwise provided in this Agreement (as between BECL and ETA) BECL shall be solely responsible for any damage suffered by users of the project or by third party arising out of the design or the use thereof or the construction or operation of the project and any action relating to the construction, operation, and maintenance of the project or the performance hereof. <u>If any legal action is brought or claim made against ETA in respect of any such damage to users thereof or third parties or for the payment of</u>

[2] The Company undertakes construction and project management of expressways under a 30-year contract with the Expressway and Rapid Transit Authority of Thailand (ETA), starting from March 1, 1990 to February 28, 2020.

any damages, BECL shall assist ETA in defending such action or claim at BECL's own cost and if ETA has already paid for the same, BECL shall reimburse ETA forthwith." (clause17.1: Liability with respect to users and third parties)

"The provision of clause 17.1 shall not extend to any damage to the extent that it does not arise out of the construction or operation of the project or is caused or contributed to by any action or inaction of ETA itself." (clause17.2)

Insurance Provision in Concession Contract: Agreement for the MRTA Project

"Insurance
BMCL agrees that within a period not to exceed 30 days from the date of Financial Close, BMCL shall procure All Risks and Third Party Liability Insurance from an insurance company operating in Thailand whereby BMCL shall be the insured party with MRTA and the Lenders as co-insured and co-beneficiaries. Such insurance policies shall be valid throughout the Contract Period and shall cover the following (clause 4.2 e):

(1) Property "All Risks" throughout the Contract Period for the entire MRTA Initial System including the Civil Infrastructure….
(2) Third Party Liability which shall cover risks of all kinds which may arise from claims, demand and property damage, bodily injure or loss of life including any damage which may be a result or consequence of the performance of BMCL during Phase1 and operation by BMCL during Phase2"

In this respect, BMCL shall be responsible for payment of the insurance premiums and related expense.

The above case studies of Thailand show that, in practice, the government as a contracting party usually pushes the responsibility to manage construction and operation risks to the concessionaires, or adds insurance provision in PPP contracts which enforces the concessionaires to purchase and manage the insurance.

3.5 Roles of PPP Parties Involves in Infrastructure Insurance

This part examines the roles and responsibilities in insurance provision concerning the relationships between the primary parties: Special Purpose Vehicle (SPV) and the government, and the relationship of the SPV with the insurers and lenders. The objectives are to review the activities performed by each professions separately as well as to establish how relationships are managed between private sector organizations within the concession, and between the private organizations and the public sector.

Before moving on to the explanation of roles, there are some features of insurance regarding the decision making of each party that need to be understood. Even if a risk is insurable, many factors related to the insurance policy need to be considered, including: adequate limit; cost/premium; insurance period; negotiation and flexibility of an insurance policy; limitations and exclusions of the insurance policy; sharing risks with insurers (deductible); ability and honor of insurer to indemnify the damage to the insured (security); insurance gaps and overlaps (Liu, et al., 2004). The deducible is usually one of the most sensible things in placing insurance. The reasons for deductibles are twofold: firstly to eliminate small claims, where administration costs can sometimes exceed the claim itself; and secondly, to ensure that the insured will comply with their obligation to avoid claims by taking all reasonable precautions to prevent loss (Howard, 1997). Thus, it encourages better risk management especially in risk reduction.

Overview, insurance markets are greatly dependent on the flow of information from one party to another. Information on policyholder risk characteristics is always transferred from insurance intermediaries (i.e. brokers and agents) to primary insurance companies which issue policies. Primary insurers, on the other hand, need to provide information to global reinsurers when they purchase reinsurance. This is often done through reinsurance brokers (Cummins & Mahul, 2009). The roles and perspectives of parties involved in the risks according to their own background and benefits are explained as following:

Insured Party

There is always misunderstanding between these two words: “Insured Party or Insured” and “Insuring Party” which is often seen in contract. The first one is defined as the status

under the insurance policy as the first party who is paid by his or her insurer as the second party in the event of an accident, injury, or loss occurs. The latter is defined as anyone who is responsible to make a contact and purchase insurance for a project. To put it simple, an insured can be more than one party including the government agency, the sponsor or contractor, the lender, the supplier and any other parties nominated under the insurance policy. They are under protection altogether when someone sues them even though the insuring party is only a contractor who makes a contract agreement with the insurer. The word "insuring party" can be found regularly in construction contract such as FIDIC.

Nowadays insurance is always mentioned in construction contract. This trend has become prevalent including the projects under the PPP scheme. Generally in insurance acquisition, insurance can be purchase by either a government authority, known as "Owner-controlled Insurance Program (OCIP)", or a project sponsor/ contractor, known as "Contractor-controlled Insurance Program (CCIP)". So far, there has been no clear standard or regulation which assigns a party to buy insurance. For example, in construction period, general contract such as the International Federation of Consulting Engineers (FIDIC) or the Engineers Joint Contract Documents Committee (EJCDC) has a clause that risks of losses (unanticipated causes not the fault of and beyond the control of contractor and owner, referred to as force majeure in such contract; see Yelton (2014)) are supposed to be transferred to the insurer. Accordingly, insurance acquisition depends on mainly negotiation or the matter of concession/ construction contract designed by the owner. Nevertheless, for the projects which the government gets involved, there is always a provision written in construction contract that insurance is necessarily required and in the near future, insurance will be a crucial part in every project of infrastructure due to the new PPP act.

Lenders

Obviously, the problem of insurance acquisition appears greater from the lenders' standpoint. It is always the lenders who direct the need for insurance within the project finance arrangements and is therefore the party that will determine how much and what type of coverage should be purchased (Chengwing, 2008). For instance, in the past, the concession contract of the Thailand international airport, Suvarnabhumi contained the provision of insurance assigned by Japan Bank for International

Cooperation (JBIC). Project finance lenders want to ensure that they have priority on any claim proceeds and maintain the subrogation rights throughout the period of policy. According to Chengwing (2008, p. 7), this can be achieved through:

- Loss payee clauses which nominate the project finance lender as the recipient of any claims money
- Assignment of policies, where the lenders are assigned the rights of the policy, as opposed to merely the proceeds
- Joint insureds, where the lenders become joint policy holders
- Warranty waivers, which allow for payments of claims to the lenders in certain circumstances, despite the fact that the insurers could deny liability to the owners as policy holders because of a breach of condition on warranty in the policy
- Lenders interest policy to circumvent a legitimate denial of a claim due to policy holder's breach of policy conditions (vitiation).

Sponsors

In general, the sponsors always wants to meet the requirements of the lenders in order to obtain the required financing. This is mainly due to the fact that in project financing the extent of sponsor's liability is limited to the equity contributed to the project via the project vehicle. Lenders have constrained or no lien on the sponsor's assets outside the project vehicle, so as far as the sponsor is concerned the insurance program for the project has no impact on its own corporate insurances.

However, the project sponsor (through the project vehicle) usually takes the lead role in arranging project insurances as it has the ultimate responsibility for ensuring that it meets the requirements of the financing program. If this responsibility is passed onto the contractor, problems arise as the contractor is not the party to the financing agreement and therefore will not be in a position to properly assess the insurance needs of the project. Besides, it will be very difficult for the project vehicle to obtain stand-alone DSU cover that does not follow a property program. To eliminate these issues the project vehicle will initiate an owner controlled insurance programme (OCIP) which will act as an 'umbrella' over the entire project site.

Host Government/ Government Agency

The host government may be indirect sponsors and therefore have a vested interest in the insurances of the project. The government can simultaneously be part of the project and the regulatory role governing its activities.

In the past there was a case that the Thai government required insurance to be taken out with local insurers and/or in local currency by adding a specific clause. Later on, due to the transparency issue, the government removed the clause for the subsequent projects. At present, for Thailand cases, on the one hand, the state authority which is able to develop and manage its own contract (e.g., the Electricity Generating Authority of Thailand (EGAT)), has its own explicit contract provision which contains a condition that every contractor who wants to bid for any project owned by EGAT has to prepare bidding document including insurance. A contractor who wants to bid for such a project can buy an insurance from any Thai insurers in the market but the policy has to cover all require risks as written in construction contract. On the other hand, some mega projects such as the New Bangkok International Airport (NBIA) or currently known as Suvarnabhumi Airport project had a unique insurance. Regarding there were many contractors and sub-contractors working at the same area, the owner, Airports of Thailand Public Company Limited, intended to control a single insurance in order to prevent conflicts of overlapping coverage, then it launched the plan that every contractor and sub-contractor had to buy insurance from one designated company, namely Dhipaya Insurance. The reason behind was that the government had a share in that company as a state enterprise (but this approach is no longer available anymore because other companies complained that such a move was monopoly and not fair for them). By this approach, the contractors could negotiate only minor agreement.

In addition, there were very few projects which the government gets involved and say nothing about insurance, even a very small project, because the government wants to avoid argument and dispute in the court when claims arise. At least in some instances, governments might require the private companies to purchase insurance. Government-mandated purchases of insurance has a purpose of ensuring that injured parties will be compensated (The Council of Insurance Agents & Brokers, 2010).

However, in Thailand, there is another approach to purchase insurance. An insurance broker also plays an important role since many insurance policies often have unique and elaborate conditions, which are difficult to understand by the contractor and the owner. So, such brokers take step to assist in finding and comparing policies from insurance companies, arrange the document and match insurance provisions on their behalves. All the mentioned approaches can be explained in the following figure.

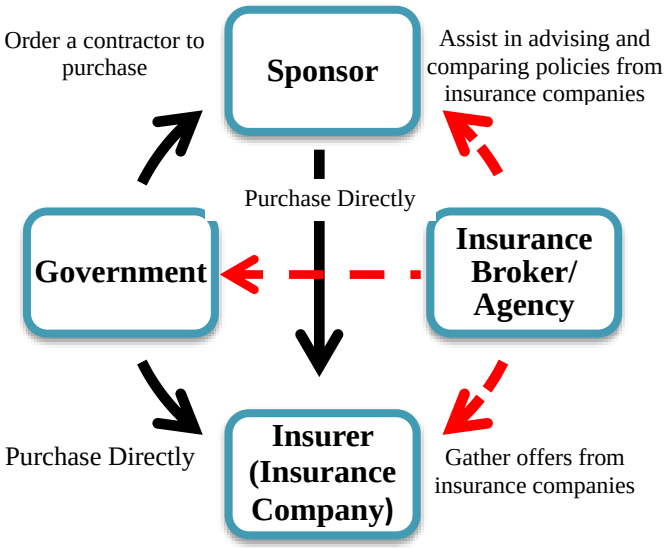

Figure 3.2 Players in Insurance Acquisition

In Thailand, the insurance policy can be drafted in 2 methods: (1) Tailor Made Policy – for this type of policy, an insurance company drafts clauses and format as mutual consent with a buyer. This kind of policy can be found only in mega projects because insurance companies see that it wastes time and money to draft policies for every project. (2) Standard Policy – for this type of policy, an insurance company uses the same format and clause for every project. Only few clauses and monetary terms can be changed. This policy can be found in common construction projects such as condominiums, factories, etc.

Insurer

The insurance industry has years of experience addressing project risks that includes writing coverage for completion risk, operating risk, political risk, off-take risk, and residual value (Percopo & Haller, 1999). When brought into the front end of the

development process, insurance companies can help structure deals and increase the probability that they will obtain financing.

Insurers can also play a significant role in the project financing process beyond offering insurance coverage. They have the capacity to take on risks that lenders may not want. Where an insurer has a significant global presence, it has experience in dealing with local currencies and governments, and making investments in local markets. With the responsibility to honor the terms of insurance policies, the insurer is unlikely to diminish its presence in a local market. In this sense, insurers also may be a party who is able to serve as sources of equity. An insurer may be willing to make a direct or indirect equity investment in a project. As an example of indirect equity funding, American International Group, Inc. (AIG) subsidiaries develop, market, and manage several direct equity funds for emerging markets. AIG has rapidly become a leading sponsor of private equity funds for emerging markets.

More traditionally, insurers provide financing through insurance. The ability to offer financial resources does not minimize the benefits insurers can provide a project through insurance coverages. Completion and operating risk coverage have long been a part of the project financing process. These coverages help ensure that projects are completed on time and within budget critical issues to project finance lenders. Additionally, a project's ability to minimize cost impacts its cash flow and its ability to service debt (Outreville, 1990).

The important finding that the author finds in insurance market is the possible amount of coverage and the number of policies underwritten by domestic insurance companies in a period of time are limited. Apart from the characteristic of insurance business which normally share risks to insurance market (as risks are contingent and their premium is significantly low compared to the sum insured), one of the biggest constrain is the law legislated in a country. It is found that, in Thailand, there is a restriction that the sum insured which an insurance company can underwrite has to be proportional to its authorized capital. Hence, the disadvantage of a developing country is, there are not so many big firms which can underwrite insurance for projects alone, particularly the high sum insured in PPP infrastructure megaprojects. When the risks insured in a country reach the maximum capacity of domestic market, the insurers have no choice but to share

such risks to international market by the process of reinsurance or coinsurance. The advocate of the international market will be explain again in the following chapters.

Insurance Intermediaries (Insurance Agents and Insurance Brokers)
Insurance intermediaries are categorized as either insurance brokers or insurance agents who represent consumers in insurance transactions. They are contracted with multiple insurance companies so they can focus on matching their client's needs with the most suitable insurance products

Insurance agents are licensed to conduct business on behalf of insurance companies. They represent the insurer in the insurance acquisition process and operate under agency agreement underwritten by the insurer. The relationship between an insurer and an agent can be in different forms. Agents in some markets are independent and able to work with more than one insurance company. Agents in other markets either represent a single insurance company or sell a single line of business for different companies (The Council of Insurance Agents & Brokers, 2010).

According to the Council of Insurance Agents & Brokers (2010), insurance brokers work for the clients (insurance policyholder) in the insurance acquisition process and act independently in relation to insurers. The brokers help clients by presenting them with alternatives terms from a range of products proposed by insurers. Insurance brokers normally work with several companies to get quotes from them to guide clients in determining the adequate insurance policy.

With the assistance of insurance agents or insurance brokers, the insurance buyers will have more choice which provide different terms (coverage, deducible) and premium. This also increases the bargaining power of the buyers to obtain the most suitable policy with a reasonable price in the market.

3.6 Conclusion

In order to understand how the project sponsor can deal with risks in PPP infrastructure projects effectively, this chapter presents fact findings and reviews background

knowledge relevant to the research area of insurance in Public-Private Partnership (PPP) projects. The risk allocation is still focused on the PPP risk identification and the principle of risk allocation in the previous chapter.

It is found that the level of risks in a PPP infrastructure project can be reduced by: 1) allocated to subcontractor, 2) the risks which can be insures (known as insurable risks) are then shared to insurers in insurance markets and 3) the residual risks are then allocated to the party best able to manage with the lowest cost. The definitions of insurable risk were explored from both theory and practical perspectives. The problem to identify insurability always arise mostly when a risk is not mutually consent to be covered by the insurers in the insurance market. It is found that, in practice, business opportunity of insurers strongly influences their willingness to insure even though the risk does not follow the 4 conditions of being an insurable risk. However, theoretically, insurability can be judged according to the "technology" of each economy.

On the one hand, insurance policies, by definition of financial instrument which are legally binding obligations by a party to conditionally transfer something of value (i.e. money) as reimbursement against losses of casualties (such as fire, earthquake, and other insurable events) to the other party on a future date, are therefore a representative of liquidity to allocate insurable risks in PPP projects. On the other hand, those risks which cannot be transferred are borne by either public or private sector. It was further explored that the residual risks borne by the SPV are recommended to be hedged by liquid assets in forms of financial instruments provided by capital market or the government.

Moreover, the chapter demonstrated how contract provisions are related to insurance acquisition of PPP projects. Fact finding from the case study of Thailand's PPP projects shows that risk transfer by using insurance has become more popular lately after the new PPP Act was promulgated. Even though the insurance is not compulsorily enforced to all project, some projects contain a provision to instruct the project sponsor to take responsibility of acquiring and managing the insurance while other projects assign an important checklist as a guideline for project agencies to assess their project risks. This is a kind of signaling for such authorities not to overlook purchasing insurance.

Furthermore, the chapter also explored and used of different types of insurance regarding PPP projects and summarized the roles of relevant parties. So far insurers have launched plenty of choices of insurance in market for buyers. Types and coverages being purchased always depends on the complexity of the project and degree of risk they want to take. For example, the operator can buy Industrial All Risks insurance which can cover all risk except some terms written in exclusion parts (big loss such as war, riot) or just buy Fire insurance if he judges that a project is not convoluted.

Last but not least, it is found that the advocation of the international insurance market to absorb risks from domestic market (especially in developing countries) is important since there is always a law restriction that the sum insured which an insurance company can underwrite has to be proportional to its authorized capital. This constraint limits the amount of liquidity that the domestic insurers can supply to the projects in a country.

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Chapter 4

The Liquid Asset Pricing Model for PPP Infrastructure Projects

4.1 Introduction

In this chapter, the financial theoretical model which basically helps project owners and investors on investment decision making and measuring the feasibility and potential of the project is studied, aiming to understand the mechanism of risk allocation with liquidity as a risk transfer tool. The Liquid Asset Pricing Model (LAPM) is opted to be used in this research based on the fact that it is not only directly associated with liquidity provision, but also more suitable than other models (such as the conventional Capital Asset Pricing Model (CAPM) widely used) in many aspects. In this chapter focusing on the context of PPP, the special purpose companies (SPCs) (or the project sponsors called in this model) play an important role to rationally preserve liquidity asset in hand to meet contingent liquidity shock resulting from some risks in PPP projects in order to prevent the project freezing (a stage where a project is unable to proceed its construction or operation) in the future.

The chapter is structured as follows. First of all, in section 4.2 the Holmstrom and Tirole's Liquid Asset Pricing Model (LAPM) is formulated. The allocation of risks between the project sponsors and domestic investors is analyzed through a framework based on this model. In section 4.3, the liquidity analysis model further provides insights on the transfer of risk and financial assets to additional parties: the government, and the international investors. Beyond the role to monitor markets, and to provide liquidity nationwide as a form of intervention to remedy the market failure against unfavorable events (i.e. catastrophe), the unique responsibility to alleviate liquidity shortage with instruments, like infrastructure bond or catastrophe bond against PPP infrastructure projects also fall upon the government in different approaches. Similarly, it is possible that risks might come from the government's lack of financial capabilities and resources to provide for reinvestment needs. This risk of government's inability to pay its debts, referred to as sovereign risk (which also leads to liquidity shock), can be weathered with the aid from domestic consumers and multilateral financial institutions. Lastly, the result built upon the above analysis of the liquidity supply from various parties including the project sponsors, investors, the governmental and international participations, then constitutes the proposed alternative risk allocation principle in section 4.4.

4.2 The Liquid Asset Pricing Model for PPP Projects

The analysis in the following section mainly uses the well-known Liquidity Asset Pricing Model (LAPM) developed by Holmström & Tirole (2011). They developed this new model for project investment decisions by considering an intermediate period between project launch and completion in which reinvestment need is anticipated to cover risks. The basic theory behind LAPM is that risk allocation is planned for before the risks occur.

By integrating risk management as a part of liquidity management, Holmström & Tirole (2011) claim that their model is superior compared to other traditional models such as the Capital Asset Pricing Model (CAPM), because their ex-ante provision of liquidity takes into account how much cash to keep in comprise hand to cover unexpected liquidity needs and how to deal with uncertainty. Furthermore, CAPM does not provide rigorous financial arrangement approach. In general, the CAPM model is utilized to describe relationship between investment risks and expected return and to price risky securities (Pamane & Vikpossi, 2014). However, the CAPM is built upon the assumption that an economic entity is risk averse with criticism regarding how suitable the calculation of its risk premium is (Holmström & Tirole, 2001). By assuming risk-neutral agents in the alternative model, Liquid Asset Pricing Model (LAPM) eliminates this issue and provides insight of liquidity determination instead. Additionally, another assumption of CAPM is that the project is assumed to be a static variable that automatically yields the expected returns if completed. In many projects however, problems and risks are encountered midway through the project. Accordingly, the CAPM fails to consider the occurrence of uncertainty and risk allocation during the progress of the project, and thus does not compensate for additional costs incurred by uncertainty and risks as the project progresses.

With regards to PPP context, this underlines that risks and liquidity should be managed jointly, since the sponsor's investment is decided so that adequate liquidity to withstand PPP risks is assured throughout the project timeline with the most cost effective way. In this case, the cost of capital in future states encompasses the sponsors' investment plan. Following dynamic approach of LAPM, the investments are divided into 3 stages where the interim stage represents the contingent claim corresponding to when the liquidity

shock coming from risk events such as construction risk, operational risk, or catastrophe risk arises. With the perspective of liquidity, the risk allocation is therefore more realistic and suitable to apply to long-term PPP projects.

In this section, the Liquid Asset Pricing Model (LAPM), comprised by several features and parties, is introduced. The workable model will be explained, starting from the basic settings under the framework and assumptions of PPP projects' investment in section 4.2.1. By simplifying the reality's complexities, the early model shows how inside liquidity is generated within cooperative firms, followed by the case in section 4.3 where government takes actions and when international market of liquidity is taken into account.

4.2.1 Basic Assumptions and Settings

The model consists of three timings, indexed $t = 0, 1, 2$. As the LAPM is useful in terms of risk management, this basic setting allows the LAPM to consider the reinvestment due to possibility of risk occurring in the intermediate period of investment between the project launch and completion. There is neither discounting nor inflation between the periods. This assumption implies that there is no time preference which helps remove unnecessary calculation without any effect with behavior of agents. All economic agents in the model which are risk neutral in the economy have an identical utility function

$$U(c_0, c_1, c_2) = c_0 + c_1 + c_2 \tag{4.1}$$

There are only 2 parties involved in this basic model; the "project sponsor" and "investors" (e.g., banks or multilateral financial institutions (MFIs) as project lenders, individual investors and insurers). Apparently, the private sector's goal to invest capital, time, and effort in such PPP project is to achieve a return on their investment in generating adequate future cash flows to cover initial capital costs and continuity finance charges, thereby providing enough profit to invest in future projects and pay shareholder dividends. However, based on the contract theory, an additional assumption that there is no risk premium in this model is given. By assuming this, the investors satisfy the contract only if they get the initial investment they made back when the project completes (no positive return is required).

The model assumes that a project needs one unit of investment capital and that all projects in the economy is homogeneous. With this concept in mind, further assumption is that a representative PPP project, (known as "project" in this model), has date-0 endowment or assets worth A in the economy. These assets (regarding PPP concept, provided by only sponsors instead of the government in tradition procurement) are liquid in the sense that they have the same value in hands of sponsors as in hands of investors. Investors can procure the liquidity at each date from the agents who are given the endowment at each date. If I units of project is undertaken, the left over $I - A$ is borrowed from the investors in the economy. The following analysis highlights how important of determinants in sponsors' investment and the impact that credit rationing has on sponsors' choice of investment. Furthermore, the result of this analysis can show the benefits and costs when a project uses different kinds of collateral when the information asymmetry is also taken into account shown in the next section.

4.2.2 Information Asymmetry (Moral Hazard) Problem

As the theoretical model in this study is designed to deal with the project-related resource distribution between the project sponsor and investors, it is explained based on the principal-agent problem. Hence, before moving on to the formulation of the LAPM, it is necessary to prove that the information asymmetry (moral hazard) problem exists and all assumptions used throughout the model consider the prevention of this phenomena. The principle-agent problem emerges when two contractual parties have different levels of information. This section simply employs the two-period (date 0 and date 2) standard model of investment (the initial period and payoff period) with moral hazard.

With no discount rate between periods, an investment project with constant-return-to-scale[1] technology initially requires contributions from the sponsor and investors at date 0. At date 2, once the project is completed, the investment return is distributed to the promised participants. If the additional investment is successfully procured, the project continues and yields verifiable income either of $RI > 0$ or 0 at date 2. If the additional investment failed to be procured, the project is liquidated and yields no income.

[1] If a technology exhibits constant returns to scale, then average cost will be constant in output.

In practice, the project sponsors are much more aware of the project details than investors. The information asymmetry arising when the investors has less information than the sponsor results in the problem known as moral hazard that the sponsor may exploit to divert the project resource for the maximization of his own benefit. The solution to prevent this moral hazard is to assign the sponsor's benefit in the form of incentive obtained only when the project is successful.

In order to illustrate the incompleteness of financial market in this model, suppose the sponsor chooses either 'effort' or 'shirk' to invest the funds at date 0. If 'effort' is chosen with the cost I, the probability of success is p_H , and if 'shirk' is chosen, the probability of success is p_L which is lower than p_H. With the latter choice, the sponsor gains the private benefit B as the actual investment costs only $I - B$ (i.e., he chooses the inefficient technology which leaves some investment for his private consumption instead of choosing the superior technology). Such a private benefit can be enjoyed only by the sponsor since the investor do not value it. The choices the sponsor made can be structured as shown in Figure 4.1. The choice of 'shirk' yields the negative expected return of investment, while 'effort' yields the positive expected return at date 2:

$$p_H R - I > 0 > p_L R - (I - B) \tag{4.2}$$

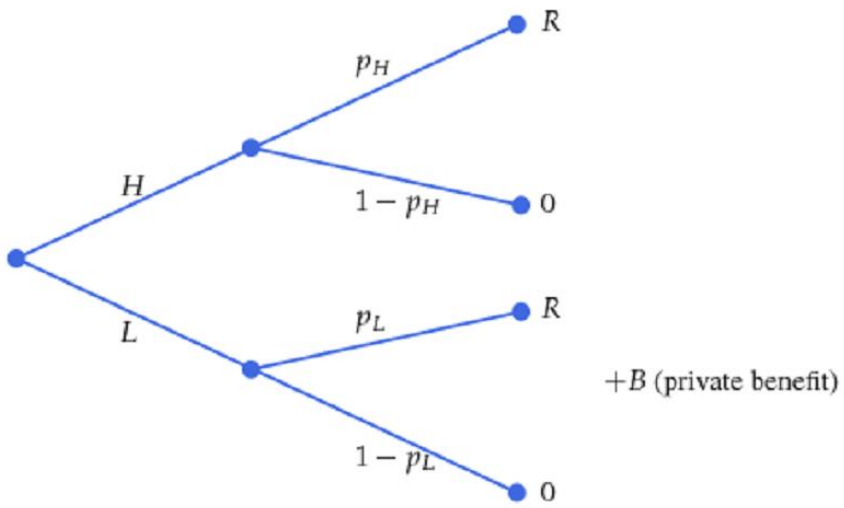

Figure 4.1 Sponsor's Choices of Investment

Investors and the sponsor can determine the contingent allocation of the fruit of project. Let the outcome of the project, X_s be the sponsor's payoff at date 2 if the project succeeds and X_f if fails. Following the ordinary setting of corporate finance, the sponsor is

protected by limited liability and hence $X_s, X_f \geq 0$. The project is invested only when 'effort' is chosen. The incentive compatible condition where the sponsor chooses 'effort' is

$$p_H X_s + (1 - p_H)X_f \geq p_L X_S + (1 - p_H)X_f + B \tag{4.3}$$

The investors' payoff is $Y_s = R - X_s$ if the project is successful and $Y_f = -X_f$ if it fails. With the probability of both outcomes, the participation condition that investors are willing to invest is

$$p_H(R - X_s) + (1 - p_H)\big(R - X_f\big) \geq I - A \tag{4.4}$$

In other words, (4.4) guarantees that the investors can at least break even. However, the highlight of this section relies on the behavior of the sponsor. The constraint (4.3) can be simplified into the incentive compatible:

$$X_s - X_f \geq \frac{B}{\Delta p} \tag{4.5}$$

where

$$\Delta p = p_H - p_L > 0 \tag{4.6}$$

In this model where the moral hazard problem exists, the investment plan is changed upon the agreed contract because of the sponsor's selfishness tempted by more hidden information. The only way to remove the doubt of such a sponsor's morally hazardous action is to allocate the sponsor only private benefit (B), called "nonpledgeable income", gained when the project is successful by paying the sponsor the minimum rent (but still necessary to be positive as being paired with incentive compatibility constraint). From (4.5) the sponsor's rent is minimized when $X_f = 0$, resulting in $X_s = \frac{B}{\Delta p}$. From (4.6), it is clear that the project has more possibility to be successful if the sponsor does not take advantage on hidden information.

On the other hand, such rent which investors are paid to, is called "pledgeable income, Z_0", defined as the maximum expected amount that investors can be promised when sponsor receives the minimum rent. The pledgeable income can be rewritten in the form

$$Z_0 = p_H(R - \frac{B}{\Delta p}) \quad (4.7)$$

As denoted the total return at date 2 = $Z_1 = p_H R$, the sponsor's minimum rent is

$$Z_1 - Z_0 = p_H \frac{B}{\Delta p} > 0 \quad (4.8)$$

The positive wedge points out that the sponsor does not divert fund immorally as long as the equation (4.8) is binding (the sponsor's nonpledgeable income is positive).

4.2.3 Model of Liquidity Demand: Two Liquidity Shocks

From the previous section, the settings of the model are introduced together with the principal-agent problem, moral hazard. In this section, the basic model of liquidity demand is presented. Since insurance is treated as liquidity in this study, PPP projects' demand of liquidity to insure themselves against credit rationing is presented and analyzed. Additionally, the workhorse model of liquidity demand which will be fundamentally used throughout this dissertation is initially proposed following the optimization between initial investment scale and continuation scale.

Apart from other traditional financial models which projects never demand liquidity, in this model, the project or sponsor's demand of liquidity is given in anticipation of future financing needs either because it is cheaper to get financing earlier or because it is risky that such financing might not be available if the project waits until the need for funding arises. The general set up of this section is that the time frame consists of three dates $t = 0, 1, 2$, and the single good being considered is insurance (security) products.

At date 0, in practice, the special purpose vehicle (SPV) realizes the project value which enables the sponsor to decide the project's investment, I. This amount is the scale of the project in the model. To simply illustrate, in the insurance contract for example, this amount can be viewed as the project's "sum insured", which is the maximum amount that insurance company will compensate when loss occurs. It should be noted that, from the perspective of insurance, it is always mislead that this amount is supposed to be equal to the project value or number shown in Bill of Quantity (BOQ). In fact, it is possible to

be higher due to the insurer's consideration if the insurer sees that the loss of project has potential to become higher than the project value itself. For example, the project which is built in downtown possibly has more chance to ruin not only its own property, but also the neighborhood asset nearby. In contrast, sometimes, the insurer may deny to underwrite the whole amount of the project if risks seem too high to bear. Instead, the insurer limits the amount of sum insured within its acceptable amount and let the insured absorb the remaining risks[2]. Such a project is the so-called "underinsured" project. Consequently, the insurance premium is then calculated after 2 parties make agreement of sum insured and details of coverage. Although it is against the practical method to purchase insurance, the model is analyzed here without premium cost first. The modification is provided in the next section.

At date 1 (an intermediate period), suppose the project encounters risks of casualties (e.g. an accident or reinvestment need), an additional fund has to be reinvested in order to carry on the project, the state of nature, and any payoffs are also realized. Such a reinvestment need, referred to as "liquidity shock", $\rho > 0$ arises. This value ρ determines how much more needs to be invested (per unit of investment) to continue. The variable cost of production ρ in this model includes payments for intermediate inputs, labor, and so forth. Continuing at a smaller scale than I is feasible. Let $i(\rho) \leq I$ denote the "continuation scale" when the liquidity shock is ρ. With insurance context, the parameters $i(\rho)$ represents the unit of insurance claim reimbursed in case the project has to remedy deflect which allows the project to continue again. When the liquidity shock ρ becomes greater than the "pledgeable amount" ρ_0, the project cannot raise funding from outside to continue the project unless such funding has been prepared in advance. Continuing at this scale requires a date-1 investment $\rho i(\rho)$ and yields a date-2 public (pledgeable) return $\rho_0 i(\rho)$ and an illiquid (private) return $(\rho_1 - \rho_0) i(\rho)$ to the sponsor. There are no returns from the portion of the project that is not carried forward. If $i(\rho) = 0$, the project is abandoned and the payout, both pledgeable and private benefit, turn out to be zero. The processes from date 0 through date 2 can be illustrated as shown in Figure 4.2.

[2] The under insured project might encounter big loss which is over the sum insured value. This case is interesting when the government and the sponsor mutually agree terms of insurance policy. The residual amount of loss, as a sovereign risk, needs liquidity aided by the government to alleviate. Such an aid becomes domestic outside liquidity analyzed in the chapter 5.

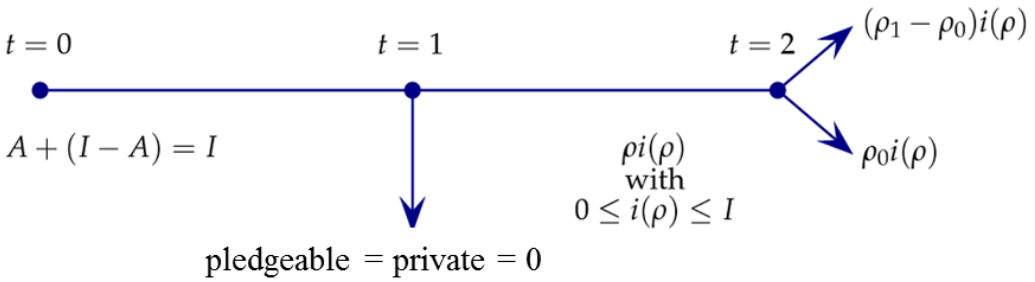

Figure 4.2 Time Frame of Investment

According to the process at date $t = 0$, the parameters I and $i(\rho)$ are determined. Practically, the premium is calculated and adjusted every year. However, to simplify the model, the premium is kept constant until date 2. After observing ρ at date $t = 1$, the project can decide at what scale to operate.

Next, in order to understand the concept of LAPM model, the simple case of "two liquidity shocks" is introduced. Since the shocks are distinguished into only high shock (ρ_H) and low shock (ρ_L); the liquidity shock, ρ here can only be either high or low. The first constraint is

$$0 < \rho_L < \rho_0 < \rho_H < \rho_1 \tag{4.9}$$

The parameter ρ_0 is added to identify the necessity of pre-arranged financing. Shocks below ρ_0 do not require such advanced arrangement, while shocks above ρ_0 do. Let f_L and f_H denote the probabilities of a low and a high liquidity shock respectively. Consequently, an additional assumption is

$$\rho_0 < \min\left\{1 + f_L \rho_L + f_H \rho_H, \frac{1 + \rho_L f_L}{f_L}\right\} < \rho_1 \tag{4.10}$$

Recall that the case which ρ is less than ρ_0 is neglected because the project becomes self-financing and desirable in the low-shock state. Therefore, the project can weather shock itself so its continuation is always possible. In the middle term of (4.10), the minimum expected cost of carrying out one unit of the project to completion is taken into account. Two possible cases are:

1) If the project is enabled to continue in both states, the first term in the brackets represents such an expected cost to completion.

2) If the project is continued only in the low state, the second term measures the expected cost per unit completed.

The inequality on the right implies that the project is "socially desirable", while the inequality on the left assures that the project is not "self-financing". The self-financing means investment requires a positive contribution from the sponsor and the pledgeable income does not cover the total cost of investment regardless of the optimal policy. A self-financing project is neglected in this study because it means the project could be carried out at any scale, leading to unbounded payoffs.

The model is designed as a second-best contract; resources are scarce and have to be traded off between the initial investment scale and the ability to withstand higher liquidity shocks. The level of investment I and the continuation scales $i_L \equiv i(\rho_L)$ and $i_H \equiv i(\rho_H)$ (both $\leq I$) correspond to the low and high liquidity shocks respectively. A contract specifies final payments to investors all the liquid returns $\rho_0 i(\rho)$, leaving the sponsor to enjoy only the illiquid part $(\rho_1 - \rho_0)i(\rho)$. The reason behind is because the return on internal liquid funds exceeds the market rate (which is 0 in this model).

The second-best solution solves:

$$max_{\{I,i_L,i_H\}}\{ f_L(\rho_1 - \rho_L)i_L + f_H(\rho_1 - \rho_H)i_H - I\} \tag{4.11}$$

Subject to

$$\{f_L(\rho_0 - \rho_L)i_L + f_H(\rho_0 - \rho_H)i_H\} \geq I - A \tag{4.12}$$

$$0 \leq i_L, i_H \leq I \tag{4.13}$$

The objective function is to maximize the expected social return of the investment. Owing to the fact that social welfare is maximized when all projects in an economy maximize total project value, indirectly, the mechanism is to maximize the private benefit of the sponsor as investors earn no benefit from market when interest rate equals 0 mentioned in the assumption. By substituting the budget constraint (4.12) into the objective function (4.11) in order to eliminate I, the sponsor's expected rent can be solved. Although the sponsor's rent, which equals his expected net utility, is considered

as the objective, the developed model not only establishes the sponsor's utility maximization, but also solves the resource allocation problem between the initial investment scale, I and the continuation scale, i. The trade-off between these 2 parameters by sparing liquidity thus results in reduction of the initial investment scale.

Due to the budget constraint, when the low shock occurs, the project pays the investors $\rho_0 - \rho_L > 0$, whereas when the high shock occurs, investors pay the project $\rho_H - \rho_0 > 0$ per unit of continued investment as insurance.

By adding a liquidity demand to standard financial competence shown above, it evidently emphasizes how important the project must plan for its liquidity. Projects demand liquidity because they want to insure themselves against credit rationing which occurs due to a wedge between the pledgeable income to investors and the total income to the project. If the cost of continuing a project falls between the pledgeable income and the total income, projects can continue only when funding has been arranged in advance.

4.2.4 Inside Liquidity, Outside Liquidity, and Liquidity Premia

The model development in the previous section apparently becomes one important step of asset liability management of the investment. This section starts with the short introduction: what are "inside" and "outside" liquidity? In addition to liquidity premia, the implication of these 3 features has to be explained before moving to the extensive case and analysis.

Inside Liquidity, Outside Liquidity

The idea of inside and outside liquidity referred to in this research is originally given by Holmström & Tirole (2011). In their study, a distinction between inside (aggregate) liquidity and outside (aggregate) liquidity depends on the source of the pledgeable income. When the pledgeable income is generated within the corporate sector, the claims on it constitute inside liquidity. On the other hand, other claims on goods and services outside the corporate sector (i.e. consumers own assets unrelated to the corporate sector, the government, and international financial market) constitute outside liquidity. The benefit of existing outside liquidity is that the sponsors are able to save some of their

date-0 endowment to insure, at least partially, against a high liquidity shock at date 1. The analysis from this point on to the end of chapter 4 will show the situation when there is no outside liquidity in the economy, but only inside liquidity generated from corporate firms. The condition limits resource of the sponsor's and investors' endowments to store within the so-called close economy.

In the previous section, the basic model of liquidity demand is presented. For this section, sufficiency and cost of limited pledgeability for those supplying liquidity is then analysed into 2 following aspects. First, the maximum pledgeable amount of income that is available to back up promises of future liquidity, called the economy's aggregate liquidity, as well as its investment plan are studied. In such a case when not only a project but all projects are hit by the same aggregate liquidity shock, those projects are assumed identical and each gets hit by the same liquidity shock, which can be either high ($\rho_H > \rho_0$) or low ($\rho_L < \rho_0$). This means that all projects can continue in the low-shock state, but none can continue in the high-shock state if there is neither inside liquidity in that state nor outside liquidity. Secondly, how the corporate sector can coordinate the use of available aggregate liquidity adequacy in each state of nature is analysed.

To further consider the mechanism of project's providing inside liquidity among themselves, the next step of LAPM treats the whole PPP projects as well as their sponsors alike in a country as a continuum of identical projects and sponsors with unit mass. To put it simply, a continuum of identical economic agents is a representative of the whole population used in maximization problem. In other words, in a close economy, the project with a single sponsor in study therefore makes decision on behalf of all PPP projects of a country.

In Holmström & Tirole's book, various situations and assumptions of shock are analysed. It is shown that when the productive sector is a net lender ($I - A < 0$, where A is the aggregate endowment of the sponsors), they are not able to provide sufficient aggregate liquidity. From equation (4.12), expected date-1 net return of the corporate sector is negative, and thus that the corporate sector does not have sufficient assets to support the proposed plan. On the other hand, when the corporate sector is a net borrower ($I - A > 0$), the presence of aggregate liquidity shortages depends on the stochastic structure of

the firms' liquidity shocks. If all uncertainty is idiosyncratic and there is a continuum of firms, there is always enough aggregate inside liquidity. In this case, firms can meet their demand for liquidity simply by holding a fraction of the market portfolio. At the other extreme, when there is only aggregate uncertainty and all firms are hit by the same shock, there is always a shortage of aggregate liquidity. This creates a demand for outside liquidity, such as government bonds, which will be a vital part to control a liquidity premium discussed in the following section.

State Prices and Liquidity Premia

Next, the supply of liquidity is directly related to the "state prices". Namely, the state prices are directly derived from the state of nature which is unknown but account for a local economic fluctuations when investment's decision is made (date 0), but is revealed later at the intermediate stage (date 1). For example, if date 0 the investors expect a high liquidity shock at date 1, then the state price of liquidity would increase as to compensate the opportunity cost of consuming date 1 endowments. The state prices are necessary to determine the liquidity premium in the market.

Inside liquidity will always be in short supply, with a shortage of aggregate liquidity, some sources of outside liquidity are necessary. Competitive bidding among projects will raise up the price of liquidity inevitably, resulting in a liquidity premium. In other words, liquidity premium lubricates liquidity holders to convert supply of liquidity and then to finance the domestic aggregate shortage of liquidity instead of their own consumption. A simple analysis of how the liquidity premium is determined and how it affects the investment decisions of firms when the outside liquidity (for example, government bonds boosted up by the government's ability to tax citizens) is exogenous will be provided in the next section.

4.2.5 Model of Liquidity Demand with Liquidity Premium

One of the goals of this study is to find the sufficient level of liquidity to meet corporate demand due to the second-best production plans, however, sometimes the corporate sector are unable to provide enough liquidity on its own. For instant, the situation when all projects in economy are hit by the same aggregate liquidity shock, leading to short

supply of inside liquidity among projects. In that case, corporate sectors have no choice but turn to find other alternative to supply liquidity. With a deficiency of aggregate liquidity, competition among projects will bid up the price of this liquidity since sources of outside liquidity is scarce, eventually resulting in a liquidity premium.

Moving on to the case that such liquidity premium also influences the insurance pricing of finite number of j concession projects. Let the state, ω revealed at date 1, the probability distribution of state of nature, ω is $f(\omega)$, and the state price $s(\omega) \geq 1$, the date 0 realized at date 1 price of liquidity is $s(\omega)f(\omega)$. Each project, indexed by j as a "representative project", is characterized by 3 parameters $\{\rho_j(\omega), \rho_{j0}(\omega), \rho_{j1}(\omega)\}$ where $\rho_{j0}(\omega)$ is the pledgeable payoff returned to investors at date 2, $\rho_{j1}(\omega)$ is the total payoff at date 2, $\rho_j(\omega)$ is the liquidity shock or reinvestment needed in the aggregate state. All the numbers are per unit of investment $i_j(\omega)$. With the strictly positive wedge between total return and pleadgeable return to investors

$$\rho_{j0}(\omega) < \rho_{j1}(\omega) \tag{4.14}$$

From this part, an additional assumption is made. Concession projects are grouped into only 2 types: the "regular" projects and "contrarian" projects. The contrarian projects are the projects which always supply liquidity even in the aggregate shock state whilst the regular projects always demand liquidity. They can be classified by the following 2 conditions:

1) If $\rho_{j0}(\omega) - \rho_j(\omega) < 0$ the project*s* in economy cannot continue because they have not enough liquidity, the representative project is therefore classified as a regular project (which is the main highlight in the model).
2) If $\rho_{j0}(\omega) - \rho_j(\omega) > 0$ the projects in economy can continue because they have enough liquidity, the representative project is therefore classified as a contrarian project.

With an additional assumption that $\rho_{j0}(\omega) \neq \rho_j(\omega)$ for all j, every project has to fall into either one of those categories.

To simplify equation, the sign of the difference between pledgeable return and liquidity shock of the representative project is taken into account regardless of whether all projects

in economy demand or supply liquidity. If the representative project (sponsor) demands liquidity (i.e. the supply of inside liquidity from the contrarian projects are all depleted by the demand from regular projects), outside liquidity is required.

Equilibrium Analysis with LAPM

This part presents the LAPM equilibrium between aggregate liquidity demand and supply. From the previous section, without the supplementary supply of outside liquidity, an equilibrium condition cannot be met since the aggregate demand of liquidity is greater than how much the projects can supply. By this assumption, the source of outside liquidity in the form of asset $\{L_k\}$, k=1, 2,…, K is introduced. Each provides liquidity $L_k(\omega) > 0$ in the state, ω. At this modification, with the outside liquidity which is still treated as exogenous source, the aggregate supply of liquidity in state ω is:

$$L_s(\omega) = \sum_{\omega} \rho_{j0}(\omega)\, i_j(\omega) + \sum_{\omega} L_k(\omega) \tag{4.15}$$

The aggregate demand of liquidity in state ω is:

$$L_D(\omega) = \sum_{\omega} \rho_j(\omega)\, i_j(\omega) \tag{4.16}$$

The equilibrium can be achieved with a condition that $s(\omega) \geq 1$ because the regular project can obtain the liquidity it needs only when it pays for liquidity premium as mentioned in 4.2.4.

Given the state price and all equilibrium conditions above, the utility maximization of the project is

$$\max_{\{I_j,\, i_j(\cdot)\}} \sum_{\omega} [\rho_{j1}(\omega) - \rho_j(\omega)]\, i_j(\omega) f(\omega) \tag{4.17}$$

Subject to the budget constraint:

$$\sum_{\omega} [\rho_j(\omega) - \rho_{j0}(\omega)]\, i_j(\omega) s(\omega) f(\omega) \geq I_j - A_j \tag{4.18}$$

$$0 \leq i_j(\omega) \leq I_j \text{ for all } \omega$$

Note that, the objective function can be viewed as to maximize the sponsor's expected payoff because when the budget constraint binds, it equals the social surplus.

Same as the program in section 4.2.3 (which considers only one sponsor and investors as agents in one project), the extended projects' utility maximization above can help the sponsors and investors solve the resource allocation between initial investment, I_j and continuation $i_j(\omega)$ when contracts at date 0 are made contingent on ω.

In addition to the above program, the date-0 price for a unit of the exogenous asset L_k , where the unit is defined as the amount of asset that in expectation delivers one unit of liquidity at date 1, is obtained by solving:

$$\mathrm{q}_k = \frac{\sum_\omega L_k(\omega)\mathrm{s}(\omega)\mathrm{f}(\omega)}{\sum_\omega L_k(\omega)\mathrm{f}(\omega)} \tag{4.19}$$

This price q_k is the price that the regular project which already exhausted its inside liquidity is willing to pay in order to get the exogenous financing. Because $\mathrm{s}(\omega) \geq 1$ and by assumption, the outside sources of liquidity deliver non-negative liquidity in each state of nature, the price of the exogenous asset q_k results in a strictly positive liquidity premium $\mathrm{q}_k - 1 \geq 0$ whenever there is the positive amount of liquidity supplied by asset k.

4.2.6 General Equilibrium of LAPM: with Considering Consumers' Investment

In addition to the project sponsor and investors, this part considers the additional party, consumers, as individuals who do not invested in the project directly but provide wealth to society depending on their endowment at each date. This additional party plays a vital role as outside domestic liquidity suppliers (the other outside domestic liquidity supplier is the government which is later explained in section 4.3). The general equilibrium model is then used as a tool to analyze the following case when inside domestic liquidity generated from corporate firms is not enough but the wealth comes from exogenous consumers instead. The LAPM in this section is still based on the assumption that the resource of each period is limited in the closed economy. To be more specific, this means that all resources produced within society will always stay inside the economy. Hence, the converted endowments from consumers play very important role in liquidity provision. This section will present the model considering the project's decision on initial

investment scale and continuation scale with assistance of general equilibrium analysis between demand and supply of liquidity.

Equilibrium Analysis.

The concept of this analysis bases on the assumption that equilibrium between aggregate liquidity demand and supply in the close economy can be met when the excess demand on the corporate sector's side is equal by the supply of outside liquidity. For convenience, variables from this part will be accordingly seen as demand-related ones.

The modification is made by changing perspectives. By viewing the project as selecting its demand for liquidity $\ell_j(\omega)$ in that state ω instead of selecting a continuation scale $i_j(\omega)$ in state ω, the equation for the demand for liquidity is defined by:

$$\ell_j(\omega) \equiv \quad [\rho_j(\omega) - \rho_{j0}(\omega)]i_j(\omega) \tag{4.20}$$

In states where $\rho_j(\omega) - \rho_{j0}(\omega) < 0$, the project supplies liquidity.

Assume $\rho_j(\omega) - \rho_{j0}(\omega) \neq 0$ for technical convenience. With the change of variables (4.20), the constraint $0 \leq i_j(\omega) \leq I_j$ can then be expressed as

$$0 \leq \frac{\ell_j(\omega)}{\rho_j(\omega) - \rho_{j0}(\omega)} \leq I_j \tag{4.21}$$

Note that this constraint forces $\ell_j(\omega)$ to have the same sign as $\rho_j(\omega) - \rho_{j0}(\omega)$ as required by (4.20).

Project *j*'s payoff in state ω becomes

$$\mathcal{U}_j(I_j, \ell_j(\omega), \omega) = [\rho_j(\omega) - \rho_{j0}(\omega)]i_j(\omega) = \frac{\rho_{j1}(\omega) - \rho_{j0}(\omega)}{\rho_j(\omega) - \rho_{j0}(\omega)}\ell_j(\omega) \tag{4.22}$$

For every project *j* we assume that there is an upper bound $\overline{I_j}$ on the initial investment level. This assumption guarantees the compactness of the set of feasible investments. Thus, project *j*'s investment set is defined as:

$$\Phi_j \equiv \left\{ I_j, \ell_j(\cdot) \middle| 0 \leq I_j \leq \overline{I_j}, 0 \leq \frac{\ell_j(\omega)}{\rho_j(\omega) - \rho_{j0}(\omega)} \leq I_j \text{ for every } \omega \right\} \tag{4.23}$$

Note that Φ_j is determined by primitives alone (including $\overline{I_j}$ as defined later).

The exogenously given liquid assets $L(\omega) \geq 0$ could be owned by the government and hence indirectly owned by the consumers and sponsors. For simplicity, this section assumes that all of the outside liquidity is owned only by the consumers (because if sponsors are included, there is always private benefits which cannot be transferred. The government supply of domestic outside liquidity is then analyzed in the next section, 4.3.), and that the total amount of outside liquidity is strictly positive:

$$L(\omega) \equiv \sum_k L_k(\omega) > 0 \tag{4.24}$$

Project j's choice problem is

$$\max_{\{I_j, \ell_j(\cdot)\}} \sum_{\omega} [\rho_{j1}(\omega) - \rho_j(\omega)]\ i_j(\omega)\mathrm{f}(\omega) \tag{4.25}$$

Subject to

$$I_j + \ell_j(\omega)\mathrm{s}(\omega)\mathrm{f}(\omega) \leq A_j \tag{4.26}$$

and

$$\{I_j, \ell_j(\cdot)\} \in \Phi_j \tag{4.27}$$

On the other hand, with all consumers identical, the representative consumer solves

$$\max_{\{c_0, c_0(\cdot)\}} \left\{ c_0 + \sum_{\omega} [c_1(\omega) + c_2(\omega)]\, f(\omega) \right\} \tag{4.28}$$

subject to

$$c_0 + \sum_{\omega} [c_1(\omega) + c_2(\omega)]\, f(\omega) \leq A^0 + A^1 + A^2 + \sum_k L(\omega)(s(\omega) - 1) f(\omega) \tag{4.29}$$

$$c_0, c_1(\omega), c_2(\omega) \geq 0 \tag{4.30}$$

Here A^0, A^1, A^2 are the representative consumer's endowed incomes in the 3 periods. These endowments are sufficiently large so that the price of consumption at each date is

equal to 1 (the normalized price of date-0 consumption). The endowed incomes are non-pledgeable. By contrast, from (4.29), the amount of outside liquidity $L(\omega)$ that consumers own earns rents or generates wealth from securing commitments to fund reinvestments. The value of the rent in the budget constraint is equal to the liquidity premium $(s(\omega)-1)f(\omega)$per unit which the project has to pay to purchase consumer's liquidity. In other words, the consumers receive additional utility from consumption at date 1 provided by this rent of liquidity. This assumes that $L(\omega)$is not consumed (or rather, it is capital with a predetermined allocation of consumption benefits, which cannot be reallocated). The reason why this formulation is used is that consumption out of $L(\omega)$, which also can act as collateral, would have to be treated separately from consumption out of non-pledgeable endowment income. This would add notation, without changing anything materially.

Regarding each date, rational consumers opt to consume with different amount (i.e., $c_0, c_1(\omega), c_2(\omega)$) and there is no storage that enables consumptions to be allocated. As a result, the amount of endowments left to invest with projects are up to the amount of consumption. The economy's resource constraints are:
At date 0:

$$c_0 + \sum_j (I_j - A_j) \leq A^0 \tag{4.31}$$

At date 1:

$$c_1(\omega) + \sum_j \rho_j(\omega) i_j(\omega) \equiv c_1(\omega) + \sum_j \rho_j(\omega) \frac{\ell_j(\omega)}{\rho_j(\omega) - \rho_{j0}(\omega)} \leq A^1 \tag{4.32}$$

At date 2:

$$c_2(\omega) - \sum_j \rho_{j0}(\omega) i_j(\omega) \equiv c_2(\omega) - \sum_j \rho_{j0}(\omega) \frac{\ell_j(\omega)}{\rho_j(\omega) - \rho_{j0}(\omega)} \leq A^2 \tag{4.33}$$

The consumers' date-0 endowment is allocated between only consumption and the projects' initial investments. However, the consumers' date-1 endowment is allocated between consumption and the projects' reinvestments. Finally, at date 2, the consumers consume their date-2 endowment and the pledgeable income of projects.

Beside the resource constraints above, the amount of aggregate liquidity available in the economy in each state is constrained by the exogenous outside liquidity:

$$\sum_j \ell_j(\omega) \leq L(\omega) \text{ for every } \omega \tag{4.34}$$

The case of consumers' participation in the economy can be modeled by LAPM with the general equilibrium analysis which simultaneously considers the utility maximization of a representative project together with the utility maximization from the consumers. In equilibrium, both utility maximizations subject to combined sets of resource constraints. On one hand, the liquidity-deprived projects are able to get opportunity to raise fund from a very large supplied source of liquidity. On the other hand, consumers in economy can also benefit from additional utility from consumption endowments which are contingent to the state of nature ω (at date 1).

In fact, the governments of many developing countries historically held the view that the financial systems they had inherited could not serve their countries' development needs adequately; accordingly, during the past 30 years, they directed considerable efforts to change the structure of these financial systems and to control their operations in order to channel savings to such investments which were considered a priority in their development programs (Outreville, 1990).

However, the allocation of demand and supply between the projects and the consumers above always mismatches. As the consumer's endowments cannot be preserved nor transferred from each date (for example, from date 0 to date 1), in reality liquidity supply sometimes cannot be transferred in time and becomes wasted. The next section will present the role of the government as a mediator who has taxing power to manage this problem, as well as the role of international insurers and international financial institutes to supply liquidity to a domestic liquidity shortage.

4.3 Outside Supply of Liquidity for Infrastructure Concession Projects

Previously in section 4.2, the basic idea of liquidity is given. The shortage of liquidity supply within cooperate firms, called a shortage of inside liquidity, induces the project to seek for other sources of liquidity. In this section, the scope of the study is broaden into an economy with globally free access international financial market. The role of governments[3] and international organizations (including the non-profit ones such as the World Bank, as well as the international insurers which can be seen as private enterprises to supply liquidity) supplying outside liquidity[4] will be analyzed. The first objective of this section is to apply the LAPM in order to explain and place emphasis on the essential role of governments in concession projects. Beyond the role to monitor markets, and to provide liquidity nationwide as a form of intervention to remedy the market failure against unfavorable events (i.e. catastrophe), the unique responsibility to alleviate liquidity shortage with instruments, like insurances and bond against PPP infrastructure projects in hands also fall upon the government in different approaches. The unique of the government's ability to provide liquidity ex post which gives it a potential advantage over privately supplied liquidity is then explained.

Second, following up with the involvement of the international liquidity suppliers, for example foreign insurers, the economic significance of domestic and international insurance markets in developing countries is also analyzed with the LAPM model. The interchange between domestic and international liquidity to meet the alleviate liquidity shock are highlighted. Thereafter, the LAPM solution will show the conditions to mitigate liquidity shock aiming to run the project continuation at full scale.

[3] In this research, the government is included a state-owned enterprise (SOE) which is a legal entity that is created by the government in order to partake in commercial activities on the government's behalf. A state-owned enterprise (SOE) can be either wholly or partially owned by a government and is typically earmarked to participate in commercial activities.

[4] In Holmström & Tirole (2011), outside liquidity is from 3 different sources. However, consumers own assets unrelated to the corporate sector (which is the biggest component of household wealth of home ownership in the US), is remarkable in business analysis but negligible and out of scope of this study of PPP analysis. They claimed that when homeowners takes loans using their houses as collateral it tends to increase the supply of liquidity by creating opportunity for others to invest in the asset. Nevertheless, such pledgeable income generated from housing such as home equity loans is irrelevant and deserve to be ignored because this research focuses on the investment in developing countries.

4.3.1 LAPM in PPP projects: The Supply of Government Subsidy

Based on the broad picture of the government's role as the sole source of outside liquidity discussed in the previous section, this section describes the concept of public supply of liquidity. Such government's intervention policy can, at an abstract level, be viewed as remedying the waste of liquidity. Sometimes, consumers have the funds needed for insurance payments at date 1, but the corporate sector may not offer enough financial claims with which consumers can back up funding commitments at date 0, therefore creates a demand for outside liquidity. The LAPM in this section analyses how the government, seen as a financial intermediary (or referred as an "insurance broker" in the original work of Holmström & Tirole) between consumers and sponsors in need of insurances against liquidity shocks, considers the amount of liquidity supply for PPP infrastructure projects.

Practically, the government's supply of liquidity comes in a variety of arrangements. For instance, it can come through industry and banking bailouts, deposit insurance, the discount window, open-market operations, implicit insurance against major accidents or epidemics, unemployment insurance, social security (Holmström & Tirole, 2011). Particularly in this research, insurances and bonds are the apparent examples. With these instruments, the government can intervene the market when there is a shortage of liquidity supply from missing contract between consumers and project sponsors. The reason behind this is because the consumers cannot pledge their future income, so the government, instead, acts like an intermediary who can use the taxation on behalf of consumers to transform the consumer's future income into pledgeable income. For example, the Federal Reserve System (Fed), in 1999, offered state-contingent liquidity by issuing call options, because it feared that the computer systems might break down due to the so-called "Y2K problem", causing chaos in the financial markets (Holmström & Tirole, 2011).

What is the superiority of the government's supply of liquidity over that of the private sector? The major difference between the government's supply of liquidity to the private sector's is that the private sector has to decide on the supply of liquidity before the state of nature is known, while the government can wait and see whether the aggregate shock

is high or low before taxing consumers. In other words, the government is able to act ex-post whereas firms are only able to act ex-ante, thus the government does not have to identify the state in advance. Only if the aggregate shock is high does the government need to step in and offer liquidity. This reduces the cost of providing liquidity without losing any of its insurance benefits. For this reason, the public sector may be able to produce liquidity more efficiently than the private sector.

To illustrate, for instance, at date 0, the government issues a non-contingent bond of which face value is returned to buyers no matter what state of nature at date 1 is. The income of selling bond is then distributed to develop the country. If at date 1, the liquidity is low, the bond acquired by sponsors is unused and its value goes to the investors. In contrast, if at date 1 the liquidity shock is high, the bond holders sell the bond back to cover their shock. In both cases, the government realizes the state of nature and redeems the bond using taxation. Even though the government gains advantage of taxation power, it has to carefully consider the possibility and efficiency to supply its liquidity because there is also tradeoff from the above transactions. Whenever the government uses power of taxation transforming some of the future income of consumers into pledgeable income before allocating to any activities, the "deadweight loss of taxation" inevitably arises.

The next question is how to identify what amount is considered effective. To gain insights into the effectiveness of these instruments, the simple criteria is to compare the price of liquidity provided by the government to the deadweight loss of taxation. Since the government has an exclusive right to pledge the citizen in terms of taxation on behalf of all consumers in the country, consequently, the government can invest in projects in hands, including infrastructure projects at date 0. In this research, however, assume that the additional deadweight loss, λ per unit of tax raised is a result of using taxation for the purpose of alleviating national liquidity shock. There are various practical methods for the government to supply liquidity including insurance (other methods will be explained in chapter 5). For simplicity, in this section all such supports are assumed as liquidity supply in terms of bond. The bond which is guaranteed not to be default (its default risk or the chance of the debt not being paid back is extremely small) is counted as "non-contingent bond" and the bond which is uncertain to default or get paid back is counted as "contingent bond".

Based on Holmström & Tirole's model, suppose additional liquidity in the private sector requires an investment (a so-called "silo") to preserve. Then the private sector's marginal cost of supplying liquidity will be determined by the cost of building additional silos, a cost analogous to the non-contingent bond. Let private investment cost = c^{silo}. In the first case, when the government could only issue non-contingent bonds, it would be more efficient for the private sector to build silos than to use government supplied liquidity if $c^{silo} < q^{nc} = 1 + \lambda$ (because of the cheaper unit price of liquidity).

In contrast, moving on to the situation that the government could issue only state-contingent bonds, it pays 1 if the aggregate shock is high $\rho = \rho_H$, and pays 0 if the aggregate shock is low. The public sector's cost of supplying liquidity is then $q^c = f_H(1 + \lambda)$. Thus, the government by taking the probability when the high state occurs into account, will be able to supply liquidity more efficiently than the private sector whenever

$$f_H \leq \frac{c^{silo}}{\lambda}\text{ , for every } \omega\text{, with } s(\omega)\text{= 1 , if the constraint is slack} \qquad (4.35)$$

Therefore, the government has to consider to use tax income effectively, otherwise the country will pay a heavy price for its failure.

Even though there are arguments cited in many research (Cummins., 2006; Sykes & Gron, 2002; Selden, 1993; Harrington & Niehaus, 2001) concerning whether the government should play a more prominent role in supplying insurance (such as to cover natural disaster), such measurement has been applied in many countries already. The principle to help the government decide when it should provide the public supply of liquidity is proposed in chapter 5.

4.3.2 LAPM in PPP projects: The Supply of International Suppliers

The theoretical model used in this section proposes the extension of LAPM into open economy. The original model rests on a shortage of aggregate liquidity within a country. Hence, the additional assumptions and conditions used in this section are as follows. First, as the model is used to delineate the role of international financial institutes and international insurers in providing liquidity, it is very important to assume that a shortage

of liquidity within a country has no effect on the outside liquidity provided by the international market because it is considered as idiosyncratic and the supply of international market cannot be in shortage.

Second, the objective function used in this section is modified to help the sponsor and investors make a decision on the project's initial investment scale *I*, and the continuation scale $i(\omega)$ as in previous section, together with the demand for the international liquidity $t^{\$}(\omega)$. The pleadgeable income in this section has to be considered from two different sources: domestic and international. However, the question is how domestic and international liquidity (e.g. insurance) can be distinguished? Regarding this issue there are now two sources of insurance: the domestic insurers only use the domestic liquidity whereas the foreign insurers use the foreign liquidity. Following this idea, it is essential to explain the meaning of currency and types of consumption goods before moving on to introduce variables.

Liquidity with different currency: peso and dollar

In section 4.3.1 the analysis proposes that whenever the sponsors are under crisis of lacking liquidity supply, the government has to consider to supply liquidity itself by using tax income effectively. Within the limited amount where the government's cost of providing bond is not higher than the country's deadweight loss of taxation, the government can effectively provide the outside liquidity in terms of infrastructure bonds or catastrophe bond. The supply of liquidity generated from the corporate sponsors and the government is considered as domestic supply of liquidity, hereby in this section called as "liquidity in peso". Beyond that stage, based on the assumption of no shortage of liquidity in the international market (insurance and securities instruments are always available) leading to no increased premium as discussed above, the residual demand of liquidity (after the government taking up the projects) is overcome through the international financing hereby in this section called as "liquidity in dollar". The addition assumption based on Holmström & Tirole's original model is that there are two kinds of consumption goods as follows:

- Tradable goods, which both foreigners as well as domestic residents consume. These goods are called "dollar goods" or simply "dollars". In this research, for example, insurances issued by international insurers fall in this category.

- Nontradable goods, which are consumed only by domestic residents. These goods are at times called “peso goods” or “pesos”. In this research, for example, insurances issued by domestic insurers fall in this category.

In this research, when reinvestment in a PPP project is needed, the liquidity shock in peso goods which can be financed through both domestic and international liquidity is supplied by domestic and international insurers, while liquidity shock in dollar goods is assumed zero and out of scope of the study. All variables in dollars are indexed with “$” sign whereas those in peso are non-indexed.

The model still has 3 periods, indexed $t = 0, 1, 2$ as analyzed above. All economic agents which are risk neutral in the economy care only the sum of their consumption from all periods and demand zero expected rate of return from investments. However, the highlight of this session is from the addition assumption of 2 sources of outside liquidity and 2 products: tradable and nontradable goods, utilities have to be divided into:

The utility function of foreign investors is

$$\sum_{t=0}^{2} c_t^{\$} \tag{4.36}$$

On the other hand, the utility function of domestic residents who view tradable and nontradable goods as perfect substitutes is

$$\sum_{t=0}^{2} [c_t^{\$} + c_t] \tag{4.37}$$

In this session, the variables introduced in section 4.2 and variables from addition assumption above are listed as following:

- I = Initial investment scale of the project at date 0
- A = Project sponsor’s endowment or asset at date 0
- $\rho(\omega)$ = Liquidity shock (in peso goods) per unit of investment
- $i(\omega)$ = Continuation scale of the project at date 1
- $t^{\$}(\omega)$ = Amount of international liquidity transformed into domestic liquidity
- $\rho_1(\omega)$ = Total return per unit of the investment

- $\rho_0(\omega)$ = Pledgeable income of domestic investors per unit of the investment
- $\rho_0^{\$}(\omega)$ = Pledgeable income of international investors per unit of the investment
- $s(\omega)$ = State price per unit of domestic liquidity
- $s^{\$}(\omega)$ = State price per unit of international liquidity
- e_0 = Exchange rate of a unit international into a domestic good at date 0
- L = Exogenous government's supply of domestic liquidity at date 1
- $L^{\$}$ = Exogenous international insurer's supply of international liquidity at date1

All variables are contingent on the state of nature ω, which is unknown at date 0 but realized at date 1.

At date 0, in a project which requires initial investments I, the representative project sponsor contributes a peso endowment A and leaves the rest I-A to be completed by investors (assume that there is no dollar initial investment $I^{\$}$ and dollar endowment $A^{\$}$). With the additional exchange rate e_0 (the relative peso price of dollar at date 0), the international investors have to contribute $e_0(I - A)$ to the project. However at date 0, e_0 is always 1, while the date-0 forward exchange rate for dollars at date 1 in state ω is denoted $e_1(\omega) = s^{\$}(\omega)/s(\omega)$. Additionally, at date 1, there is an exogenous supply of domestic liquidity from the government on peso goods L and exogenous supply of international liquidity from international insurers and international financial institutes on dollar goods $L^{\$}$. Conditional on the realized state of nature ω at date 1, the project make reinvestments $i(\omega)$ and $i^{\$}(\omega)$ which are constrained by the initial investment I. The total cost of reinvestment in state ω is $\rho i(\omega)$ in peso and $\rho^{\$} i^{\$}(\omega)$ in dollars (in this PPP context, however, continuation scale in dollar $i^{\$}(\omega)$ is 0, then $\rho^{\$} i^{\$}(\omega)$ is 0 as well). At date 2, private benefits of the sponsor (who see no difference whether those benefits come from pesos or dollars), $\rho_1 - \rho_0 - \rho_0^{\$}$ is strictly positive.

As mentioned earlier, all promises to international investors have to be backed up by claims on dollar goods since international investors consume only tradable goods. The amount of international collateral produced by the corporate sector is $\rho_0^{\$} i(\omega)$. In contrast, since domestic investors are indifferent between consuming tradables and nontradables,

the total amount of collateral which is available to be pledged to domestic investors on the domestic market is $\rho_0 i(\omega) + \rho_0^{\$} i(\omega)$.

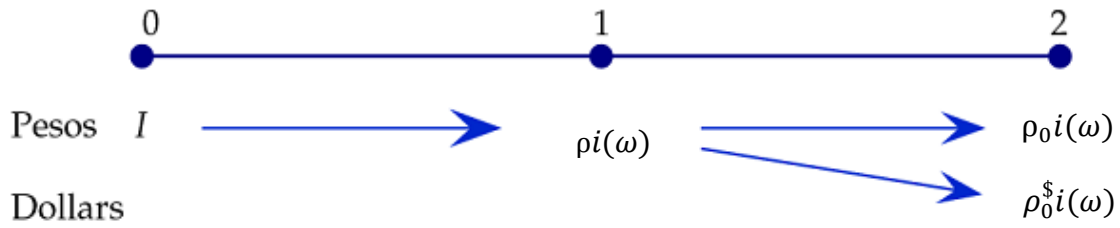

Figure 4.3 Domestic Input and International Collateral (modified from Holmström & Tirole, (2011))

The project's decision problem is to decide the date-0 level of initial investment I, date-1 reinvestments $i(\omega)$, and more importantly, how much to buy domestic and international liquidity in advance. In this model, the project is unable to substitute international liquidity for domestic liquidity (but not the other way round because international investors cannot accept pesos). The nonnegative amount of international liquidity that the project transformed into domestic liquidity is denoted as $t^{\$}(\omega)$.

The firm's decision problem is as following:

$$\max_{\{I,,i(\cdot),t^{\$}(\cdot)\}} \{\mathrm{E}_{\omega}\left[(\rho_1 - \rho_0 - \rho_0^{\$}) i(\omega)\right] \tag{4.38}$$

Subject to

(i) $(I - A) + \mathrm{E}_{\omega}[(\rho - \rho_0) i(\omega) - t^{\$}(\omega)] \leq 0$

(ii) $A^{\$} + \mathrm{E}_{\omega}[\rho_0^{\$} i(\omega) + L^{\$}] \geq \mathrm{E}_{\omega}[t^{\$}(\omega)]$

(iii) $(\rho - \rho_0) i(\omega) - t^{\$}(\omega) \leq L$, for every ω,

(iv) $t^{\$}(\omega) \geq 0$ and $0 \leq i(\omega) \leq I$, for every ω.

The equation (i) considers budget constraint of investment (in peso). The constraint (ii) is the international liquidity constraint (for the expected amount of international liquidity that is transformed into domestic liquidity which always hold as an equality). It has to be noted that the asset of the project in dollar $A^{\$}$ in (ii) can be assumed 0 in this research because asset of infrastructure project always belongs to the country. The constraints (iii) is the domestic liquidity constraint. The dollar liquidity helps the project relax the peso

liquidity constraints (iii) in an arbitrary state-contingent. It proves the important of insurance role of the international participants. Since all projects in a country are hit by the same shock, there would be no insurance at all across states ω if they cannot access to international markets. In each state ω, the domestic market have to manage net inside liquidity $(\rho - \rho_0)i(\omega)$ (the difference $(\rho - \rho_0)$ is the amount of liquidity supplied among domestic projects by decreasing the initial investment I at date 0) together with the support from the outside domestic liquidity supply $L+L^{\$}$. For any country, if the shocks are small, there would be excess liquidity but if there are high shocks ρ there would be a shortage of liquidity. This inefficiency can be reduced by the attendance of international investors, who can provide insurance across states. For the former inequality equation in constraint (iv), the amount of the international transformed into domestic liquidity, $t^{\$}(\omega) \geq 0$ is important for this LAPM to allocate risks and liquidity. With an assumption that inside domestic liquidity is exhausted, this value has to be non-negative. The latter equation guarantees that the continuation scale is determined for reinvestment, and therefore cannot exceed the existing investment. If the constraints (i)-(iv) are binding, the total surplus equals the sponsor's private benefit, and the objective function is therefore maximized.

4.3.3 Solution to the LAPM for PPP projects

The previous section shows the formulation built from the extended open economy assumption, hereby this section provides a solution by using the Lagrangean multiplier method based on all constraints. As the analysis in this section based on the date-1 decision concerns level of liquidity shock ρ (which is assumed to be a continuous distribution) rather than the state of nature ω, hence for convenience, ρ is used instead of ω to denote the state of nature. The utility function is maximization for the values of I, $i(\cdot)$, and $t^{\$}(\cdot)$ based on the probabilistic function of ρ. The Lagrangean of the problem is:

$$\begin{aligned}
&\mathcal{L} = \mathrm{E}_{\rho}\left[\left(\rho_1 - \rho_0 - \rho_0^{\$}\right)i(\rho)\right] + \\
&\lambda_1\left\{-(I-A) - \mathrm{E}_{\rho}\left[(\rho-\rho_0)i(\rho) - t^{\$}(\rho)\right]\right\} + \\
&\lambda_2\{A^{\$} + \mathrm{E}_{\rho}\left[\rho_0^{\$}i(\rho) + L^{\$}\right] - \mathrm{E}_{\rho}[t^{\$}(\rho)]\} + \\
&\lambda_3\{-(\rho - \rho_0)i(\rho) + t^{\$}(\rho) + L\}
\end{aligned} \tag{4.39}$$

where λ_1, λ_2, λ_3 are the nonnegative Lagrangean multipliers corresponding to each constraint. In order to obtain the first order conditions that maximize the utility function, the Lagrangean is differentiate with respect to variable $i(\rho)$ and $t^{\$}(\rho)$.

The first order condition is therefore:

$$\frac{\partial \mathcal{L}}{\partial i(\rho)} = \rho_1 - \rho_0 - \rho_0^{\$} + (\lambda_1 + \lambda_3(\rho))\{(\rho - \rho_0)\} + \lambda_2\{\rho_0^{\$}\} \tag{4.40}$$

$$\frac{\partial \mathcal{L}}{\partial i(\rho)} \geq 0 \text{ when } i(\rho) = \mathrm{I} \tag{4.41}$$

$$\frac{\partial \mathcal{L}}{\partial i(\rho)} = 0 \text{ when } 0 < i(\rho) < \mathrm{I} \tag{4.42}$$

$$\frac{\partial \mathcal{L}}{\partial t^{\$}(\rho)} = \lambda_1 - \lambda_2 + \lambda_3(\rho) \leq 0 \tag{4.43}$$

It has to be noted that λ_3 has to bind with a function of ρ because the original constraint (iii) is not in an expected vale as other constraints.

From (4.43), the boundary of the first order condition with respect to variable $t^{\$}(\rho)$ are

$$\text{when } t^{\$}(\rho) > 0, \frac{\partial \mathcal{L}}{\partial t^{\$}(\rho)} = 0 \text{ and } \lambda_1 - \lambda_2 + \lambda_3(\rho) = 0 \tag{4.44}$$

$$\text{when } t^{\$}(\rho) = 0, \lambda_3(\rho) = 0 \text{ and } \lambda_1 - \lambda_2 \leq 0 \tag{4.45}$$

From the first-order condition, the solution of the representative firm's program can be explained based on the boundaries of $\frac{\partial \mathcal{L}}{\partial i(\rho)}$ with the graphic as shown in Figure 4.4. The solution solves linear program between the total amount of liquidity needed to make the project continue $(\rho - \rho_0)i(\rho)$ and the level of liquidity shock ρ.

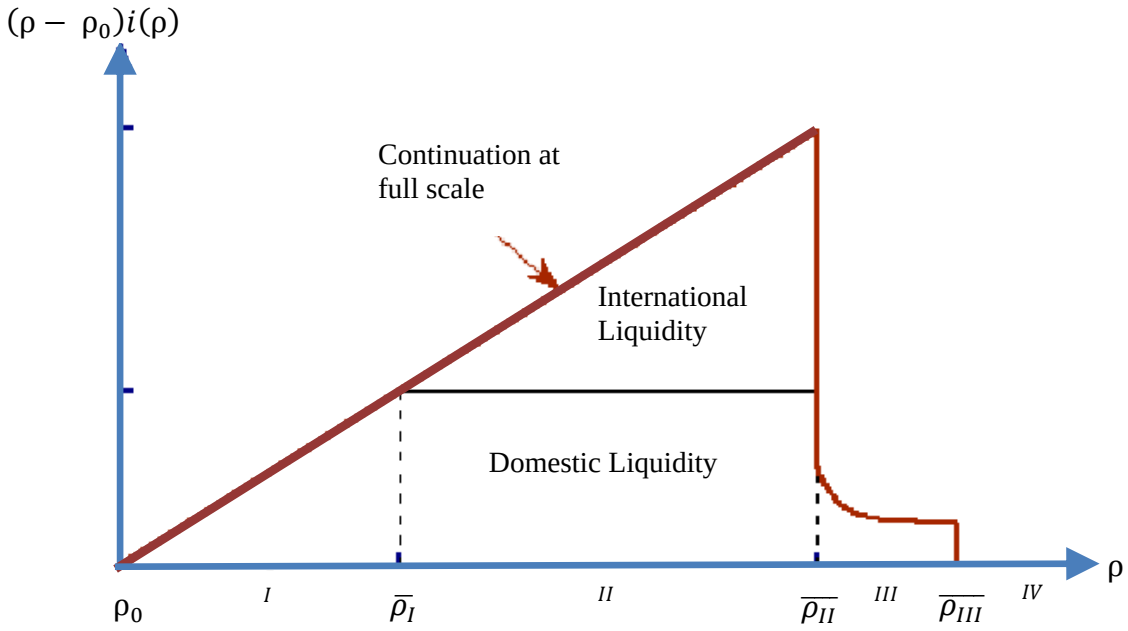

Figure 4.4 The Graphical Solution of LAPM

Region I: if $\rho \leq \overline{\rho_I}$, where $(\overline{\rho_I} - \rho_0)I = L$, (4.46)

Then $i(\rho) = I$ and $t^{\$}(\rho) = 0$

Region II: if $\overline{\rho_I} < \rho \leq \overline{\rho_{II}}$, where (4.47)

$\int_{\overline{\rho_I}}^{\overline{\rho_{II}}}[(\rho - \rho_0)I - L]\, f(\rho)d\rho = \rho_0^{\$}I + L^{\$} + A^{\$}$,

Then $i(\rho) = I$ and $t^{\$}(\rho) = (\rho - \rho_0)I - L$

Region III: if $\overline{\rho_{II}} < \rho \leq \overline{\rho_{III}} \leq \rho_I$, (4.48)

Then $i(\rho) = \frac{L}{\rho - \rho_0} < I$ and $t^{\$}(\rho) = 0$

Region IV: if $\rho > \overline{\rho_{III}}$, (4.49)

Then $i(\rho) = 0$ and $t^{\$}(\rho) = 0$

The graphical solution shows the relationship between the liquidity supply needed on the Y-axis, and the scale of liquidity shock on the X-axis. The utility maximization of the LAPM has 3 cutoff values for ρ (which are $\overline{\rho_I}, \overline{\rho_{II}}$, and $\overline{\rho_{III}}$).The solution focuses on the value of ρ which makes the full scale continuation ($i(\rho) = I$) possible. In the first region I where $\leq \overline{\rho_1}$, the liquidity shock ρ is very low allowing the projects to continue at full scale even without the supply from international liquidity (no dollar liquidity is needed). In region II, when $\rho \geq \overline{\rho_I}$, continuation is still at full scale, but requires the addition of international liquidity. The sponsor needs to allocate risks to the domestic and the

international liquidity suppliers. As ρ increases, full scale continuation is possible until the cumulative amount of dollar liquidity used in region II (the top triangle in the figure) reaches the total amount of available international liquidity. Beyond region II, all international liquidity is used up to counter ρ, the full continuation is therefore no longer possible. The beginning of region III corresponds to the case where $i(\rho) \leq I$ and, $t^{\$}(\rho) > 0$. There is no more international liquidity that can be requested. The project has no choice but to head back to using only domestic liquidity. In regionIII, the insufficiency of international supply of liquidity reduces the continuation scale. The continuation scale of investment is now below I and decreasing in ρ (This scale is lower so that it could achieve in region I). Beyond region III, ρ becomes too high, so it is impossible to continue. Therefore, in region IV it corresponds to the case where $i(\rho)$=0 and $t^{\$}(\rho)$=0.

Previously in 4.3.1, the government can supply liquidity to the market with attempt to secure an ex-ante wealth transfer from taxpayers. However, this support also leads to opportunistic behavior of the project sponsor who may reduce the sum insured of the project in order to avoid paying high liquidity premium. This issue will be discussed again in chapter 5. The solution in this section proves that when both the sponsor and government encounter the liquidity depletion, the government might consider the aid from Multilateral Financial Institutions (MFIs) such as the World Bank or allow more investment flow from oversea such as international insurers, to overcome the financial crisis.

4.4 Introduction of Alternative Principle of Liquidity Risk Allocation

The results from LAPM analysis and the graphical solution show that in normal situation, PPP projects in a closed economy always handle their risks by transferring insurable risks to domestic insures and transferring the uninsurable risks left over to financial market (e.g. using bonds or other securities). Generally when inside liquidity, coming from corporate sponsors with the small size of the market of domestic insurance liquidity in developing countries, like Thailand, becomes shortage, this results in the requirement of liquidity from international market's engagement. This phenomenon is explained based

predominantly on Holmstrom and Tirole's LAPM. When idiosyncratic (independent) risks hit a project, the project which prepares adequate liquidity assets beforehand is able to weather the unfavored risk event and continue its operation. If the liquidity shock is substantially high and the project does not preserve enough liquidity, it can bring about the project freezing (a stage where a project is unable to proceed its construction or operation), or in the worst scenario, project default or bankruptcy. However, when the whole country is hit by catastrophe, all projects are desperately in the same situation and suffer with aggregate liquidity shock which means liquidity becomes shortage (no insurers want to supply liquidity or highly raise the premium). The result from the model points out that the government has to supply liquidity to domestic PPP projects. The government with its power of taxation can act like a mediator to allocate liquidity on behalf of all consumers to the project in need of liquidity. In order to do so, it has to increase the national liquidity-supplied capacity in advance in case the country is under the aggregate shortage of liquidity in the future. For example, it can issue the government bond, catastrophe bond, or even the Multi-country Catastrophe Insurance Pool (which only the government can do) that the sponsor can leverage. Nevertheless, there is possibility that the asymmetric information (soft budget problem) may emerge when the government intervenes the market to reallocate liquidity itself.

The important role of international participants is also emphasized here. Since the orthodox risk allocation principle recommends that risks should be allocated to the parties best able to control it with the lowest cost, the model proves that supply of liquidity from international (no matter whether it comes from the insurance market or financial market or aid financial institutes) can share risks and more importantly reduce the price of liquidity (risk mitigation cost) in the market. It is because, in case that there are aggregate risks (liquidity shocks), only limited amount of domestic liquidity cannot sufficiently meet demand for all projects, leading to the competitive bid and high price of liquidity.

In addition, there is possibility that the government is sometimes in the situation that it lacks of liquidity to supply projects like sovereign risks, or when aggregate liquidity shock, like catastrophe, hits. In those cases, the international financial institutes which have plentiful liquidity available to supply are not affected by liquidity shock in peso because they are not based in only one country. Therefore, they are in the best position

capable to finance and mitigate this shock in times of reinvestment need. From the international aid institutes' point of view, such a move empowers the government to enable transformation of international liquidity into domestic government's liquidity to complete projects in hands. It is one of missions that most international aid institutes such as the World Bank have tried to accomplish.

4.5 Conclusion

This chapter theoretically investigates how the Liquid Asset Pricing Model (LAPM) can be formulated to determine the liquidity needed to allocate risks within the PPP concession project investment. The concept of LAPM is to highlight liquidity demand and supply in project financing when risks emerge between the project launch and project completion. The model is designed to help both the entrepreneur (herein this research refers to the project sponsor) who utilizes his own endowment to invest, and the complementary investors to determine the liquidity demand to mitigate risks.

With the first and the simplest form of LAPM, the problem which assumes that the anticipated liquidity shock is idiosyncratic, can be solved to optimize benefit of the sponsor along with the resource allocation subject to several constraints. Next, by considering the sources of liquidity, the study extends to the cases where the demand of liquidity can be met by different suppliers. By adapting the initial idea developed by Holmström & Tirole, the distinction of liquidity in this analysis is considered by its sources of the pledgeable income. "Inside and outside liquidity" represent liquidity generated among project insiders (i.e. corporate private parties) and liquidity generated by financial instruments that originate outside the corporate sector (i.e. "domestic liquidity" from the government and "international liquidity" from international insurance markets) respectively. The model further analyzes the case when domestic inside liquidity is dried up resulting from the aggregate liquidity shock. This shortage of aggregate liquidity is the reason behind the competitive bid from the outside liquidity and therefore results in a liquidity premium.

Without the supply of outside liquidity, the domestic liquidity crisis would be difficult to solve. The model extends to cases that the outside liquidity can be obtained from different sources. The consumers' supply of liquidity is a case, even though they do not invest in

the project directly. As the consumer's endowments cannot be preserved nor transferred from each date, the project's planning regarding demand of liquidity can be done by considering the converted wealth from consumers contingent on their different levels of endowment at each date with the assistance of general equilibrium analysis.

Next, due to the limitation mentioned above, the liquidity demand from the projects and the supply from consumers always mismatches and becomes wasted in practice. The assistance from the government, which can act as a mediator to help domestic projects allocate liquidity supply, is analyzed. For example, by using a well-known government bond, the government can liquidate the value of taxation gained from consumers' future resource into pledgeable income and then allocate it to alleviate aggregate liquidity shock in the economy.

In developing countries, sometimes the governments are nevertheless unable to mitigate the failure of private financial flows due to their limited budget and weak power of taxation. When the governments lack the financial capabilities to generate adequate amounts of liquidity, the unfavorable projects turn to seek other resources. In this situation, the international investor such as insurers or multi-lateral financial institutions (MFI) such as the World Bank step in. The World Bank has been launching a program to support guarantee due to a shortfall in cash flow resulting from a government's (or a government entity's) failure or from regulatory noncompliance of contractual obligations undertaken by the private project company. Such institutes have more capabilities to finance emergency investments than the government. The model considers the case and extends to answer the question on how the sponsor in anticipation of liquidity shock should plan for domestic lack of liquidity and determine the supply of liquidity from the government together with the international participants.

The analysis of this chapter gives the idea to design alternative principle of risk allocation by considering liquidity supplied from parties other than the government and the project sponsor. The theoretical mechanism of the market of liquidity as well as the utilizations of liquidity assets will be further analyzed and discussed through detailed processes in chapter 5, considering the original LAPM's distinction of "inside and outside liquidity" proposed by Holmström & Tirole.

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Chapter 5

Alternative Principle of Risk Allocation for PPP Infrastructure Projects from the Perspective of Liquidity Supply

5.1 Introduction

Given its ability to handle debt and redeem or reschedule liabilities when they mature, as well as its ability to transform other assets into cash in hand, the use of liquidity has been highlighted in corporate finance and business plan for many years. However, as mentioned in chapter 2, recently the increased number of unsuccessful infrastructure projects has pushed researchers and practitioners to become aware of their existing risk management which is sometimes infeasible for both pre- and post-completion phases. The key message in chapter 2 is, the risk allocation principle which is widely referred to by many researchers is explained and the author proposes the way to improve the use of the principle by the liquidity perspective.

In order to improve an ineffective risk management, recent researches have been adapting to related topic in both corporate finance theory and managerial practice (Gatti, 2008). The focus of project managers has been shifted from pure risk management to enterprise-wide risk management instead (Nocco & Stulz, 2006). More attention has been paid to the relationship between project risks, business risks, and enterprise risks. Such risks arising anytime throughout its project economic life, from the construction phase when the projects are unable to generate income to the operation phase, have to be anticipated and carefully taken care by relevant parties. Indeed, the decision on how much cash the projects are supposed to keep in hand to face unfavorable events is crucial (Holmström & Tirole, 2011). The integration of liquidity and risk management which is built up from the advantages of dynamic approach liquidity management and the familiar risk transfer widely used in the infrastructure industry, is therefore an alternative for the project sponsors and the governments to decide their investment plan.

In chapter 4, the Liquid Asset Pricing Model (LAPM) is used to conceptualize the framework of the alternative risk allocation principle. The aim of this chapter is to complement this principle by considering the use of liquidity supply in effective ways. The explanation on how diversified liquid assets are used to improve the project finance and transfer risks is given. Furthermore, the roles of liquidity suppliers (including project sponsors, investors, insures, and governments) are identified. To begin with, section 5.2 starts with the explanation on how risks and liquidity shock in PPP projects are associated. Next, based on Holmstrom and Tirole's inside and outside liquidity which is introduced in the previous chapter, sources of liquidity

available for practical project investment in this PPP context, with the additional classification of suppliers from capital market and insurance market are therefore clearly distinguished and presented in section 5.3.

Afterwards, section 5.4 explores the use of a wide variety of liquid assets as risk transfer tools (e.g., bond and insurance) owning to their feature to preserve and transfer value when reinvestment is needed. The mechanism of risk and liquidity's demand and supply allocation as well as the flow of liquidity among parties in both insurance market and capital market are also analyzed. The flow of liquidity can be a complementary part used to build the alternative principle of risk allocation for PPP projects from the perspective of liquidity. Lastly, the proposal for the government to increase the liquidity-supplied capacity and the asymmetric information (soft budget problem) arising when the government intervenes the market to reallocate liquidity itself is discussed in section 5.6.

5.2 Risks and Liquidity Shock in PPP Projects

As mentioned in previous chapters, a PPP infrastructure project has high possibility to encounter an unfavored event at any stage, especially during construction and operation. Hence, risk allocation in PPP projects is basically different from conventional projects as the private sponsors/ contractors in the latter are responsible just until the projects are taken over (Grimsey & Lewis, 2004). Operational and financial risks in PPP projects still remain with the private sector.

When a risk event occurs, it causes negative impact of a certain degree to the project finance. In this research, the event which leads to reinvestment need, sometimes resulting in a shortage of liquidity, is referred to as a "liquidity shock". If the liquidity shock is substantially high, it can bring about the project freezing (a stage where a project is unable to proceed its construction or operation), or in the worst scenario, project default or bankruptcy. By integrating conceptual ideas of liquidity together with risk management, this section will explain how the provision of liquidity has a significant impact on PPP project continuity and identify risk events which relate to liquidity shock.

Many scholars have already classified risks in PPP project. For example, Grimsey & Lewis (2004) develop risk matrix to identified major categories of risks. Correspondingly, according to Economic and Social Commission for Asia and Pacific (2011), risks in PPP projects are categorized into 11 groups as following:

- Construction and completion risks (delays in construction or cost overruns),
- Technology risk/Manufacturer's risk (new and untried technology, whose performance cannot be checked against existing references during testing /commissioning phase),
- Sponsor risk (ability of private sponsor(s) to deliver the project),
- Environmental risk (environmental constraints in construction and operation),
- Commercial risk (lower demand and/or revenues than the ones projected),
- Operating risk (inefficiency in operation leading to higher operating cost),
- Financial risk (change in interest and currency exchange rates, and tax laws),
- Legal risk (change in legal regime),
- Regulatory risk (change in regulatory regimes),
- Political risk (change in government policy or action that affects the business case of the project), and
- Force majeure (risks due to unpredictable natural events such as earthquake, flood, or man-made political event such as civil war, etc.)

Taking a look at the above list, risks related to liquidity are intuitively considered as risks from categories which directly influence project finance. Sometimes, it is confused with sponsor risk. However, due to the fact that some risks such as political risk or legal risk can also impact financial status of the project in indirect way, the question is what kind of risk can possibly lead to liquidity shock. The answer is that risks which have impacts on productivity of projects can possibly lead to liquidity shock and in this study, the scale of the risk which affects the production of the project matters. Considering the scale of the risk, if the risk is big enough it causes the liquidity shock to become greater than the pledgeable amount. In this case, the project cannot raise reinvestment fund to maintain and enable its operation to earn income again, unless it has allocated such funding beforehand. This research pays attention to how liquidity shock should be managed in cases where an unexpected event such as an accident or a catastrophe arises, not to the measurement of risks which can become liquidity shock. The following section will show the sources and parties where liquidity can be supplied from.

5.3 Sources of Liquidity in PPP Project

In a PPP project finance featuring different parties, wealth and liquidity assets should be transferred without barrier among the parties in order to allocate and distribute both fiscal responsibilities and risks across different states of nature. Moreover, wealth can be saved by acquiring assets that can convert current wealth into future value. By adapting the initial idea developed by Holmström & Tirole (2011), the distinction of liquidity in this research is made considering its sources. "Inside" and "outside" liquidity represent liquidity generated among project insiders (i.e. corporate private parties, lenders) versus liquidity generally provided by others besides the insiders (i.e. "domestic liquidity" from consumers (households), the government and "international liquidity" from international financial markets). For example, by using a well-known government bond, the government can liquidate the value of taxation gained from public into liquid asset and then allocate it to support the projects in hands. Therefore, with the integration of liquidity concept, the risk management in PPP projects, which will be further delineated from this point on, will encompass both inside and outside features. Wealth and risks together are transacted without losing any value among parties via liquid assets which are available in markets (e.g. lines of credit, mortgage, and other forms of collaterization). By using the insurability (and technology available each a country) as discussed in Chapter 3, the project sponsor who holds risks can make a choice as follows: insurable risks are covered by insurance market, and uninsurable risk are covered by other securities.

Apart from the project sponsor who plays the main role to supply project liquidity, the government, as a real project owner and indispensable co-investor has a role to monitor the risk exposure throughout the project lifetime and supply complementary liquidity if necessary. Bond financing, for example, has long been used conventionally by governments as an alternative liquidity source to refinance existing project loans (Gardner & Wright, 2014). Nonetheless, since the 90's, the increase in coverage, the inadequacy in quality of service, and the low levels of operational efficiency drive most countries to transfer the provision of infrastructure services to the private sector (Guasch, 2004). By shifting the financial burden to the private sector in many schemes, including PPP or concession, it does not mean the government is totally discharged from the projects' financial responsibility. Very often, the government takes a role to manage risks which cannot be controlled by the private sector. For

example, the host government shares the financial debt from the private partner by providing a subordinate loan and therefore become a guarantor for international bank. In many cases, the multilateral financial institutions (MFIs) are invited by the host government to be a choice to supply liquidity such as the World Bank which offers the cheaper interest rate than commercial banks. Nonetheless, the government may encounter the situation where it is unable to pay the debt or supply liquidity for the project due to national financial crisis. This event is defined in literature as "sovereign risk". Thus, the obligation to generate and seek for liquidity is not only essential for the private partner but also the government. Not only can bonds be issued by the private sector, but due to the importance of the well-functioning of the country's financial system and the risk sharing obligation, bonds can also be issued by the government, or by both together as Special Purpose Vehicle, SPV to support the unfavorable projects. Good examples are infrastructure bonds or bonds issued for natural disasters, or to relieve economic crises. These countermeasures are not only beneficial for specific PPP projects, but also for the national economy as a whole.

In addition to the liquidity supply generated among aggregate projects in a country and the supply from the government as mentioned above, this research considers insurances as another important source of liquidity. The liquidity sources from the domestic projects and the government aid are both generally backed up by the transaction in domestic capital market, whereas the latter hedged to the insurer is produced from domestic and international insurance market. It is inevitable that liquidity management are intertwined with the risk management because to provide insurance coverage in terms of liquidity to any projects means the insurers have to absorb such risks themselves. Thus, risk transfer and liquidity transfer have to be considered simultaneously, not only between parties but also between the two markets.

The subsequent analysis will exhibit how corporate insurance integrates with liquidity management. In short, when projects purchase insurance, normally via domestic insurers, such risks are pooled among those insurers with re- or co-insurance process. However, with the high value of infrastructures, particularly mega projects which cost billions, the risks are too high to share only among domestic insurers, especially in developing countries where the size of market is small. Thus, the domestic rationale insurers insulate themselves from big claim by (i) hedging against potential risks to international insurance market, or (ii) using other underlying assets, securities such as bonding, and contingent capital back to investors in capital market. By integrating Holmström & Tirole's inside and outside liquidity concept with sources

of liquidity from two markets, the specific liquidity-supplying parties in this model can be summarized as shown in Table 5.1.

Table 5.1 Liquidity-supplying Parties

	Inside liquidity	Outside liquidity
Capital Market (for uninsurable risks)	Investors (lenders, or consumers/ individuals who directly invest via project fund or bond)	Consumers, Government, Multilateral Financial Institutions
Insurance Market (for insurable risks)	Domestic Insurers	International Insurers, Reinsurers

The upcoming section 5.4 will provide the idea of mechanism of liquidity and risk allocation in PPP projects. Flow of liquidity and risks are delineated in detail with different products of insurance and securities, which related parties are obligated to supply in Table 5.1.

5.4 Liquid Asset Pricing Model (LAPM) and Mechanism of Liquidity-Risk Allocation

The analysis in the following section mainly uses the well-known Liquidity Asset Pricing Model (LAPM) developed by Holmström & Tirole (2011). They developed this new model for project investment decisions by considering an intermediate period between project launch and project completion where risk is anticipated. The basic theory behind LAPM is that risk management is planned before the risk occurs.

By integrating risk management as part of liquidity management, Holmström & Tirole (2011) claim that their model is superior compared to other traditional models such as the Capital Asset Pricing Model (CAPM), because their ex-ante provision of liquidity takes into account how much cash to keep in hands to cover unexpected liquidity needs and how to deal with uncertainty. This underlines that risks and liquidity should be managed jointly, since the sponsor's investment is decided so that adequate liquidity is assured throughout the project timeline with the most cost effective way. In this case, the cost of capital in future states guides the sponsors' investment plan. With dynamic approach of LAPM, the investments are divided into 3 stages where the interim stage represents the contingent claim corresponding to when the liquidity shock emerges. The liquidity risk allocation is therefore more realistic and suitable

to apply to long-term concession projects. The explanation from this point on will first illustrate how the framework of liquidity supply across the parties and markets is built up and then explicate in regard of risk allocation once the framework has been completed.

5.4.1 Liquidity Supply from Project Sponsors and Investors

The model consists of three timings indexed t=0, 1, 2. The main objective of project sponsors, as entrepreneurs, is to maximize their profit. However, the risk allocation with the perspective of liquidity suggests the sponsors to allocate their investment at date 0 into "initial investment scale" and "continuation scale", anticipating liquidity shock occurring at date 1 (an intermediate period). Such a reinvestment to cover liquidity shocks is necessary in order to allow the project to continue. In this study, the trade-off between the increase in the initial investment scale and the decrease in the continuation scale allows the project to carry on until date 2, when payoffs are also realized. In other words, the increase of insurance a firm purchases in the form of liquidity backup conversely decreases the illiquid assets investment. This section points out where the sponsor can find liquid assets to cover liquidity shocks.

An important assumption here is that all infrastructure PPP projects are not "self-financing", which means the sponsors alone cannot carry out the projects. Even though it is clear that most of the investment capital comes from the project sponsors, fund raising is still necessary. The sponsors have to attract lenders and individuals in economy to finance the leftover of the initial investment. This amount needed from investors to fulfill is called "pledgeable income" or collateral of the project. Only when the project can weather the shock at date 0 can the project sponsors enjoy their return, known as "entrepreneur's rent" in this model, while the investors can obtain their promised returns. If the collateral is insufficient when an aggregate shock hits a country, the model considers that, ideally, domestic consumers and the projects which have abundant liquidity play a role of liquidity suppliers to the shortage ones.

Corporate Projects' Supply of Liquidity

The first and most convenient resource from which the projects may plan to demand liquidity when shock occurs is corporate finance in capital market where projects share their risks together. According to the model developed from Holmström & Tirole's LAPM, concession projects in a country are grouped into only 2 types: the "regular" projects and the "contrarian"

projects. The contrarian projects are the projects which always supply liquidity even in the aggregate shock state whilst the regular projects always demand liquidity. This research considers the inside liquidity as an asset representing, or backed by, any form of private credit from the private firms in the aggregate. If private firms have no pledgeable income, there is no corporate claim and hence no inside liquidity to back up promises of funding.

Infrastructure Fund

Fund raising via infrastructure funds, which is a type of mutual fund used for fund mobilization from both general and institutional investors in the revenue stream or rights to seek benefits from infrastructure projects, aims to alleviate additional budgetary burdens for the central government (The Securities and Exchange Commission, 2010; The Stock Exchange of Thailand, 2005). It also essentially gives advantage to the state enterprises because they still remain owners and administrators of the infrastructure projects. This establishment of fund does not require the transfer of state enterprise assets, but utilizes future earnings and profitability of infrastructure projects for fund raising. The infrastructure fund enhances the capital markets by being an additional fund-raising channel for the government-owned projects, and by giving public (both local and foreign) investors an attractive choice of investment for the country. At the same time, it also increases production capacity as well as efficiency contributing to directly boost the long-term national competitiveness.

A practical example on how to raise liquidity from capital market in developing countries is demonstrated in Thailand. Another alternative source of capital and liquidity raising widely established by the private sector under delegation of the Thai state-owned enterprises for their infrastructure projects is infrastructure fund. Nowadays, the following 11 types of Thai infrastructure projects that can raise the capital with infrastructure funds are: rail mass transit; power plant; toll road, express way and concession way; airfields or airports; deep seaports; telecommunications; alternative energy; waste management; water supply; water management system and irrigation system; and natural disaster protection system (including the warning and management system to mitigate the severity of natural disaster occurred) (BTS Rail Mass Transit Growth Infrastructure Fund, 2016).

5.4.2 Liquidity Supply from Insurance Market

The risk sharing principle allows risks in PPP projects to be apportioned to the party best able to manage it (Kobayashi, et al., 2006; Van Herpen, 2002). However, insurance, as an important contractual risk allocation tool, is often overlooked. Most of the time, it is not treated as an essential part of project finance but the add-on (Gatti, 2008). In this section, the essence of insurance market relating to risk and liquidity is explained.

Wang et al. (2004) argue that risk transfer using insurance is deemed to be one of the most prominent risk mitigation measures for country, market or project level risks. Accidents or risks related to catastrophe or big loss can be covered by various types of insurance available in the market, making not only project sponsors, but also the government, project lenders, and other relevant investors more secure. The goal of the LAPM is to explain the pricing of assets and to find the optimal design between illiquid and liquid investments in insurance.

However, the crucial question of this model is how the project sponsors themselves can preserve (store) or transfer funding assets across each date without losing the value. The answer is that the project sponsors have to transform their investment fund into other forms of liquid assets or liquid securities. The simple idea proposed in this research is that the project sponsors have to purchase insurance or bonds at date 0 and let wealth be transferred to other parties before obtaining it back when liquidity shock arises at date 1. As previously mentioned in chapter 3, the sponsors have to figure out what kinds of insurances are needed by analyzing the project risks including business and enterprise risks in order to precisely select suitable insurance programs. In this study, insurance market and capital market are therefore interrelated as transaction proceeds when risks and wealth of liquidity are pooled among relevant parties as shown in Figure 5.1.

Figure 5.1 illustrates the flow of inside liquidity from the sponsor and corporate investors (mobilized from capital market) in section 5.4.1 together with the liquidity from domestic insurance (from insurance market) in this section. When the idiosyncratic liquidity shock arises, the projects which prepare enough liquidity beforehand can get the claim and continue their business and activities. The following section will answer the question; what if the liquidity shock from these sources are depleted, how the government takes steps since the PPP

infrastructure project as public service cannot fail. The examples of liquid assets that only the government has the right to support the project is given.

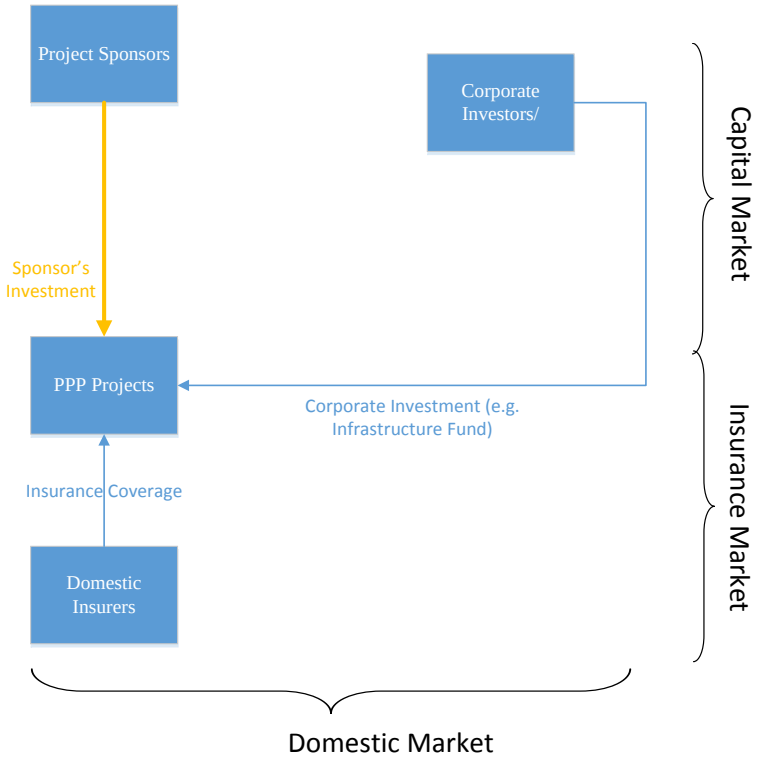


Figure 5.1 Supply of Inside Liquidity

Note: The examples of liquid assets available in the insurance market which the project sponsors as well as the government can consider to use mutually (as a co-insured) for assuring their liquidity needs in PPP projects, are not shown here because they have been shown previously in section 3.3.

5.4.3 Liquidity Supply from Consumers and the Government

This section will provide simple ideas on how consumers in an economy and the government can provide liquidity to support PPP projects. Suppose that the projects cannot find sufficient liquidity from limited source of corporate investors and insurances domestically, particularly in developing countries where the market size is relatively small comparing with developed countries, this stage of lacking domestic liquidity generated from corporate sector is called a shortage of inside liquidity. Therefore, the projects have to look for outside liquidity to alleviate

liquidity shocks. One of the solutions is, the government who is an investment partner of the project sponsors plays essential role to make decision on the citizens' behalves to convert fund from households (or consumers referred to in Holmström & Tirole's original work) to be liquidity supply for projects. It is shown in the model in section 4.2 that saving (the remaining endowment left from consumption) of consumers in each date can be channelled to projects. However, without the intermediary, the allocation is always mismatched. Beyond the role to monitor markets, and to provide liquidity nationwide as a form of intervention to remedy the market failure against unfavorable events (i.e. catastrophe), the unique responsibility to alleviate liquidity deficit with instruments, like insurances and bond against complex PPP infrastructure projects also fall upon the government. Holmström & Tirole compare the role of the government as an insurance broker, who transfers funds from consumers to projects when the latter are hit by aggregate liquidity shocks.

Practically, the government's supply of liquidity comes in a variety of forms and arrangements. For instance, through industry and banking bailouts, deposit insurance, the discount window, open-market operations, implicit insurance against major accidents or epidemics, unemployment insurance, social security, etc (Holmström & Tirole, 2011). Particularly in this research, government bonds and infrastructure funds are apparent examples. With these instruments, the government can channel consumers' investment with them or use the taxation power to increase pledgeability of consumers' future income when there is a shortage of inside liquidity. Such a move is viewed as remedying the waste of liquidity or making up for missing contract between consumers and project sponsors. This is because consumers cannot pledge their future income by themselves. Thus the government acts like an intermediary who can use the taxation on behalf of consumers to transform the consumer's future income into pledgeable income as shown in Figure 5.2.

The corporate investors and consumers are in the same group in Figure 5.2 based on the interpretation of Holmström & Tirole's inside and outside liquidity concept. They explained that consumers can be any individual in economy (except the sponsors because of their opportunistic decision). Thus, if an individual directly invests in the project (e.g. via infrastructure funds, or infrastructure bonds for specific projects), it is referred to as a corporate investor (the solid line in Figure 5.2), whereas if the same individual is taxed by the government or transforms his savings into non-specific purpose bonds, the fund diversion is counted as

indirect investment and the individual is therefore referred to as a consumer or a household (the dash line in Figure 5.2).

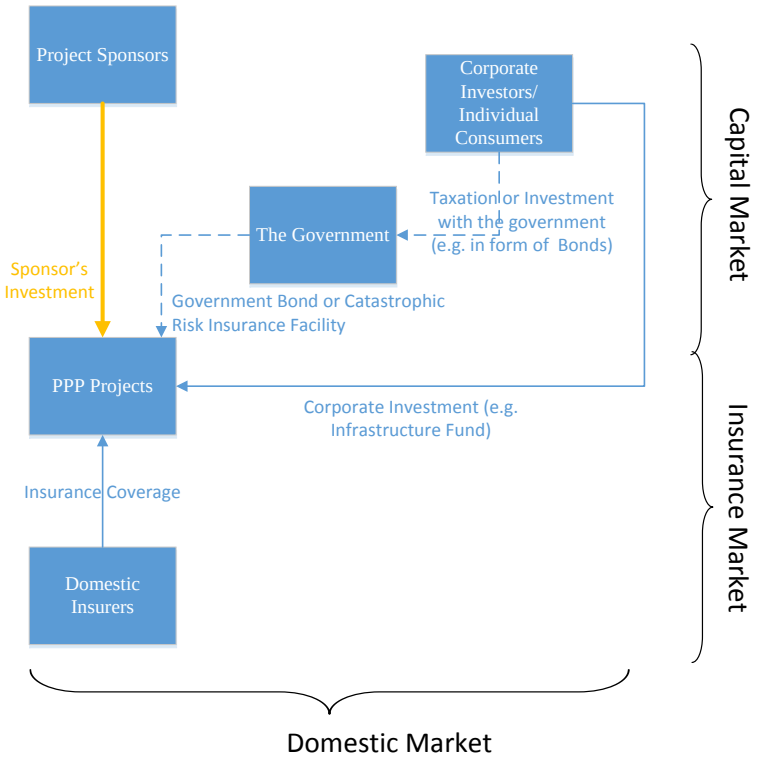


Figure 5.2 Supply of Outside Domestic Liquidity

The superiority of the government's supply of liquidity over that of the private sector's is that the private sector has to decide on the supply of liquidity before the state of nature is known, while the government can have an alternative to wait and see whether the aggregate shock is high or low before taxing consumers. In other words, the government is able to act ex-post whereas firms are only able to act ex-ante, thus the government does not have to identify the state in advance. Only if the aggregate shock is high does the government need to step in and offer liquidity. This reduces the cost of providing liquidity without losing any of its insurance benefits. For this reason, the public sector is deemed be able to produce liquidity more efficiently than the private sector.

Among a wide variety of financial instruments, to issue bonds is a possible way to enable a project entity to raise its fund and the government to increase national liquidity. Not only are the private firms able to issue bonds (known as corporate bond), but in financial crisis situation within a country, the government is also able to take steps as a security supplier via issuing

bonds if it is considered beneficial for overall social welfare. Macroeconomic policy rests on the presumption that the government can do things that the market cannot.

5.4.3A Government Bond

When investors buy bonds, they simultaneously lend money to the entities that issue such bonds. The bond is a promise to repay the face value of the bond (the amount loaned) with an additional specified interest rate within a specified period of time. With the perspective of liquidity supply in this study, the proceed mobilization created by this transaction enables liquidity to be supplied from the individual in capital market in the form of inside or outside liquidity as mentioned earlier.

The market of liquidity provided by government bond has been increasingly of interest to policymakers due to its many different functions which fulfill within the financial system (Anderson & Lavoie, 2004). Government bonds which offer a decent rate of interest plus tax benefits approved by the government, are broadly used because they are considered as risk-free assets which can price other types of securities. In general, the government has alternatives to either issue bond for general uses or for the specific purposes such as for agriculture or infrastructure development. This section will only show an example of infrastructure bonds which is broadly issued in many countries.

Infrastructure Bond

An Infrastructure bond is a debt instrument issued by the private company or the government to raise funds from the capital markets to finance infrastructure projects that operate mainly in the public service sectors such as renewable energy, waste water treatment or transportation. Globally, the market of infrastructure bonds has rapidly grown since 2008 when there was the global financial crisis. As a result, the issuance of infrastructure bonds around the world has increased about three times compared to its pre-crisis levels (Waweru, 2014). For example, in Canada, frequent issuers of bonds are NAV CANADA, a non-profit corporation that owns and operates Canada's civil air navigation system; Aéroports de Montréal; and Hydro One Inc (Normandin Beaudry, 2012). In Kenya, bonds are issued to raise funds for various infrastructure projects in key economic sectors: transport (roads), water and irrigation, and energy sectors (Waweru, 2014). Such securities are used as a source of liquidity to cover

unexpected cash outflows and as collateral for other financial transactions. The liquidity treated as outside domestic liquidity can fall in the above mentioned category of production of goods as well.

The issuance of infrastructure bonds was deemed to be all responsible by the government as a government's production of goods even though the fact is, in many countries, infrastructure bonds can be issued by private companies too without the need for assistance from the government (Waweru, 2014). As the line between public and private production regarding infrastructure services shifts over time, in order to improve or maintain existing infrastructures by allowing the private sector to finance the projects, investments trend has been undergone massive changes. As a result, infrastructure bonds are increasingly issued under the name of SPV's securitization instead. In some countries, like Thailand, the form of infrastructure fundraising by using bond corresponds to this trend.

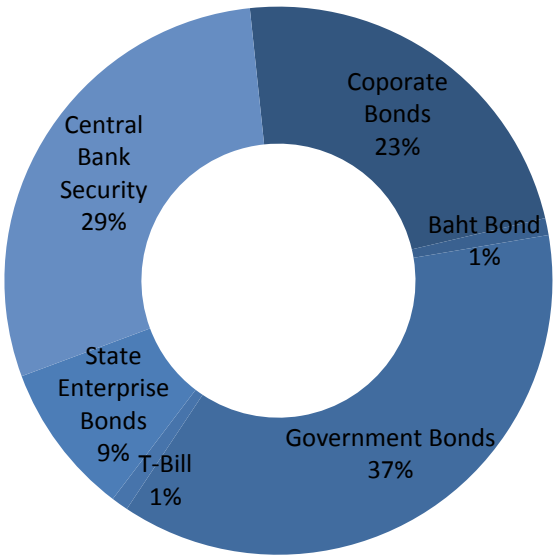


Figure 5.3 Composition of Bond Market in Thailand by Bond Type (Q1/2015) (Laksanasut, 2015)

Even though public sector bonds comprise around 75% of bond market (Laksanasut, 2015) as shown in Figure 5.3, the issuance of specific purpose bond for infrastructure projects has never been implemented solely by the government (There was a fundraising plan by using infrastructure bond and borrowing in 2014 when the Thai government unveiled a long-term Bt2.4tn ($60bn) mega-infrastructure plan but it was turned down by the change of government). Instead, following the 2005 Public Debt Management Act, Public Debt Management Office under supervision of the Thai central government encourage the State-Owned Enterprises

(SOE) to raise fund for their own purposes by issuing the SOE bond (with the central government as a guarantor) and their own revenue (Yongvikul, 1977; Rojanavanich, 2014). Various kinds of SOE bonds have been issued. For instance, bond issuing of the Electricity Generating Authority of Thailand, or the Expressway Authority of Thailand (Public Debt Management Office, 2015).

Catastrophe Bond

The issuance of Catastrophe Bond has long been studied because catastrophe concerns the well-being of all citizens. Many researchers such as Cummins (2006), (Selden, 1993), Jaffee & Russell (1997; 2006) and Harrington & Niehaus (2001) suggest that the government should take steps to be an adherent to launch such a program. Consequently, Intergovernmental Risk Pools (IRPs), which are operated under the same general principle except that they are made up of public entities (e.g., government agencies, school districts, county governments and municipalities), includes the catastrophe bond as an instrument.

By definition, catastrophe bond or CAT bond is classified into an event-linked bond which allows investors to speculate on non-occurrence of certain events, including earthquakes, floods, hurricanes or any events declared in the prospectus of the bond issue. If an event (usually referred to as a "trigger event") occurs, the holder of the bond can see a loss of all future interest payments or a loss of most principal.

The CAT bond has not only been a tool for the government, but also been developed and used as insurers' tool since the mid-1990s (after the Hurricane Andrew in Florida in 1992), aiming to help insurance and reinsurance companies mitigate risks against catastrophe or major claims and at the same time raise their funds. This usage will be further explained in section 5.4.4.

5.4.3B Government (or National) Catastrophe Insurance

The essence of the government fund reserved for catastrophe is based on the idea that, due to the severe damage to the economy and society, the government needs to reconstruct and rehabilitate the country as soon as possible. The remedy always relates to infrastructure (e.g. setting up the water/ flood management system and investing in public utility enhancement). Since the catastrophe puts the insurance industry at risk, insurance companies face difficulties

in managing insurance risks from the crisis. This results in soaring premiums for the insured or the insurers not being able to provide insurance coverage. Therefore, in order to make catastrophe insurance coverage accessible for firms and individuals to restore the protection of their properties and businesses once again, the government has no choice but to provide public access to the extensive catastrophe insurance coverage with an appropriate premium rate. This measure benefits the economy by creating trust and confidence for future investments as well (National Catastrophe Insurance Fund, 2012).

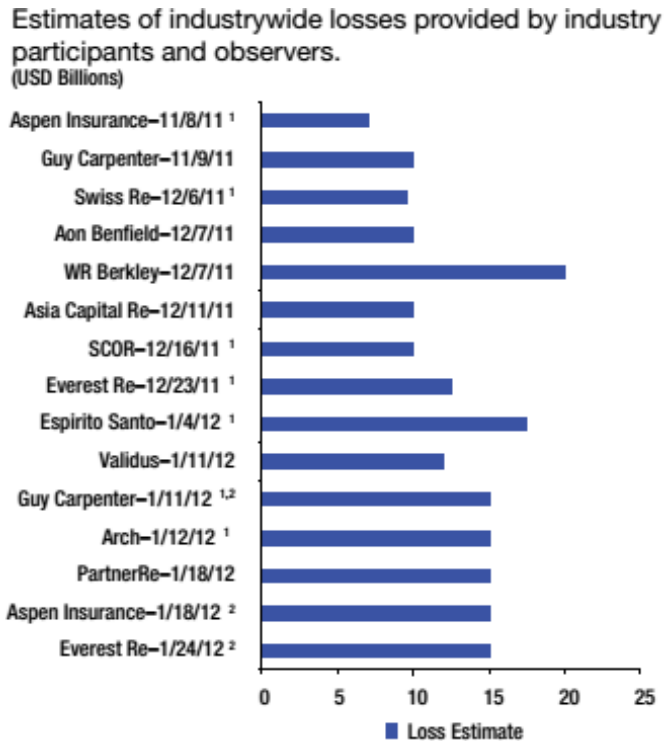
The national catastrophe insurance fund is more efficient than private insurance since it provides broader coverage to communities, having different levels of risks. Additionally, it promotes the development of risk models and data collection on risks, threats, and vulnerability to natural disasters, as well as competition in insurance markets (O'Donnell 2009).

As explained in section 3.3.2, even though the government prefers risks to be shared among domestic insurers and reinsurers abroad, the government's market intervention is sometimes necessary. For example, the Thai government, as well as many other countries, considers national insurance as an alternative solution to spread risks with hedging instruments when other sources of insurance and liquidity are insufficient (PR Newswire, 2013; World Bank, 2003).

Turning to perils in Thailand, for example, it suffered from devastating floods in 2011, resulting in heavy loss for more than 4 million household, business, and large industries. This has generated structural damage 4 times greater than what resulted from Japan's earthquake and tsunami in March 2011, but due to a low rate of insurance adoption, only half of the total loss was compensated (Lee & Coppola, 2012). The insured loss was estimated at USD 12-15 billion as shown in Table 5.2 (Mahul & Gurenko, 2012; Lee & Coppola, 2012). Moreover, according to the results of an interview conducted in Thailand, there was a Japanese insurance company which held all risks without sharing to reinsurance, leading it to suffer heavily (Sriprom, 2014). Normally, the government sets the nominal interest rate and collects taxes in order to conduct conventional fiscal and monetary policy (Molteni, 2014), including policy issuing for subsidization and market stabilization. After the flooding in 2011, the domestic supply of catastrophe insurance fell short as insurers and reinsurers became scarce in the Thai market. Some foreign reinsurance companies denied to reinsure properties or increased premiums significantly. The role of the government regarding liquidity is to launch feasible policies to

improve social welfare legitimacy, so the cabinet announced the catastrophe situation. The catastrophe situation leave the government no choice but to create the "Government (or National) Catastrophe Insurance Policy" to take the place of foreign reinsurers in offering reinsurance services. Due to the high demand after flooding, the Thai National Catastrophe Insurance Fund reports that only between 28 March 2012 and 7 January 2013, both domestic and foreign companies which suffered during the 2011 great flood purchased a total of 3,745 catastrophe insurance policies, with a total of US$470.7 million in proportional reinsurance funding (PR Newswire, 2013).

Table 5.2 Thailand Non-Life – Insured Flood Losses in 2011 (Lee & Coppola, 2012)



The effective strategies are implemented as proactive approach of risk mitigation, in particular against severe flooding. Clearly, it proves the vital role of the government to supply liquidity as a risk manager which can build confidence and assure investors not to move their production bases out of Thailand.

5.4.3C Multi-country Catastrophe Insurance Pool

In the past, governments were often unaware of their natural disaster vulnerability. Thus measures to alleviate disaster risks were also overlooked because major disasters had rarely

occurred. This section will provide the essence of multi-country catastrophe insurance pool and continue explaining the national liquidity preserved by the government.

The pool of insurance is reinsured in the capital market (not the insurance market as other risks), to share the catastrophe risks among countries in the same region. This pool puts emphasis on the important role of the government to prepare liquidity at a country's level. Even though the project sponsors or infrastructure managers cannot deal with the funds in this pool themselves, the participating governments can use this coverage tailor-made to their needs at a considerably lower expense than to individually purchase in the financial markets. The so called pro-active risk financing support can assure the participating governments that they can have liquidity to start emergency recovery while maintaining essential government infrastructures and services (Ghesquiere, et al., 2006).

The first region which form this pool named Caribbean Catastrophe Risk Insurance Facility (CCRIF) is the Caribbean Island States. The CCRIF will allow Caribbean governments to purchase coverage akin to a business interruption insurance that will provide them with immediate short-term liquidity in the aftermath in case of a major natural disaster such as hurricane or earthquake.

This collaboration results in an efficient risk-financing instrument that participating countries can obtain insurance policies at almost half the price comparing with how they can obtain by approaching the reinsurance industry by themselves.

5.4.4 Liquidity Supply from the International Insurers/ Reinsurers

By nature of insurance, similar risks that underlie the concept of insurance from different projects are shared in the shared risk pool among a large number of insurers. One of the risk pooling methods widely used is called reinsurance.

Reinsurance companies can be (1) any domestic insurance company which is interested to make an agreement to share risk from a designated project with the ceding company or (2) a specialist reinsurance company. However, with limited size of reinsurance market capacity within a country, the acknowledged reinsurers from oversea are always invited. The largest

reinsurance companies (ranked by Net reinsurance premiums written in 2014) are Swiss Reinsurance Co (31640 Mil$) and Munich Reinsurance Co (30,478 Mil$) (S&P Global Ratings, 2015). This study is interested in how important international reinsurers allocate liquidity to PPP projects when domestic liquidity is scarce.

Reinsurance is not only used as liquid asset for the infrastructure projects, but it can also help domestic insurers to continue supplying liquidity when its capacity is low. There are various reasons why insurances in a country can possibly fall short. For example, the inexperience of unfavored events, which is why the awareness of using catastrophe insurance in the previous sector 5.4.3A is not enough. Apart from flooding, Thailand has fortunately never experienced an earthquake at 7 on the Richter scale because the country is not located on the boundary of geological faults, coastal areas, or in the so called earthquake zones. In addition, windstorms with speeds of 120 km. per hour are rarely seen. Thai insurers therefore did not pay much attention to preparing the target marketing. Domestic firms or multinational clients in need to require such coverage should, instead, rely on the oversea commercial insurance market for earthquake and windstorm insurance. The crisis of Thai catastrophe insurance market became worse after the great flood had occurred, as the domestic supply of catastrophe insurance became shortage especially in developing countries where the size of such kinds of insurance market is so limited. Not many insurance companies, even the international insurers, can issue such insurances. Sometimes, the government has to play the role of reinsurer to provide liquidity itself, as explained in 5.4.3

Nevertheless, reinsurers themselves have to somehow allocate the risks in hands. Capital markets have been at the forefront of innovation in the reinsurance marketplace in the last decade (Outreville, 1990). The reinsurers also need instruments to do such an allocation. To issue bonds is an alternative to release risks held by insurers back to the financial market.

Catastrophe Bond

As previously mentioned in section 5.4.3, this bond is an example of a financial technique to facilitate the transfer of risks from insurance market to capital market. To put it simply, catastrophe bond allows investors to receive an above-market return when a specific catastrophe does not occur in a specified time but sacrifices interest or part of the principal following the event. Disaster risk is thus transferred to (international) financial markets that have many times the capacity of the reinsurance market. Another advantage accrues to

investors. By adding catastrophic risk to their investment portfolios, necessary diversification is increased since natural catastrophes are not correlated with stocks and other investments tied to economic performance (Linnerooth-Bayer & Mechler, 2007).

In fact, catastrophe bond notes are always issued by a special purpose vehicle (SPV), sponsored by the insurer. The SPV is a legally independent entity that is set up for the sole purpose of arranging the catastrophe bond transaction. The SPV is used to transfer the proceeds of the issuance from investors and invest it in high quality, liquid securities. However, this entity can be established by the host government (Parmar, 2014)

The set-up of the SPV serves several purposes. The use of an SPV mitigates the credit risk in the transaction, as neither the party seeking insurance cover nor the party providing it needs to worry about either counterparty becoming insolvent. This differs from a swap arrangement where the protection buyer may bear substantial counterparty risk. If the catastrophe bond is triggered, the SPV will distribute the bond principal to the sponsor. It also helps to isolate catastrophe-specific risks from the sponsor's portfolio (Parmar, 2014).

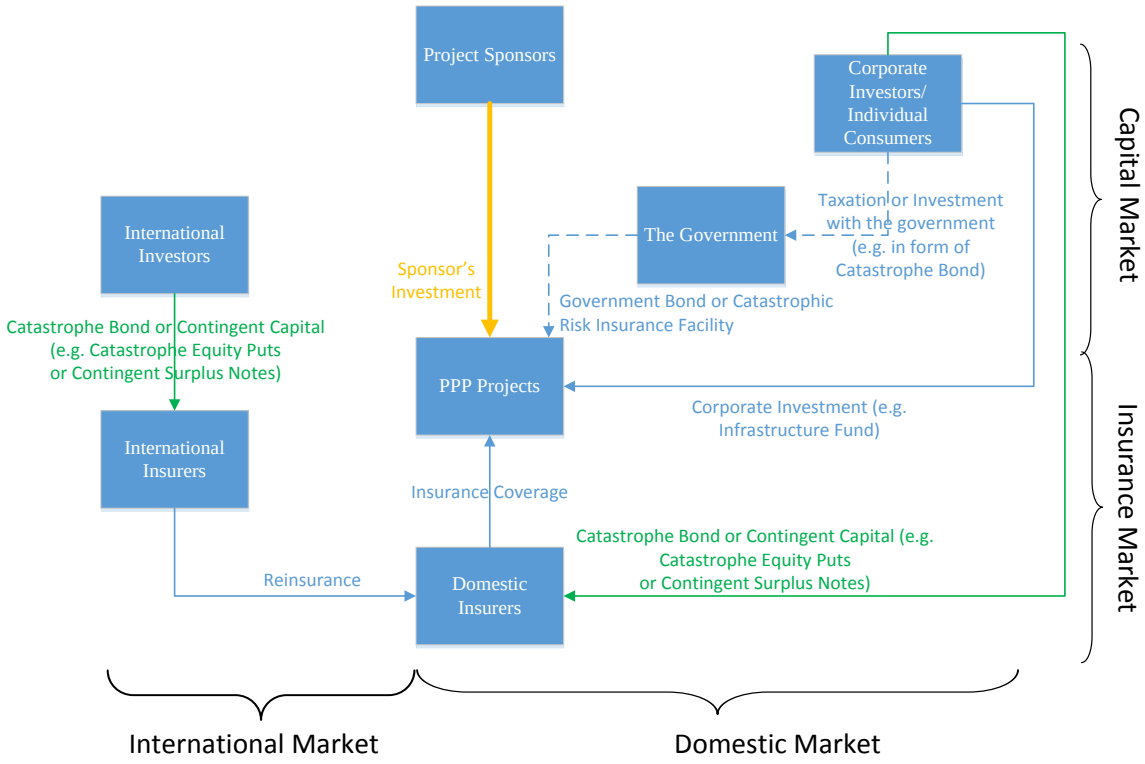


Figure 5.4 Supply of Outside International Liquidity (Insurers/ Reinsurers)

In the view of risk and liquidity management mechanism after catastrophe bonds is issued, the stock market is the primary channel by which insurance risk is transferred to the capital markets shown in Figure 5.4. By purchasing stock, investors are able to indirectly acquire insurance risk and become the ultimate risk bearers of the risk insured. This method of investing exposes investors to an entire portfolio of risks assumed by the insurers as well as other company-specific risks. CAT bonds allow investors to participate directly in specific, well-defined insurance related risks without having the investment diluted by the business risk of the company or any systemic risk (Parmar, 2014).

5.4.5 Liquidity Supply from the Multilateral Development Banks

There is a case that the government encounters risks and is also unable to generate adequate amounts of liquidity to finance the projects in hands. In this situation, the international financial institutions (MFIs) such as the World Bank or the Asian Development Bank should step in to provide international liquidity. The supply of liquidity can be given only when the government has made an agreement in advance, such as in form of the Word Bank's Partial Risk Guarantees (PRGs), which covers private lenders or project companies when the government fails to perform its contractual obligations with respect to a private project (World Bank, 2012).

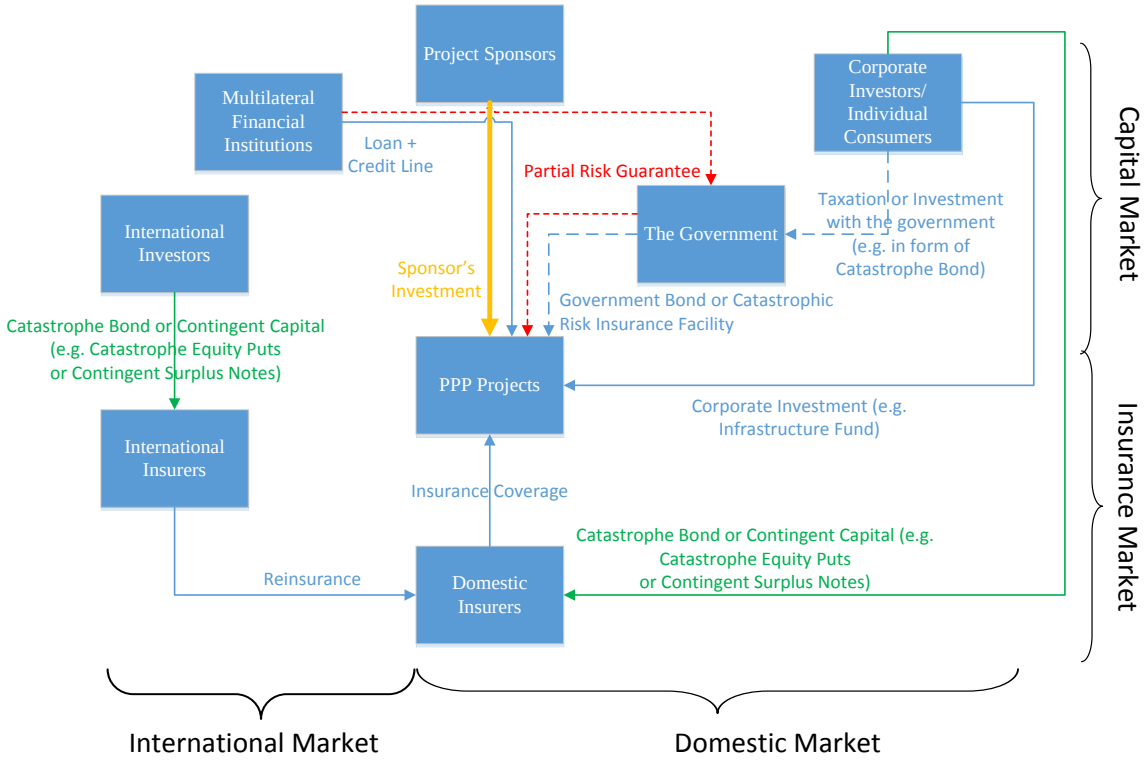


Figure 5.5 Supply of Outside International Liquidity (Multilateral Development Banks)

5.5 Alternative Principle of Risk Allocation for PPP Projects from the Perspective of Liquidity Supply

The flow of liquidity from the previous section can be used to build the Alternative Principle of Risk Allocation for PPP Projects from the Perspective of Liquidity as shown in Figure 5.6. In order to make decisions on the supply of liquidity in order to allocate risks effectively, the relating parties have to understand the situation they are in.

The first question to be asked is whether the liquidity shock can be covered by insurance. If the answer is yes, then the project sponsors can obtain liquidity from domestic insurance market. If the answer is no, they can use other securities to hedge in capital market. The second question is whether the shock is idiosyncratic or aggregate. If it is idiosyncratic, domestic liquidity is always sufficient and PPP projects can continue at full scale. If it is aggregate, the international or the public supply of liquidity is necessary. (It does not mean that without aggregate shock, the investment from international suppliers is not welcomed. It can be treated as corporate investment in this principle too. However, it will become indispensable for a country only if the liquidity shock is aggregate. For example, apart from the role of general lenders, the MFIs take another role to aid suffering countries by supplying liquidity in emergency situations.) The third question is whether the government can provide cheaper liquidity. When the country is hit by aggregate shock, sometimes the international insurers are reluctant to supply liquidity or they sharply raise the price of insurance. However, an aggregate shock in one country may not affect the price of insurance much if the international insurers treat it as an idiosyncratic shock in the international market. When the market price is high, the government can use the taxation power to convert future resources of consumer to supply to projects and individuals. Such action results in the deadweight loss of taxation and makes liquidity of the government more expensive. The government should compare its liquidity price with that from international insurers, and if it is cheaper, it is rational for the government to intervene to aid the country. If the international insurers' liquidity is cheaper, the government should let the sponsors buy it from the insurance market on their own.

In the case where the government lacks national liquidity to supply (e.g. sovereign risk), the problem can be solved only if the government has made an agreement with multilateral development banks such as the World Bank beforehand. This case can also count as the

government providing more expensive liquidity, thus the supply comes from the multilateral development banks instead.

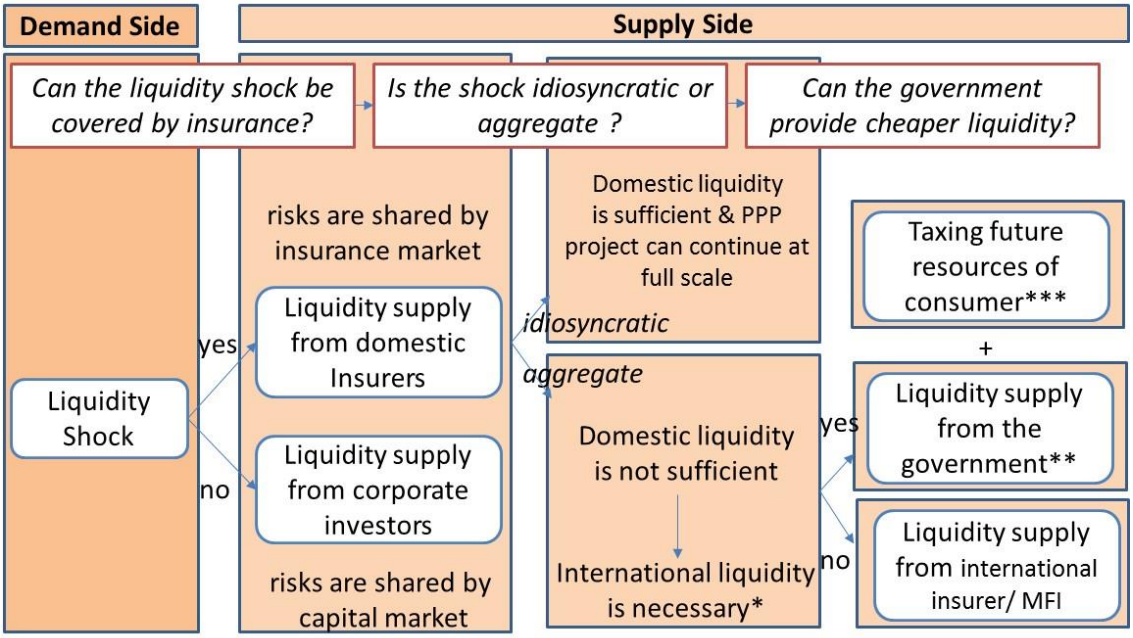


Figure 5.6 Alternative Principle of Risk Allocation for PPP Projects from the Perspective of Liquidity Supply

5.6 Discussion

Even though the government has taxation power, it has to be considered carefully regarding to what extent the government should supply liquidity. The discussion in this section rests on the assumption that whenever the government uses the power of taxation, deadweight loss of taxation increases. The following discussion is whether the government in developing countries like the Thai government should play a more prominent role in issuing the public supply of liquidity such as the CAT bond.

5.6.1 The Thai Government's Decision on Issuing National Insurance and Bond with regard to Insurance Life Cycle

Damages due to natural disasters tend to cost Thailand more in terms of values per disaster. Economic losses resulting from disaster negatively affects investors, individuals, and the government's long term budget. According to the Thai Fiscal Policy Office (2011), historical

data shows that in the last 30 years, flood hits Thai economy the most, comparing with other disasters in term of frequency, value of loss, and number of victims badly affected per occurrence. In Thailand, to help citizens get recovered, the Thai government has to work out a plan by allocating budget or to introduce quasi-fiscal policy through Special Financial Institution (SFI). Either way, it comes with "cost" to the government. These draw attention to "Disaster Risk Management" as an extremely important issue in which the Ministry of Finance should pay attention to.

As mentioned in section 5.4, a major advantage of the government to provide liquidity over the private sector is that the government can use either proactive liquidity preparation before any unfavored event occurs or liquidity raising and injection to alleviate the loss after its occurrence by using power of taxation. So far, Thailand has long been using "Ex Post Financing" approach (i.e., arranging funding for emergency responses, rehabilitation and reconstruction after disasters happen) by using variety sources of fund (i.e., budget allocation, loan, and tax expenditure). According to Holmström & Tirole (2011), not only for natural disaster, but the ex post public liquidity was also provided to alleviate the liquidity shortfall and its market crisis from the so-called Y2K (fear of computer breakdown at the beginning of the year 2000) by issuing put option. Such state-contingent liquidity is praised as a successful mitigation measure of the US government. On the other hand, funding for disaster management prepared before disasters hit known as "Ex Ante Risk Financing" has been studied to replace the conventional approach in many countries. Thus, in order to reduce financial liability, the issue of the government's ex ante risk financing is under consideration from the Thai cabinet.

The study of Thai Fiscal Policy Office (2011) proposes that among the 3 feasible arrangements of ex ante risk (reserve emergency funds, contingent debt and forgiveness of debt, and insurance), to transfer or hedge risks to private sector in capital market via insurance is considered the best choice for the Thai government. 3 possible practical methods are to provide a so-called National Insurance, Multi-national Risk Pool, and Catastrophe Bonds as mentioned in section 5.4.

Insurance Cycle

The problem regarding the liquidity provision is that insurance premium fluctuates based on demand and supply of insurance in global insurance market. This is known in insurance research as "Insurance Cycle" in Figure 5.6. To put it simple, the cycle can be distinguished

into 2 stages. First, when accident or catastrophe occurs, it not only causes loss to all insurers who insured the relevant policies but also has some effect on decision making for the remaining insurers in the market as a chain because some risks are pooled in insurance market. This causes anxiety to underwrite policy in the future, resulting in the raise of insurance premium. As a result, the insurance as liquidity is dried up and this stage is known in insurance literature as a period of "hard market condition" (Cummins, 2006; Born & Viscusi, 2006).

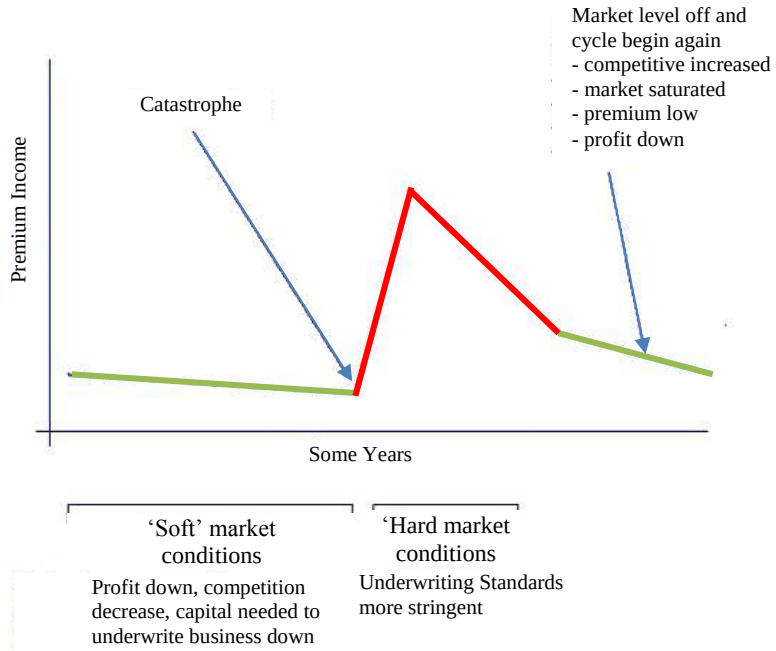


Figure 5.7 Insurance Cycle

In practice, the situation that shortage in the international insurance market has an effect on premium and the price of liquidity inevitably occurs. For example, with the catastrophe insurance shortage after disaster hits, many international reinsurers withdraw or raise the premium into the price that insured are unable to get, resulting in the market being no longer competitive. The insurance market's situation where the international reinsurance market anticipate the rise of insurance premium and minimize the supply of reinsurance is the so-called "soft market condition" in the second stage (Cummins, 2006; Born & Viscusi, 2006). When the market is under such circumstance, it becomes very difficult to transform asset into liquidity. Consequently, the government's intervention is necessary when liquidity supply is low under the hard market condition. By issuing government bonds and national insurances, the government can increase the capacity of national liquidity and thus enable the mitigation of insufficiency.

Nonetheless, political pressure might obstruct the initiative. In order to supply liquidity either via national insurance or Multi-country Catastrophe Insurance Pool, the government has to absorb high insurance premium. Particularly for countries with limited budget, if there is no claim for a long time, the efficiency on how the budget is used might be in question. There might be a force for the policy to be reviewed or the fund might be forced to be used for other purposes. Additionally, premiums have to be paid every year by the host government. It might not be easy to find political answers as to why the government should pay premiums when probability for the catastrophe to happen is low, and whether it is better to spend money on infrastructure to prevent damages from natural catastrophe.

The Thai government is now hesitating how it should develop such ex ante risk financing rather than former costly ex ante risk financing. According to the study of the Thai Fiscal Policy Office (2011), the result supports this study by suggesting the government 2 options if it would like to sponsor liquidity. The first is to encourage the government to issue CAT bond. With this option, however, the Public Debt Management Act 2005 has to be amended in order to allow the government to issue bond for the purpose of natural disaster insurance. In addition, responsible agencies should be identified to handle budgeting and reimbursement of the indemnity. Secondly, the government can establish a state enterprise agency to be an owner of the asset used to back CAT bonds. The agency has to establish a Special Purpose Vehicle (SPV) or a subsidiary to set up an SPV to do a securitization and sell CAT bonds to investors. The Royal Enactment on Special Purpose Juristic Persons for Securitization 1997 also has to be reviewed as it is unclear whether an insurance contract can be used as an asset under the act. A definition of an asset under this act might be revised to cover the activity of issuing CAT bonds.

5.6.2 Asymmetric Information (Soft Budget Constraint Problem)

From the analysis in the previous sections, the result brings up that if the inside liquidity generated from sponsors is exhausted, the need of extra liquidity from the outside source will naturally be derived up in the competitive market. The result further shows that in order to receive supplemental liquidity from exogenous assets (for example from the international insurers), the representative sponsor has to pay a liquidity premium per unit in exchange. Likewise, with the expanding model which takes consumers' investment into account, the

representative sponsor can persuade the consumers in the economy to supply liquidity by the positive rent per unit.

Up to this point, the study has highlighted different sources of liquidity which the sponsors can consider to utilize and supply for their demand. However, in the PPP concession projects, concessionaires who are under supervision of the state authorities sometimes request support from the government when they face the situation that they are unable to manage risks. If the sponsors realize that the government can intervene the market and supply liquidity to projects with cheaper price, they do not hesitate to request for such liquidity supports. When the responsible for the arrangement of projects under the public procurement is not fiscally liable for the outcomes, it often generates a moral hazard problem, known as soft budget constraint, which eventually leads to renegotiation (Kornai, et al., 2003). The soft budget constraint can emerge in many sectors. According to Kornai (1986), the subsidy is soften due to the private sector's negotiating, lobbying, or bargaining leading to soft subsidies granted by the government. The sponsors anticipate they will be bailed out in financial distress, and therefore, they have an incentive to engage in excessive risk taking, which increases the burden to the government (Mälkönen, 2008). As mentioned in the proposed principle, the role of the government is to evaluate the existing national liquidity level and the cost of burden when it uses taxation power to convert the consumer's resource to the public supply of liquidity, and then compare whether the liquidity generated is cheaper than that in the insurance market (for both domestic and international). The scale of shock strongly influences the government's decision to supply liquidity since the price of liquidity may not increase in the international market. The reason is the aggregate domestic shock in one country may be deemed as only idiosyncratic shock in the international market.

Another solution is, when both the sponsor and the government encounter the liquidity insufficiency or the situation that they are unable to manage risks simply because they lack financial capacities known as sovereign risks, the government might request the aid from Multilateral Financial Institutions (MFIs) such as the World Bank to overcome the financial crisis. This measure can be done only if the government realizes the possibility that this type of liquidity shock can occur, so it can make an agreement with the MFI beforehand. This assistance has come to developing countries many times especially when those countries were hit by catastrophe. In such cases, not only do concession projects, especially the critical

infrastructures, need immediate support, but the whole country including individuals and firms also need to recover.

5.7 Conclusion

As this chapter aims to propose the alternative principle of risk allocation from the perspective of liquidity, the attempt is made to understand the sources of liquidity and the roles of liquidity suppliers (project sponsor, the government, investors, domestic/ international insurers, and international financial institutes) when PPP projects are hit by unexpected risk events in forms of liquidity shocks as well as to explore how liquidity assets are provided across the insurance and capital markets to help the project weather those shocks. The spotlight is now turned on the liquidity management with regard to theoretical mechanism of the market of liquidity.

It was conceptualized that risks in PPP infrastructure projects, which may arise anytime throughout the project life, result in a shortage of liquidity and eventually make projects unable to continue. Such a liquidity insufficiency has to be handled beforehand with proactive risk allocation. Previously in chapter 4, the analysis of Liquid Asset Pricing Model (LAPM) proves that, in order to maintain the liquidity level to weather liquidity shock, the participation of outside domestic liquidity from consumers and the government, and outside liquidity from international insurer/ multilateral financial institutes are requested to supply to PPP projects. This chapter focusing on insurance and other securities' utilization proposes the principle which considers both risk allocation and theoretical mechanism of the market of liquidity to assure that PPP infrastructure projects are supplied sufficiently in a timely manner.

In developing countries like Thailand where PPP scheme is indispensably implemented, domestic investment funding using liquidity supplied by firms and by the government is always limited. The flow of liquidity supply in terms of insurance and securities has to be studied. To avoid the situation that liquidity needs cannot be fulfilled by corporate investment, the sound alternative is to transform some of the initial investment into continuation scale such as insurance. If the liquidity shock is idiosyncratic, the domestic liquidity is always sufficient and PPP project can continue at full scale. This is done by allocating insurable risks to domestic insurers via the transaction of liquidity and by hedging the uninsurable risks to the capital market. However, it is found that domestic insurers prefer risk diversification to bearing the

risks by themselves. The first step is to share risks with the international insurance market via the process of reinsurance. This eases the level of risks borne by domestic insurers and allows them to underwrite more policies. Secondly, both domestic and international insurers can use the capital market as a channel to transfer risks back to society through the capital market, for example by issuing CAT bond. This flow of liquidity helps practitioners realize how interrelation of markets affect liquidity demand and supply in macroeconomics.

At the national level, the study shows the linkage of liquidity needs in infrastructure management and the national liquidity storage supplied by the host government. The study further shows that on the one hand, the government, as a co-owner of the projects, has to take action when the aggregate liquidity shortage affects the project in hands. On the other hand, it has to be responsible for catastrophe which not only damages PPP projects but the whole economy. The government can increase the efficiency of budget used in disaster risk management by physical prevention for natural disaster and through budget allocation on ex ante disaster risk financing such as international insurance risk pooling. The result of this chapter can be used as a guideline for governments' decision making on when they should supply public liquidity. The role of government's supplying liquidity in terms of insurance is important since post-disaster expense is more expensive than preparation in advance. Likewise, when the insurance market is under the hard market condition, the government takes the primary role to solve this crisis. It is hence recommended that the government has to realize the importance of preserving national liquidity. However, in order to use public supply of liquidity efficiently, the government has to be able to evaluate the scale of liquidity shock and its burden when using the power of taxation in order to compare of the price of liquidity in both domestic and international markets. The case of the Thai government hesitating to supply liquidity is a good example. When social optimality is not achieved in an economy or when resources are not properly allocated, the government may intervene in markets in order to address inefficiency and maximize social welfare through regulation, taxation, and subsidies. For example, it can issue the government bond, catastrophe bond, or even the Multi-country Catastrophe Insurance Pool (which only the government can do) that the sponsor can leverage. However, it is emphasized that the government has to consider this market intervention prudentially because it often generates a moral hazard problem, known as the soft budget constraint, and renegotiation is therefore requested.

It is possible that the government suffers from sovereign risk or catastrophe risk and cannot generate enough liquidity to finance the projects in hands. In this case, neither the sponsor nor the government has other choices but to rely on international financial institutions such as the World Bank to provide international liquidity. This supply can be delivered only if the sponsor and the government can foresee the shock and make the agreement with such international financial institutions in advance.

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Chapter 6

Conclusions

6.1 Conclusions

6.1 Conclusions

This study provides a broad scope for risk allocation in infrastructure PPP projects in concerning liquidity provision and project finance. Even though many researchers present the risk allocation methods, the idea to allocate various risks associated with PPP projects were often focused and limited to finding the party between the public and private sector who can best manage those risks. This research, instead, takes into account the alternative risk allocations between domestic insurance companies and international insurance companies; and between the host government and multilateral development banks in the context of developing countries, which are still missing in the existing research of risk allocation. In order to develop this principle, liquidity which is originally used in the financial flows plays an important role to allocate resources and risks for the investment of infrastructure projects, particularly when the projects encounter unexpected incidents.

Even though there is an extensive literature discussing the use of risk financing instruments in PPP projects, little attention has been paid to the supply of liquidity for these projects in macro-economic level. In this research, the risk event which leads to reinvestment need, sometimes resulting in a shortage of liquidity, is referred to as a "liquidity shock". The liquidity shock emerging in the construction or operation phrase might cause difficulty for the sponsor and the government to raise fund to complete the project.

The main objective is to study how different types of risks in PPP projects that are conceptualized as liquidity shock should be allocated among relevant parties (e.g., the project sponsor, the lender, the insurer, and the public authority) from the perspective of liquidity supply. The framework employed in this thesis owes to the Liquid Asset Pricing Model (LAPM) developed by Holmstrom and Tirole which provides theoretical mechanism of the market of liquidity.

Findings in each chapter are summarized as following:

Chapter 2 reviewed the previous studies on PPP. To begin with, the reasons why the government has encouraged the private sector to invest in infrastructure projects and the definitions of PPP found in literature reviews were described. The PPP arrangement can draw the public and private parties which have different goals to jointly design, construct, and operate the project with rational risk-sharing principle. The role and responsibilities of parties constituting PPP was explored. It was found that, with the PPP scheme, the government opts to provide the platform for collaborative measures in order to share risks with the private entities instead of bearing most risks itself in the conventional procurement method, while the private sector can use its resources, technologies and experiences in handling business risks. In this regard, not only is political stabilization, but the measures and fiscal supports are provided to attract the private investors. However, the forms of PPP and supports which always come in forms of subsidization have different levels of risks. Therefore it is challenging for both sides to forecast those risks. Due to the long term agreement, it is difficult or impossible to assign probability to all risky events and to stipulate the contract conditions to cover these events. Various researchers have attempted to identify, categorize risks into groups, and then to propose systematic methods based on the orthodox risk allocation principle. The results from most extant studies pay less attention on the alternative of transferring some risks to a professional agent via insurance and securities. Some research barely mentions about insurance against force majeure only even though the use of insurance is broadened these days (the thorough coverages of insurance were then investigated in Chapter 3).

This chapter also introduced liquidity and highlighted its integration on risk management. The definition of liquidity was given with regards to PPP context. The author proposed that not all but some risk events which are substantially high need contingent investment which requires liquidity assets, otherwise the project cannot proceed. The 2 major reasons why developing countries always lack of liquidity were explained. The first and the most important reason is that the limitation of government budget constraint and weak taxation power. The second reason is that the market size where domestic liquidity supply comes from is relatively small in developing countries. Due to the development of the world economy's globalization, the increase in demand of complementary investment in

local infrastructure creates opportunities for investment, construction, operation and other business opportunities not only for local private firms to participate but also foreign investors and multinational financial institutes channeling the supply of liquidity from global market which is much bigger than domestic market.

Chapter 3 continued to explore the risk in PPP infrastructure project, with the tools of insurances and securities. It was found that the level of risks in a PPP infrastructure project can be reduced by: 1) allocating some risks to subcontractor, 2) the risks which can be insured (known as insurable risks) are then shared to insurers in insurance markets and 3). As a result, risks retained by the project sponsors shall then be minimized. The definitions of insurable risk were explored from both theoretical and practical perspectives. The major practical problem to identify insurable risks always arises when a risk is not mutually consent to be covered by the insurer. However, theoretically, insurability can be judged according to the "technology" of each country.

On the one hand, insurance policies, by definition of financial instrument which are legally binding obligations by a party to conditionally transfer something of value (i.e. money) as reimbursement against losses of casualties to the other party on a future date, are therefore a representative of liquidity to allocate insurable risks in PPP projects. On the other hand, those risks which cannot be transferred are borne to either public or private sector. It was further explored that the residual risks borne by the SPV are recommended to be hedged by liquid assets in forms of infrastructure investment vehicles or financial instruments provided from capital market.

Moreover, the chapter demonstrated how contract provisions are related to insurance acquisition of PPP projects. With the case study of Thailand's PPP projects, the author found that the government, as a contracting party, usually adds a provision in concession contract, enforcing the project sponsor as a counter party to take responsibility to acquire and manage the insurance. Furthermore, the chapter also explored the uses of different types of insurance regarding PPP projects and summarized the roles of relevant parties.

Chapter 4 presented a theoretical model developed from Holmström & Tirole's Liquidity Asset Pricing Model (LAPM) to help conceptualize the risk allocation in PPP project through liquidity provision. The model which is originally designed for general

business analysis was adopted to be suitable for the context of practical PPP projects. The key features of LAPM is the corresponding timeline of investment scheme divided into 3 stages; the project launch, reinvestment, and completion.

The LAPM was applied to this study because of its superiority over the conventional Capital Asset Pricing Model (CAPM) in many aspects. First, the CAPM is built upon the assumption that an economic entity is risk averse with criticism regarding how suitable the calculation of its risk premium is, whereas the LAPM eliminates this issue by assuming risk-neutral agents in the alternative model and provides insight of liquidity determination instead. Second, by using CAPM, the project is assumed to be a static variable that automatically yields the expected returns if completed, so it fails to consider the occurrence of uncertainty and risk allocation during the progress of the project.

This chapter compared the role of insurance and other securities as a key role in procuring liquidity when the additional investment is necessary to continue the project due to contingencies. Such a situation, or the so-called “liquidity shock”, occurs when liquidity of a project is in shortage. The liquidity comes from cash in hand (or in forms of liquid assets such as securities) or insurance. Such cash in hand is considered as a non-contingent claim whereas insurance is seen as a contingent claim. Consequently, in this case, when the reinvestment is needed, the various liquidity suppliers of the projects (corporate sector, the government, investors: domestic/ international insurer and international financial institutions) take responsibility up to the preservable amount of liquidity that parties have agreed on. This transaction can be indicated as a relationship between infrastructure projects and insurance markets. The utilization of liquidity is novelty in this research as it helps to explain why the project sponsors and the government, who monitors the projects, should care about liquidity. At the same time, it gives some insights into how risks can be proactively managed.

With dynamic approach of LAPM, the investments are divided into 3 stages where the intermediate stage represents the contingent claim corresponding to when the liquidity shock arises. The liquidity risk allocation is therefore more realistic and suitable to apply to long-term concession projects. The result of the model showed the deficient supply of insurance in infrastructure industry and explains the consequences when liquidity supply fails to meet demand in developing countries.

Chapter 5 demonstrated the alternative risk allocation principle by considering the mechanism of liquidity management with various sources of suppliers in PPP projects. Looking at the reality in developing countries, supply of insurance service in the domestic market is not enough to meet the demand. Due to the budget constraints of the government and the relatively small insurance market size, the share of foreign insurance companies in the market of insurance service for PPP projects plays a more prominent role to supply liquidity.

In developing countries such as Thailand, generally when inside liquidity (coming from corporate sponsors and investors) becomes shortage, this results in the requirement of complementary liquidity from international market's engagement. This phenomenon is explained based predominantly on Holmstrom and Tirole's Liquid Asset Pricing Model. When the idiosyncratic liquidity shock hits a project, the project which prepares adequate liquidity assets (either from insurance or capital market) beforehand is able to weather the unfavored risk event and continue its operation. However, when the whole country is hit by aggregate liquidity shock like catastrophe, all projects are in the same desperate situation as liquidity becomes shortage (insurers are reluctant to supply liquidity or they highly raise the premium). The result from the theoretical model points out that the government has to supply liquidity to domestic PPP projects. The government with its power of taxation can act like a mediator to allocate liquidity supply on behalf of consumers to the project in need of liquidity. In order to do so, it has to increase the national liquidity-supplied capacity in advance in case the country is under the aggregate shortage of liquidity in the future. For example, it can issue the government bond, the catastrophe bond, and the Multi-country Catastrophe Insurance Pool. Nevertheless, there is possibility that the asymmetric information (soft budget problem) may arise when the government intervenes the market to reallocate liquidity itself. The recommendation is the government has to evaluate its capability to provide the public supply of liquidity based on the level of existing national liquidity and the price of liquidity in both domestic and international market. The reason is, sometimes, the price of liquidity may not be affected in the international market because the aggregate shock in one country is treated as only idiosyncratic in the international market. In the worst case scenario, there is however possibility that the government is not in the good position to manage some risks such as sovereign risk resulting in the inability to generate adequate amounts of liquidity

to finance the projects in hands. In this situation, the price of public supply of liquidity is counted as expensive. The sponsor and the government should consider the international financial institutions such as the World Bank which have plentiful liquidity (because they are not affected by domestic shocks) as a choice to provide international liquidity. This measure can be used only if the sponsor and the government have anticipated the aggregate liquidity shock and thus requested for a guarantee from such international financial institutions beforehand.