Internalization of Emission Credits, Social and Environmental risks of Lending Activities

An extension of Dealership Model

by

Shanty Noviantie, MFM

A dissertation submitted in partial requirements for the degree of Doctor of Philosophy

The Faculty of Economics

Università degli Studi di Verona

March 2013

UNIVERSITA' DEGLI STUDI DI VERONA

DIPARTIMENTO DI
SCIENZE ECONOMICHE

SCUOLA DI DOTTORATO DI
ECONOMIA

DOTTORATO DI RICERCA IN
ECONOMIA E FINANZA

Con il contributo di (ENTE FINANZIATORE)

Universita degli Studi di Verona

CICLO /ANNO (1° anno d'Iscrizione) 25° Ciclo (2010)

TITOLO DELLA TESI DI DOTTORATO

INTERNALIZATION OF EMISSION CREDITS, SOCIAL AND ENVIRONMENTAL RISKS OF LENDING ACTIVITIES: AN EXTENSION OF DEALERSHIP MODEL

S.S.D. STATISTICA ECONOMICA (SECS-S/03,SECS-P/11)
(indicare il settore scientifico disciplinare di riferimento della tesi dato obbligatorio)*

Coordinatore: Prof. Giam Pietro Cipriani

Firma ___________________________

Tutor: Prof. Luigi Grossi

Firma ___________________________

Dottorando: Dott. Shanty Noviantie

Firma _________________________

* Per l'elenco dei Settori Scientifico-Disciplinari (SSD) si veda il D.M. del 4 Ottobre 2000, Allegato A *"Elenco dei Settori Scientifico –Disciplinari"* reperibile sul sito del Ministero dell'Università e della Ricerca al seguente indirizzo: http://www.miur.it/atti/2000/alladm001004_01.htm

ABSTRACTS

La legislazione ambientale e la regolamentazione in materia di responsabilità sociale delle imprese è sempre più restrittiva tra le nazioni. Le imprese a sostenere i costi degli investimenti in ambientalmente e socialmente consapevole della tecnologia o dei costi di risanamento dei danni sociali e ambientali. Finanzieri, le banche in particolare, dovrebbero tener conto di tali costi nel prezzo e prestiti fornitura. In Europa, gli Stati Uniti, e la regione del Pacifico, molte banche sono state volontariamente valutato l'impatto ambientale e sociale, ma non è riuscito a trasmettere l'impatto sui prezzi. Così, dal 2005, la regolamentazione bancaria in Indonesia prescrive le linee guida per valutare e prezzare il rischio ambientale e sociale delle attività di prestito. Tuttavia, il regolamento non disciplina i prestiti alle proiettare attenuanti che i gas a effetto serra (GHG) di emissione[1]. Di conseguenza, solo poche banche in fattore di Indonesia l'impatto dei crediti di emissione in prezzi e dell'offerta di prestiti[2]. Prestiti a progetti che generano crediti di emissione espone le banche indonesiane di incertezza sul prezzo dei crediti di emissione durante la generazione di ulteriori entrate dalla vendita di crediti di emissione.

Questo studio indaga interiorizzazione dei crediti di emissione, il rischio ambientale e di rischio sociale nella gestione del rischio di 51 banche indonesiane. In particolare, esamina l'interazione tra i prezzi dei prodotti della banca, quali prestiti e 1) di rischio-rendimento sui prestiti che generano crediti di emissione, 2) effetto di portafoglio di depositi a scadenza indeterminata, 3) prestazioni ambientali e sociali delle imprese prestiti. Il problema di ricerca è il seguente:

> ***Come sono i prezzi dei prodotti della banca associata a rischio rendimento sui prestiti CER generatrici, rischio ambientale, e l'impatto sociale delle attività di prestito?***

---

[1] Le emissioni di GHG sono sei gas la cui abbondanza e la concentrazione cambiano il clima, causando la siccità a lungo termine, l'inverno estremo, e così via (IPCC, 2001).

[2] Crediti di emissione sono emessi ai progetti che riducono l'emissione di GHG. 1 unità di accreditamento dell'emissione è uguale a 1 tCO2-eq di meno che la quantità di GHG emesso “nel commercio come di consueto (UNFCCC, 2001).

Il credito di emissione considerati in questo studio è Certified Emission Reduction (CER), che è l'unico tipo di problema di crediti di emissione per i paesi in via di sviluppo come l'Indonesia. Rischio-rendimento sui prestiti che generano CER è indagato nel contesto di prezzi del CER. Questo studio prende in prestito dal lavoro precedente nella dinamica dei prezzi di prezzo futuro di Euroepean Union Allowance (EUA), crediti di emissione rilasciate agli Stati membri dell'UE. Tuttavia, la causalità bidirezionale esiste presumibilmente tra ciclo economico e prezzi dei crediti di emissione e di energia. Quindi, il dynamics di CER è studiato sotto la struttura di VARMAX. I prezzi di macchia di CER sono usati invece di prezzi di futuro di risolvere il problema di prodotto di convenienza. I risultati mostrano che le scosse positive sull'economia dell'UE-27, il costo di commutare la tecnologia e prezzi di EUA aumenti richiedono su CER. L'estremo tempo caldo e freddo anche aumenti richiedono su CER. I risultati sono robusti alle misure di costi di commutare tecnologici e al ciclo economico.

L'associazione tra crediti di emissione, del rischio ambientale e impatto sociale delle attività di prestito è esaminato utilizzando sulla responsabilità ambientale di Dionne e Spaeter (2003) e 'dealership model' of Ho-Saunder (1981). Dionne e Spaeter dimostrato quando costo per ripulire i danni ambientali influenza il servizio del debito, banche indirettamente pagare responsabilità ambientale dei mutuatari. "Dealership model" è scelto come il costrutto teorico poiché potrebbe catturare l'associazione tra la rifornimento di prestito ed i prezzi, e la rifornimento di deposito ed il costo. Il modello è modificato per dimostrare l'effetto di portafoglio di deposito e l'impatto ambientale e sociale di credito. Il modello è stato testato su dati panel non bilanciati trimestrali di 51 banche da marzo 2005 a dicembre 2010 I risultati sostengono modificato di “dealership model”. La differenza tra il prezzo ed il ritorno di deposito di maturità (deposito di termine) aumenti il deposito di non-maturità (depositi di risparmio e richiesta). La differenza tra il prezzo ed il ritorno di deposito di maturità (deposito di termine) aumenti il deposito di non-maturità (depositi di risparmio e richiesta). La differenza tra il prezzo ed il ritorno di maturità deposito (deposito di termine) diminuisce il non-maturità deposito (depositi di risparmio e richiesta).

Rischio di mercato, rischio di credito, rischio di sociali, rischio di ambientali, il grado di avversione di rischio, il profitto aspettato, la volatilità di prezzo di CER, volume di transazione, ed il potere di mercato aumenta la differenza tra il prezzo di prestito ed il deposito (il margine di intermediazione). Il costo di contanti, il costo di opportunità di riserva monetaria, il requisito di riserva di liquidità ed il limite superiore di prezzi di deposito diminuisce la differenza di prezzo. È importante notare che la volatilità del prezzo dei CER non è statisticamente significativo nello spiegare la variazione dei prezzi di prestito a causa del piccolo volume di CER. I risultati sono robusti per l'inclusione di tempo variabili, clustering e heteroskedasticity in residui.

ABSTRACTS

Environmental legislation and regulation on corporate social responsibility has been increasingly restrictive across nations. Firms often bear costs of investing in environmentally and socially conscious technology or costs of cleaning up social and environmental damage. Financiers, banks in particular should take into account such costs in pricing and supplying loans. In Europe, the USA, and Pacific region, many banks have been voluntarily assessed the environmental and social impact but failed to transmitted the impact into prices. Thus, since 2005, banking regulation in Indonesia prescribes guidelines to assess and price environmental and social risk of lending activities. However, the regulation does not govern lending to project abating greenhouse gases (GHG) emission[3]. Consequently, only a few banks in Indonesia factor the impact of emission credits into loan prices and supply[4]. Lending to projects generating emission credits exposes Indonesian banks to uncertainty about price of emission credits while generating additional revenue from selling emission credits.

This study investigates internalization of emission credits, environmental risk, and social risk into risk management of 51 Indonesian banks. Specifically, it examines the interplay between prices of bank's product such as loans and 1) risk-return on loans generating emission credits, 2) portfolio effect of non-maturity deposits, 3) environmental and social performance of borrowing firms. The research problem is as follows:

> ***How are prices of bank's products associated with risk-return on CER generating loans, environmental risk, and social impact of lending activities?***

The emission credit considered in this study is Certified Emission Reduction (CER), which is the only type of emission credits issued to developing countries such as Indonesia. Risk-

[3] GHG emissions are six gases whose abundance and concentration changes climate, causing overlong drought, extreme winter, and so on (IPCC, 2001).
[4] Emission credits are issued to projects abating GHG emission. 1 unit of emission credit represent 1 tCO_2 equivalent GHG emission reduced from the amount of GHG emitted in business as usual (UNFCCC, 2011).

return on CER generating loans is investigated in the context of CER prices. This study borrows from previous work in price dynamics of future price of European Union Allowance (EUA), emission credits issued to EU member states. However, bidirectional causality presumably exists between business cycle and prices of emission credits and energy. Thus, dynamics of CER is studied under VARMAX framework. The spot prices of CER are used instead of future prices to tackle debate about convenience yield in future prices of emission credits. The results show that positive shocks on the economy of the EU-27, technology switching cost, and EUA prices increase demand on CER. Extreme hot and cold weather also increases demand on CER. The results are robust to measures of technological switching costs and business cycle.

The association between emission credits, environmental risk, and social impact of lending activities is examined by introducing Dionne and Spaeter's (2003) idea about environmental liability into Ho-Saunder's (1981) dealership model. Dionne and Spaeter demonstrated that when cost to clean up environmental damage influences debt service, banks essentially bear part of borrower's environmental liability. The dealership model is selected as theoretical construct since it could capture the association between loan supply and prices, and deposit supply and cost. The dealership model is modified to demonstrate portfolio effect of deposit and the environmental and social impact of lending activities. The model is tested on unbalanced quarterly panel data of 51 banks from March 2005 to December 2010. The results confirm the modified dealership model. Supply of non-maturity deposit (i.e. savings and demand deposits) increases with spread between prices of maturity deposit (i.e. term deposit) and return on invested maturity deposits in money market. On the other hand, supply of maturity deposits decreases with spread between prices of maturity deposit and return on invested maturity deposits in money market.

Spread between loan and deposit prices, known as intermediation margin, increases with market and credit riskiness of bank's products, environmental and social performance of borrowing firms, degree of risk aversion, expected profit, price volatility of emission credits, transaction size, and market power. The price spread decreases with operating cost, opportunity cost of cash reserve, liquidity reserve requirement, and upper bound of deposit prices under mandatory deposit insurance scheme. It is important to note that price volatility of emission credits is not statistically significant in explaining variation in loan prices due to small number of banks factor emission credits in loan prices. The results are robust to the inclusion of time variables, clustering, and heteroskedasticity in residuals.

ACKNOLEDGEMENTS

I would like thank to my supervisor, Assoc. Prof. Luigi Grossi, for providing exactly the right amount of guidance. I would like to thank Central Bank of Indonesia for data accessibility and assistance in banking survey. All banks that respond to the banking survey are gratefully acknowledged for providing a wonderfully rich and exciting research setting.

I am also indebted to Asst. Prof. Silvia Centani and Laura Magazzini, and an anonymous referee in the ESE's 2011 energy conference for their insights on alternative estimation and testing techniques. I am also indebted to anonymous referees in the 25th Australasian finance and banking and GFC's 19th annual global finance conference for their critics on the theoretical construct for internalization of environmental and social impact of lending activities. Last but not the least, I would like to thank the University of Verona for their financial support and my parents for their moral support.

TABLE OF CONTENT

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

CHAPTER 1 INTRODUCTION

1.1. Problem Background

This study investigates statutory approach in internalizing environmental and social impact of lending activities into risk management process in banks. Specifically, it examines the use of loan prices to factor risk-return on projects generating emission credits, environmental risk, and social impact of borrowing firms into risk management of lending activities. The study is based on 51 commercial banks in Indonesia that represents 90% of total loan in the country. The sample consists of three state owned banks, 20 branches and subsidiaries of foreign banks, and 28 of local banks. Below explains the necessity of internalization and testing statutory approach for the internalization.

Benefits and costs of producing and consuming goods and services are often spilled over parties uninvolved in the production and consumption process. For instance, electricity production that reduces greenhouse gases (GHG)[5] emission costs electricity buyers. However, benefit from emission reduction is spilled over parties who do not buy the electricity. Another example is conversion of rain forest to palm oil plantation. The conversion enormously reduces underground water and costs farmers surrounding the plantation. Thus, some costs of producing palm oil are externalized to parties uninvolved in trading palm oil. Both examples show that market prices often do not reflect full benefits or costs of production and consumption process. Mishan (2007) noted four practical approaches to correct such market failure: (1) government's command and control by limiting the amount of pollution or requiring firms to install pollution control device, (2) market based approach such as tradable emission credits, (3) social norms such as consumers supporting green labelled products, (4) economic policy instruments such as tax and subsidy.

[5] Intergovernmental Panel on Climate Change (IPCC) defined six GHGs emitted from production and consumption process whose abundance and concentration changes climate. The climate changes such as overlong draught and extreme winter might damage human wellbeing and economic activity. The report also highlighted GHG emission abatement as one of two most important measures to tackle climate change (IPCC, 2001).

This study focuses on using government intervention and market based approach to internalize unpriced benefits and cost into cost of fund, loan prices in particular. Government intervention takes form environmental legislation and regulation on corporate social responsibility mandate parties who are responsible for degrading quality of environment and wellbeing of society to amend the damage. Paying the victims, cleaning up the contaminated sties, or spending on preventive devices incurs additional costs to the firms. The adoption of market-based approach at international level such as Emission Trading System (ETS) allows firms operating in countries where local ETS does not exist to generate additional revenue. The firms might sell Certified Emission Reduction (CER) when their projects or operations produce GHG emission less than the amount of emission under business as usual scenario. Either additional cost or additional revenue should be taken into account by buyer and seller of goods and service as well as fund suppliers on productive and consumptive investment. Otherwise, financiers overestimate firms' financing needs, financial capacity to repay while underestimating risks inherent in the funded projects.

In practice, financiers, particularly banks in Europe, the USA and Pacific region are aware of the abovementioned cost and revenue. However, they do not have benchmarking and reference of best practices to precisely quantify the cost and revenue, and transmitted them into prices of bank's products (Rhee and Lee, 2003; Thomson and Crowton, 2004; Köllner et al, 2004; McKenzie and Wolfe, 2004; Weber et al 2008; Chave, 2010). Jeucken (2001) and Labatt and White (2002) found that the risk-return on trading emission credits is often found missing in pricing loans. Lack of knowledge of factors influencing risk-return on trading emission credits and of consolidating small-scale projects are found to be the main reason. Gouldson and Murphy (1998) argued that in such situation regulatory intervention on internalization should be extended from borrowing firms to banks. In other word, regulation should also prescribe methodology or guidelines for banks to identify, measure and price the externalities.

Gouldson and Murphy's (1998) idea implies that firms' liability to mitigate environmental and social risk of their activities should be extended to banks. There is a growing body of literatures on using regulation to extend firms' liability to mitigate environmental risk to banks (Jin and Mengqi, 2010; Pitchford, 1995; Boyer and Laffont, 2007). Dionne and Spaeter (2003) demonstrated a more comprehensive setting of mandatory transmission of environmental risk to loan prices. They proposed that when banks do not have access to full information about how borrowers allocate fund to productive and preventive investment, environmental risk exposure is extended to bank with loan size as the upper bound. The model however neglects the notion that loan price and supply is dependent on fund supplied to banks. Thus, loan prices and supply might also be influenced by factors influencing fund supply such as portfolio effect and regulatory costs. It is also important to note that the abovementioned studies do not take into account social impact of lending activities and risk-return on loans to projects generating positive externalities such as emission credits.

To the author knowledge, the explicit considerations of the risk-return on lending to projects generating emission credits together with environmental and social impact of lending activities is lacking in practice and economic literature. Few countries might mandate banks to manage environmental risk of lending activities but do not govern social impact of lending activities. Indonesia, in contrast, has mandated banks to assess and price environmental and social risk of lending activities since 2005 (Bank Indonesia, 2005). The regulation requires banks operating in Indonesia to reserve provision to absorb environmental and social risk of lending activities. The provision, which is transmitted into loan prices, should tracks environmental and social performance of borrowing firms that is published by Ministry of Environment. The firms' performance is rated based on how important community development in firms' corporate social responsibility initiatives, and how well firms in reducing, reusing, recycling, and recovering wastes or pollutants. The rating does not comprise assessment on risk and return on trading positive externalities such emission credits. Consequently, banks that do not have expertise in and knowledge of ETS do not price risk and return on trading emission credits. Clearly, even in country mandating environmental and social risk management on lending activities, risk-return associated with trading emission credits might be not be factored in loan prices and supply. Understanding about price dynamics of emission credits is pivotal to factor emission credits into loan prices and supply.

Three issues need to be clarified since they form the background information required to address the research questions in next section. First, this study aims to correct problem in the existing economic model for internalizing environmental risk. Economic literatures on internalization of environmental externalities typically ignore interdependency between fund supply and demand. From bank perspective, prices of fund demanded (loan prices) are dependent on prices of fund supplied (deposit prices). Two seminal banking theories have been widely used to explain interdependency between fund supply and demand. The first theory is micro-banking model that borrows from neoclassical analysis of firms. Banks are assumed as administrators of a country's payment system. Thus, they might raise fund from one economic agent and lend it back to another economic agent. Banks set size of loans such that the ratio of net price over gross price is equal to inverse elasticity of demand for loan (Pyle, 1971 and 1972; Klein, 1971; Baltensperger, 1980). The second theory, dealership model correct the assumption about banks as price takers. In reality, banks set loan prices to influence the size of loans, not the other way around. Banks also expose themselves to interest rate risk by taking position in money market whenever demand on loans does not match supply of deposits (Ho and Saunders, 1981; Allen, 1998; Maudos and Guevara, 2004). Thus, in this study dealership approach is modified to explain how environmental and social risk, emission credits and other factors are transmitted to loan prices.

Second issue needs to be addressed is about CER[6] prices used in this study. ETS is structured such that market price of emission credits is revealed when marginal cost of switching from emission intensive technology to low emission technology equals marginal benefit from buying emission credits. Therefore, the impact of factors irrelevant to technological switch such as project risk and convenience yield are removed in this study by using spot price of CER in the secondary market. Thus, this study does not resort to previous works concerning CER prices such as Mansanet-batallier et al (2011) and Chevallier (2011) that focus on prices of future contract and consider some measures of project risk. In practice, project risk is not observable in the

[6] CER is issued by registry administrator of Clean Development Mechanism (CDM), a secretariat in the United Nation. One unit CER represent one tCO2 equivalent reduction in GHG emission. The reduction is calculated from GHG emitted under business as usual (UNFCCC,

market since we do not have information about the origin of the project producing CER. Moreover, convenience yield embedded in the future price of emission credits has been found change in sign when different measure for the yield and statistical techniques are employed (Borak et al, 2006; Homburg and Waner, 2007; Daskalakis et al, 2008).

The third concern is related to a growing body of literatures on price dynamics of emission credits draws different conclusion about directional relationship between prices of emission credits and factors such as business cycle. Business cycle and prices of low emission energy has been found important in explaining price dynamics of emission credits. Nevertheless, extreme high price of emission credit might slow down business activities and increases prices of low emission fuel (Kiriyama and Suzuki, 2004; Chesney and Tachini, 2008; Ruijen and Vuuren, 2009; Keppler and Bataller, 2010). These studies concern about future prices of European Union Allowances (EUA) that are emission credits issued by the EU ETS and freely allocated to firms in the EU member states. However, the conclusion might be drawn from CER price formation since more than 80% of demand on CER comes from the EU ETS (UNFCC, 2011).

This study takes into account the possible weakening relationships between CER and EUA that is by the inclusion of CER in ETS of countries such as Australia and New Zealand. Vector autoregressive with moving average and explanatory variables (VARMAX) is considered the most appropriate model to understand dynamics of CER prices. There are two phases of data collection in this study. The first phase is banking survey in April 2011 that is discussed in details in chapter 3. Electronic questionnaires are sent to the executives of 66 banks by adopting purposive sampling. Bank supervisors directed the questionnaires to bank personnel responsible for pricing bank products and for assessing risks of lending activities. The 66 bank represent 97% of total loan in Indonesia and consist of three state owned banks, branches of ten foreign banks, subsidiaries of 16 foreign banks, and 37 national banks. The second phase is collecting time series of endogenous exogenous variables influencing demand of CER. The endogenous variables are technological switching cost, prices of CER substitute (i.e. EAU prices), business cycle, and electricity prices. Electricity prices represent demand side from the largest buyers of CER, electricity producers. Exogenous variables considered in the model are extreme weather and international policies on CER.

To demonstrate the interplay between risk-return on CER generating lending, environmental and social risk, and loan prices and supply, banking data of 51 banks is collected from compliance reports. Environmental and social risk rating is retrieved from Ministry of Environment database. The regulatory report provides contractual prices of bank products which should generates less bias estimation than using accounting income and expenses and proxy for prices. The report also provides loss provision for each borrowing firms, including loss provision associated with environmental and social risk.

1.2. Statement of Research Problem

As discussed above, despite significant interest in risk-return of trading emission credits as well as environmental and social risk of lending businesses, there is still a lack of research investigating banks' practices for factoring the three issues into their credit processes. Specifically, less research has been conducted in examining the associations between three issues and prices of bank products. With the view to filling the gaps in previous literature, the purpose of this study is to address the research problem:

How are product prices (i.e. price of products on asset and liability side of bank) associated with risk-return on CER generating lending, environmental risk, and social risk of lending activities in Indonesian banks.

Two research questions are developed in order to address this research problem.

Research Question 1:

What factors are important in the dynamic of CER price, hence dynamic of CER risk-return?

Research Question 2:

Are risk-return in fund raising and portfolio effect as important as risk aversion, transaction size, operating and regulatory costs in pricing loan, and other products?

Research Question 3:

How are price and supply of loan and other products associated with CER risk-return, environmental risk, and social impact of lending activities associated with?

1.3. Contribution

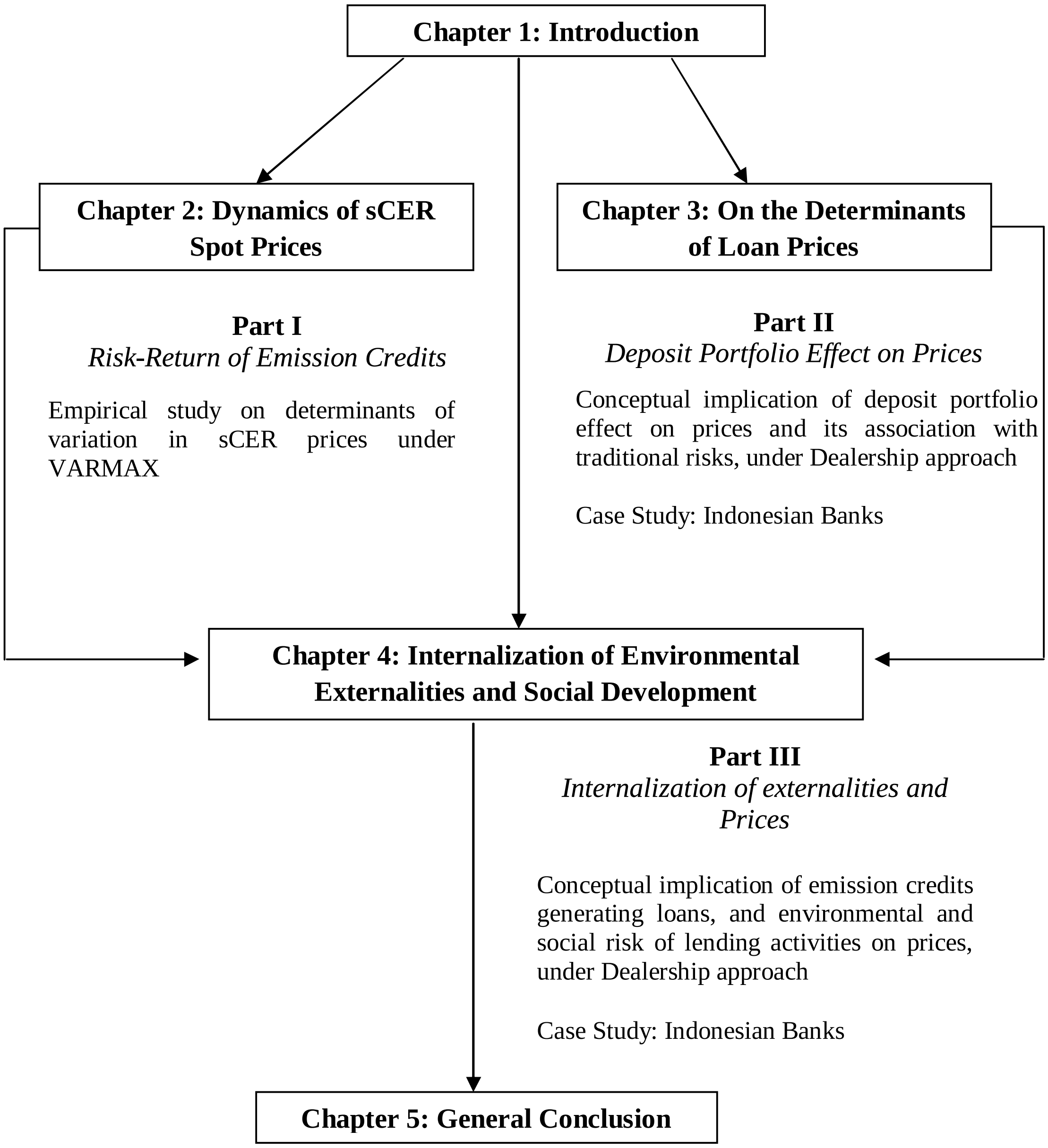
As mentioned in section 1.1, the economic literatures on environmental externalities neglect to address social impact of lending activities, risk-return on loans generating emission credits, and interdependency between fund supply and demand. Banking literatures might address the latter but fail to capture the first two issues and the impact of deposit portfolio selection. Additionally studies on emission credits have focused on future prices of EAU. In light of these, as the study likely to be the first to investigate the integration of emission credit, environmental risk, and social risk of lending activities, this study contributes to theory in several ways.

First, it provides new empirical evidence about the linkage between economic cycle, technology switching, emission credit, and energy in the spot market. Hitherto, there is no study to investigate the role of fungibility between emission credits on sCER and the joint role of energy and emission credits to the economy. Second, it relaxes the assumption about deposit in dealership model by introducing non-maturity deposit. Thus, the modified dealership model could accommodate high earnings and marketing cost on banks heavily depending on non-maturity deposits. Third contribution is providing alternative of theoretical construct that represents the internalization of environmental and social risk of lending activities as well as risk-return on loans generating emission credits.

1.4. The Structure of the Thesis

Figure 1 illustrates the linkage of the chapters and the mere structure of three major parts of the thesis.

Figure 1 Structure of the work and linkage of chapters



The first paper (chapter 2) investigates the dynamic linkage between prices of emission credits and cost of technology switching, economic cycle and energy in the spot market. Vector autoregressive moving average procedure with exogenous variables and conditional variance is employed. The second paper (chapter 3) builds on Ho-Saunder's

(1981) idea that banks act as “dealers” in money market when they receive deposits or disburse loans. Ho-Saunders (1981) model is extended to capture the impact of deposit and earning asset portfolio on price and demand of bank products. The extended model is tested on contractual prices of bank products to minimize potential bias estimation. The third paper (chapter 4) internalizing the impact of risk-return of CER generating loan as well as environmental and social risk of lending activities into the modified dealership model in the second paper. The assumption on environmental and social risk borrows from extended partial liability theory (Dionne and Spaeter, 2003). This model is also tested on Indonesian data.

CHAPTER II DYNAMICS OF sCER SPOT PRICES

2.1. Introduction

Only recently, attention has been paid to price formation of Certified Emission Reduction (CER). Even Mansanet-bataller et al (2011) found that their work is the first empirical study concerning CER prices. Generally, empirical studies on emission credits are devoted to European Union Allowance (EUA). EUA has been traded long before the introduction of CER in the EU emission trading system (ETS), and become the world's largest market for emission credits. Thus, market price formation of EUA is relatively easier to observe than other types of emission credit. Nonetheless, EUA, like other types of Assigned Allowance Unit (AAU) is traded exclusively in the ETS allocating EUA (i.e. the EU ETS). In contrast, two other types of emission credits created under the Kyoto Protocol, CER and Emission Reduction Unit (ERU)[7], can be traded across ETS. Therefore, CER market is likely to grow and diverge from EUA market with increasing number of new emerging ETS such as Australia and New Zealand ETS.

There are two notably empirical works concerning CER prices. Both works used prices of future contract on CER (Mansanet-Bataller et al, 2011; Chevallier, 2011) and borrowed from previous works on EUA future prices. Both papers consider the fungibility of CER and EUA. The fungibility has helped boost CER market to be the world's second largest market for emission credits after EUA market. The results indicated that interdependency between CER and EUA market might exist. This is expected since nearly 88.62% of demand on CER in 2011 came from the EU-27 member states (UNFCC, 2011). Nonetheless, demand is likely to emerge from new ETS such as Australia, New Zealand, and Japan where CER is allowed to substitute AAU. The implication of CER inclusion into new ETS is not only on market growth of CER but also on interdependency between CER and EUA market. In the long run, the two

[7] Under emission trading scheme, Removal Units (RMUs), Certified Emission Reductions (CERs) and Emission Reduction Units (ERUs) could be transferred to annex B countries to meet their target in GHGs mitigation. RMUs are generated from land use, land-use change and forestry (LULUCF) activities, while CERs and ERUs are generated from other market based mechanism (UNFCCC).

markets might diverge and share fewer common factors, which should be taken into account in empirical study on CER prices.

It is important to note that Mansanet-Bataller et al (2011) and Chevallier (2011) examined price dynamics of future contract on CER. In practice, CER futures contracts assume risk of undelivered CER, which evolves across stages of Clean Development Mechanism (CDM) projects. The evolution of such risk is difficult to observe since market participants in the secondary market can not trace back the origin of CDM projects. The use of future prices also raises issues about convenience yield estimation. Both papers also have strong assumption about relationship between economic activities, energy prices and demand on emission credits which might be implausible when we test it against previous works such as Mansanet-Bataller et al (2007), Convery and Redmond (2007), Alberola et al (2007, 2008) and Chevallier (2009a). These works indicated that directional causality and the sign of relationship between variables might change when time series belong to different phase of ETS.

Therefore, the contribution of this study has twofold. Firstly, it provides new empirical evidence about the linkage between economic cycle, technology switching, emission credit and energy in the spot market. Hitherto, there is no study to investigate the role of fungibility between secondary CER (sCER) and EUA in the spot market, and the joint role of energy and emission credits to the economy. Secondly, this study employs cointegrated Vector Autoregressive Moving Average with eXogenous variables (VARMAX) procedures with conditional variance on cointegrated series. This methodology allows us to examine the dynamic linkages of variables, in particular are the importance of macroeconomic and energy shocks on emission credits.

The results show that prices of EUA and sCER are influenced by the state of the economy in the EU-27 since the EU ETS is the biggest market for sCER and EUA. Thus, any investment decision associated with sCER needs to take into account business cycle in the EU ETS member countries. Second, price dynamics of sCER move in conformity with market expectation about fuel switching cost. Third, profit maximizing electricity producers should take into account changes in interdependency between emission credits and fuel switching cost. Limit on CER import in the EU ETS might explain that the shocks to sCER count for less than 3% of variability in EUA. In contrast, EUA shocks count for 8% - 28% of fluctuation in sCER. In the short run, positive shocks on CER and EUA put pressure on industrial productivity in the EU-27. Business cycle in the EU-27 counts for 1% - 6% while profit margin of electricity producers and fuel switching costs explain 7% - 30% of the variability in sCER. These factors explain less than 10% - 20% of variability in EUA. The transmission of positive shock on CER into electricity prices is much slower than the transmission of positive shock on EUA. Shocks on CER put pressure on electricity demand for about six months while the impact of EUA shocks takes less than one month before electricity price jumps. Positive shocks on CER increases fuel switching cost and put pressure on profit margin for electricity producers in the region. Positive shocks on fuel switching cost, profit margin for electricity producers, and industrial productivity in the EU-27 increases CER demand. Positive shocks on electricity price immediately put pressure on CER and EUA demand. After one month, CER and EUA demand picks up, which indicates that

2.2. Literature Review

2.2.1. Market structure of emission credits and CER issuance

CER is one of three emission credits created to accommodate developed countries to commit to and developing countries to participate in Kyoto Protocol, an international treaty that binds industrialized countries to reduce GHG emission. The two other emission credits are Emission Reduction Unit (ERU) and Assigned Allowance Unit (AAU). AAU comes with different terms across ETS. For instance, EUA is AAU allotted to regulated sectors in the EU ETS while Carbon Finance Instrument (CFI) is AAU for member states of Regional Greenhouse Gas Initiative in North America. EUA market has become the world’s largest market for emission credits and CER market comes second. CER market is considerably younger but more liquid than ERU market, which has operated since 2011. One unit of CER is worth the same as one unit of ERU or AAU i.e. one metric ton of CO_2 equivalent (tCO_2–eq).

There are at least three distinguishable features of CER. Firstly, CER has been traded across ETS. Theoretically, ERU can be traded across ETS but only the EU ETS has allowed ERU to substitute AAU. Thus, CER and ERU markets are dependent of demand and supply of AAU. In contrast, AAU is traded exclusively where ETS regulates the AAU. For instance, EUA is allocated to 11,000 power stations and industrial plants in EU-27 member countries, Norway, Iceland and Liechtenstein[8]. EUA can be traded within the EU ETS and is not valid in ETS such as New Zealand Emissions Trading Scheme, Tokyo Metropolitan Government, and Regional Greenhouse Gas Initiative. Therefore, regardless negative signal from Japan, Canada and US on international emission abatement beyond 2012, markets for CER and ERU might keep growing.

Australia has incorporated project-based mechanism into its emission trading schemes for compliance period July 2012 – June 2014 and July 2014 – July 2015. The country has not so far imposed restriction on CER import. New Zealand also allows the use of CER for unlimited amount during its transition period July 2010 – December 2012 while capping the price of its AAU, which is known as New Zealand Units. CER import is also allowed in Regional GHG Initiative (RGGI), Midwestern GHG Reduction Accord (MGGRA), and Western Climate Initiative (WCI) during their compliance periods. RGGI is cap-and-trade scheme for CO_2 from power plants for compliance period January 2009 – December 2018. The scheme comprises some states in Northeastern US and provinces in Eastern Canada[9]. MGGRA has shorter compliance period of January 2012 – December 2018 and fewer states member in US and Canada[10]. WCI has the same compliance period as MGGRA but involves different states and provinces in US and Canada[11].

[8] The EU ETS has been extended to airlines in 2012 as well as petrochemical, ammonia and aluminium industries in 2013.

[9] RGGI member states are Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, NY, Rhode Island, and Vermont. The scheme also comprises province Pennsylvania, Quebec, New Brunswick, Ontario in astern Canada.

[10] MGGRA member states are Iowa, Illinois, Kansan, Manitoba, Michigan, Minnesota plus province Wisconsin in Canada.

[11] WCI consists of provinces states British Columbia, Manitoba, Ontario and Quebec in Canada. The US states that are also members of the initiates are Arizona, California, Montana, New Mexico, Oregon, Utah and Washington.

The second distinguishable feature of CER is, like ERU, a project based emission credit while AAU is allotted to regulated sectors. Although it is difficult to trace back the origin of the project once CER enters the market, market prices of future contracts on CER and ERU assume project risk. The third feature of CER is its issuance to Clean Development Mechanism (CDM) projects in developing countries, and its sales to GHG emitters in developed countries that are listed in annex B of Kyoto Protocol. On the other hand, ERU is issued to projects in annex B countries and sold to other annex B countries.

Similar to EUA, CER is traded in forward, future and spot market. The first CER futures were launched in Nymex in February 2008. EEX, ECX and Bluenext are among exchanges followed the suit in 2008. CER spot market was opened in January 2008 by Climex and August 2008 in Bluenext. The latter has become the largest spot market for CER in terms of trading volume. Where CER is traded implies phase of CDM project that generates CER. CER can be traded in forward and future market once CDM Executive Board (CDM EB) registers the associated project as CDM project. To be registered as CDM project, a project owner should have his Project Design Document (PDD) approved by Designated National Authorities (DNA) in host country of the project. The document incorporates baseline approach, calculation on net emission reductions, monitoring plan, etc. The approved PDD is submitted to Designated Operational Entity (DOE)[12] that will validate the project. After validating the project, DOE submits validation reports and PDD document to CDM Executive Board (CDM EB).

Once CDM EB registers the project as CDM project, project owner could initiate the project and monitoring plan. At this stage, DOE verifies emission reduction in the project and submits verification report to CDM EB. Based on DOE's report, CDM EB issues CER to project owner. Once CER is issued, project owner is able to sell CER in the spot market. PointCarbon (2010) found that sometime CDM EB refuses to issue

[12] DOE is an independent auditor to validate PPD and assess the implemented projects. DOE is accredited by CDM EB (UNFCCC)

CER or issues fewer CER than project owner's calculation. Thus, CDM registration does not guarantee issuance of CER.

2.2.2. sCER price formation

2.2.2.1. Primary and secondary CER (sCER)

Primary market CER generally facilitates trading on forward contract or Emission Reduction Purchase Agreement (ERPA). Thus, price formation in the primary markets results from negotiation between buyer and project owner on the expected emission credit from the CDM project. Such price reflects seller's expectation on market price of CER on the delivery date and buyers' risk perception on acquiring emission credit in the future. Sellers' expectation on CER market prices is typically not derived from prices of primary CER since this price is not freely available. Instead, they infer CER prices from prevailing market price of sCER and floor price imposed by host country's DNA.

From buyer perspective, risk evolves across stages of project development. This is because many registered CDM projects fail to deliver the expected volume of emission credits. Therefore, CER prices climb along project's progress, implying evolution of risk of cost overrun, technology and delivery at each stage of project development. PointCarbon (2010) estimates prices of CER at PIN/concept stage are within range €8.25 – €9.75/tCO_2e in January 2010. CER price rises to €9 – €10/tCO_2e as project progress to PDD or validated stage. When the project is registered as CDM project, CER price moves up by €10 – €11.5/tCO_2e, and reaches €11 – €12.5/tCO_2e once CER is issued. Green (2008) noted that risk on primary projects also depends on how candour host country of DNA about project procedures and approval, counterparties' creditworthiness, CER distribution as well as buyer's control over CER issuance.

Aside from inherent risk across project stages, arrangement of risk sharing between buyer and seller also determines prices of primary CER. Buyers will agree on the lowest possible price if they bear major risk in each stage of project development and are willing to buy credits even if those credits are finally found illegible for CDM. The prices rise when sellers are willing to assume more risks and increase commitment to deliver fixed volume of CER. Nordseth et al (2007) illustrated that price could be €6 –

€8.5/tCO_2e higher when buyers assuming most risks than price if sellers assuming all risks.

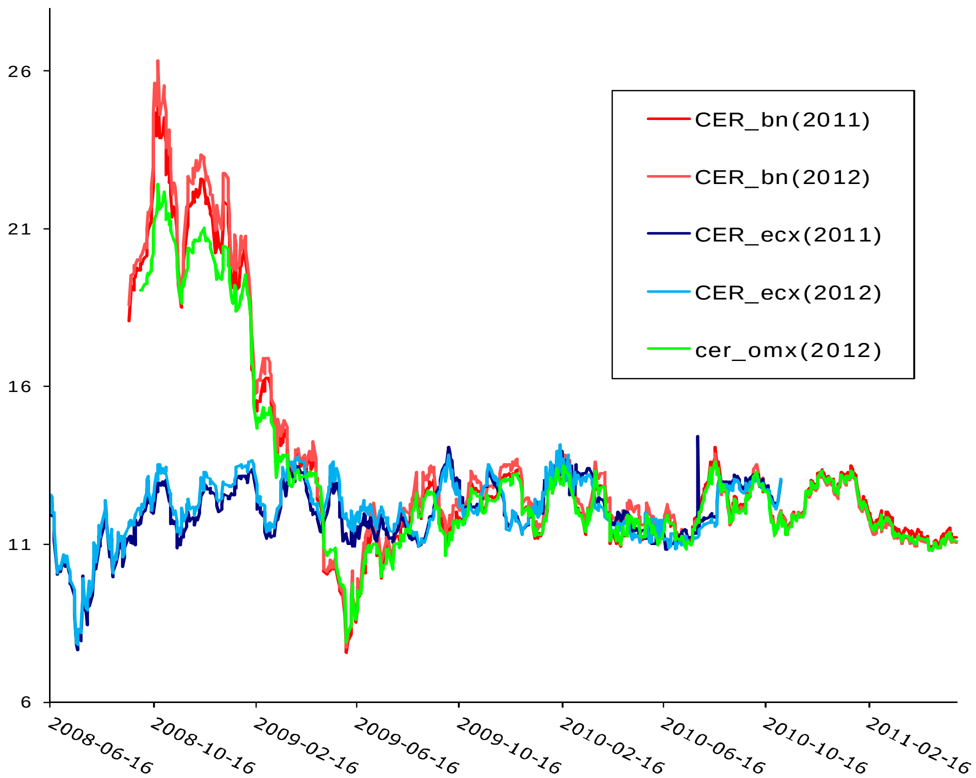
PointCarbon (2010) found that buyers are willing to pay premium price for CER produced from particular types of projects. For instance, price of generated CER in wind power is higher than that of hydropower due to World Commission on Dam. High average transaction cost in small-scale CDM project puts pressure on prices of CER from such project. Therefore, it is obvious that discovery of fundamentals of primary CER is convoluted. Nonetheless, CER prices are observable once primary CER is traded in the secondary market.

Secondary market for CER is created to facilitate trading on delivered CER, guaranteed to be delivered CER or CER giving compensation for undelivered emission credits. sCER contracts are standardized and generally separated from risk inherent in CDM project. The contracts could be futures, spot, options, structured product or secondary guaranteed forward contracts. Any form of the contract does not provide buyers access to the origin of CDM projects. Thus, buyers might unknowingly buy CER from a bulk of CDM projects. Accordingly, prices in sCER market are less likely to be determined by types, location and stage of CDM project development as well as country risk, political risk, credit risk and risk sharing scheme. Prices tend to be driven by demand and supply of CER as well as of that of CER's substitute.

2.2.2.2. sCER spot and derivatives markets

Of all forms of exchange-traded contracts, futures and spot contracts have been the most actively traded contracts. One unit contract in either spot or futures markets, typically represents 1,000 units of CER. The failure in delivery usually forces sellers to compensation buyers as much as market value of CER at delivery dates. Prices of futures contracts imply risk associated with development stages of underlying projects. Figure 2 shows futures prices of CER in the three biggest futures market (i.e. Bluenext, European Climate Exchange and Nasdaq).

Figure 2 sCER futures prices

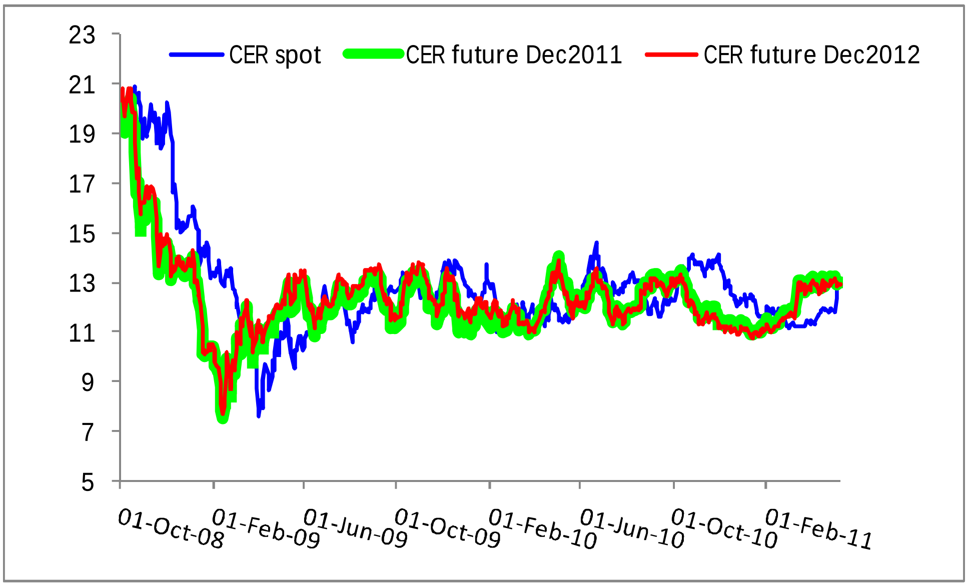


Sources: Bluenext, ECX and Nasdaq OMX

Price disparity of future contracts expired in December 2011 and 2012 were large across markets. Futures prices in Nasdaq-OMX (CER_omx) and in Bluenext (CER_bn) were extremely higher than prices in ECX future markets (CER_ecx) prior to March 2009. Nasdaq-OMX and Bluenext future markets were young during this period. As liquidity of both markets increased, prices in Nasdaq-OMX and Bluenext future markets converge to prices in EEX.

Figure 3 illustrates how prices of sCER future contracts expired in December 2011, and expired in December 2012 moved in the same direction as sCER spot prices.

Figure 3 CER spot and futures prices



Source: Bluenext

The price co-movement might be partly driven by the fact that CDM project owners often refer to current sCER price as ceiling price for primary CER. The future prices also clearly precede dynamic of spot prices. Thus, the expected spot prices might significantly determine futures prices.

Unlike other commodities, prices of CER futures have exhibited backwardation structure with being temporary flipped to contango. Theoretically, futures prices become cheaper than today's spot contract when there is insufficient supply in the spot market. This might not be the case for CER futures markets. Instead of insufficient supply, restriction on demand side might be responsible for the backwardation structure. The EU ETS as the biggest buyers of CER has imposed CER-import limit. Each country member of the scheme allows CER making up only a small percentage of emission reduction compliance. Aside from this, regulated sectors might prefer bank CER now at low cost of storage to anticipate the new imposition. The EU ETS allows CER transfer between 2008 – 2012 commitment periods and 2013 – 2020 commitment period. CER transferability coupled with EU ETS auction on all EUA and EU ETS extension of GHGs types as well as regulated sectors, are likely to increase demand on emission credits from 2012 onwards. Buyers anticipating a persistent up-trend in spot prices might prefer to buy and bank issued CER for unanticipated use in the future. Sellers might also find that cashing in CER in spot markets might protect them from adverse changes in CER roles in linking directive across nations. Additionally, delivery versus payment in the spot market might be also responsible for the high spot prices. Immediate exchange of CER instead of future exchange moves delivery risk from buyers to sellers. Sellers in the spot markets also expose themselves to the unanticipated downshift in prices at delivery date. Hence, premium prices on spot contract compensate sellers for bearing delivery and price risks. Therefore, it is clear that price fundamental of CER spot contracts is more straightforward than CER futures. Spot prices are absent from riskiness of underlying CDM projects, and likely to fully reflect supply-demand of CER.

2.2.3. Shortcoming in carbon price research

2.2.3.1. Common factors for sCER and EUA

Previous studies found empirical evidence that prices of emission credits particularly EUA move in tandem with factors such as land temperatures, energy prices, macroeconomic indicators and climate change policy (Mansanet-Bataller et al, 2007; Alberola and Chevallier, 2007, 2008 and 2009). Among those factors, energy prices impact have gained most attention since combustion installation alone makes up more than 65% of regulated installations in the EU ETS (European Commission, 2010). Energy prices as well as fuel-switching cost evidently correspond to EUA prices (Bailey et al, 1998; Montero and Ellerman, 1998; Paolella and Taschini, 2008; Seifert et al, 2008; Chesney and Tachini, 2008; Lewis, 2008; Blyth et al, 2009; Ruijen and Vuuren, 2009). Keppler and Bataller (2010) found different fundamentals structure between phase I and phase II EU ETS. During phase I, coal and gas prices influenced CO2 futures prices through the clean dark and spark spread, which in return influenced electricity prices. During phase II EU ETS, the reverse effect was found. In contrast, several authors claim that reverse effect was found in Phase I (Kiriyama and Suzuki, 2004; Blyth et al, 2007; IEA, 2007; Yang et al, 2008). Additionally, Daskalakis and Merkellos (2009) show that returns on EUA spot price increases with electricity risk premium. Thus, there is some common ground about factors influencing carbon prices. Nonetheless, there is no agreement about the sign and magnitude of the effect of each factor on carbon prices when different sample periods and proxies are used.

Cointegration between sCER and EUA spot prices is revealed when future prices are used in the analysis. Therefore, modelling sCER prices often resorts to price modelling for EUA. Mansanet-Bataller et al (2011) claiming their study as the first attempt to analyze price determinants of sCER, find that sCER and EUA share common factors. The common factors are institutional events, energy prices, weather events and macroeconomic variables. Macroeconomic variables are extracted from microstructure literatures. Among these variables are indicators of tracking past economic trends, economic sector's sentiment, impact of credit crunch crisis, euro area yield curve, aggregate market volatility, and carbon market trend. Nonetheless, only brent, coal and gas prices as well as momentum in sCER market and increasing link between European and international market for emission credit have statistically significant impact on sCER futures prices.

Although the two emission credits might share common factors, Chevallier (2011) found that sCER and EUA future prices responded differently to macroeconomics. He used latent factors in Bernanke et al (2005) in Factor Augmented Vector Autoregressive (FAVAR) model setting. Macroeconomic shocks were defined as shocks to 115 macroeconomic, financial and commodity indicators. The results showed that recession shocks pushed EAU futures prices down but simultaneously had driven sCER prices up. Intuitively, recession shocks slow down emission economic activity and reduce emission production. In result, slacken demand on emission credits pushes price of emission credit down. Chevallier did not provide explanation about positive response of CER futures prices to recession shocks. The use of future prices might be the reason for diverse response between the two emission credits.

Future prices for commodity are hypothetically influenced by convenience yield. Homburg and Wagner (2007) showed that spot – futures parity within a trading period could be explained entirely by the cost-of carry approach, implying negative convenience yield. On the other hand, Borak et al (2006) found evidence that future contracts issued in phase I and mature within phase II implied significantly positive convenience yield. Similarly, Daskalakis et al (2008) provided evidence that prohibiting emission banking results in positive convenience yield. Aside from convenience yield, future prices are often found to be determined by volatility of prices of underlying assets. This might also be the case for sCER future prices as risk varies across CDM project stages, location and types. Lastly, the introduction of spread trading which is constructed from the spread between EAU future prices and CER future prices also influence price behaviour of CER and EUA. Thus, excluding such factors might misconstrue the analyses on sCER and EUA future prices.

2.2.3.2. Emisison, energy prices and economic cycle exogeneity

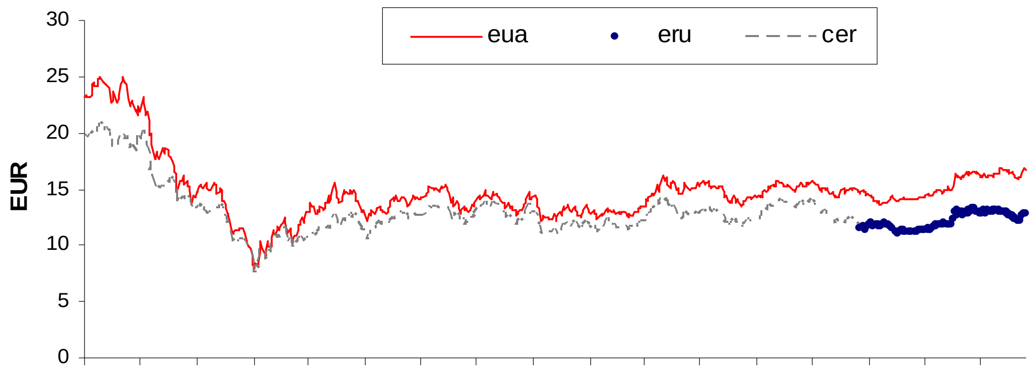
Interestingly, empirical evidences about casualty relationship between economic activity and energy prices are ambiguous. Milani (2009) suggested that oil shocks influences output and inflation. Further, Brown et al (2011) concluded that energy per capita fosters economic growth and development in term of GDP per capita. This oil price acceleration – GDP interplay has been increasingly stronger since early 1980s (Naccache, 2010). In contrast, Sadorsky (2002) and Naccache (2011) found that macroeconomic factors such as dividend yield, T-bills yield and market portfolio excess returns, have significant forecast power in oil future markets. Killian and Vigfusson (2011) suggested unidirectional causality from energy prices to macro economy. They also pointed out asymmetric responses of aggregate real output to positive and negative oil price shocks during 1970s and 1980s. Oil price shocks have reallocation effect throughout the economy such as shifting to energy efficient goods. The reallocation effect boosts the recessionary effects of the loss of purchasing when real oil price unexpectedly increases. If the real oil price unexpectedly, the reallocation effect partly counterbalance increased expenses due to gains in purchasing power. Interestingly, Belke et al (2010) found different evidence about long run relationship between economic growth and energy prices. They investigated real GDP, energy price and consumption in 25 OECD countries from 1981 to 2007. They found evidence of mutual causal relationship between the three variables.

In a broader setting, Ruijen and Vuuren (2009) gave evidence that energy uses decreases during economic recession. Inelastic energy supply coupled with increasing energy prices typically put pressure on energy consumption, hence slows down economic activity. Therefore, production of GHGs emission usually decreases during economic recession. However, when oil and gas prices are extremely high, the impact of oil and gas prices is unclear. High oil and gas prices might drive economic agents to switch to either coal or cheaper alternative energy. Coal is historically cheaper than oil and natural gas for the same heat or energy content, but higher amount of GHGs emission. High-energy prices can also have significant impact on other commodities e.g. steel used in producing low emission energy such as wind energy. Thus, for countries lacking of cheap technology for low emission scenario, high oil and gas prices might be followed by up trending prices of emission credits. However, where low emission energy can be cheaply produced, high oil and gas prices decreases demand on emission credits. Thus, the conclusion about the interplay between energy prices, macro economy and carbon prices varies across sample period and methodology. This raises possibility of interdependency among the three factors.

2.2.3.3. Effect of fungibility among emission credits

International linking directive adopted in the EU ETS and the ETS in countries such as Australia and Canada results in fungibility across types of emission credit. Although the EU ETS imposes import limit on CER, other countries do not adopt similar approach. This could be the cause of price disparity across emission credits (see figure 4).

Figure 4 Spot prices of sCER, EUA and ERU



Prices of EUA, sCER and ERU move in tandem, implying common factors shared among three series. Nonetheless, sCER has been traded at discount to EUA in the spot markets since their introduction to the EU ETS. On average, sCER prices have been slightly higher EUR0.05 than ERU prices on average. Secondary ERU has been traded just since early this year; hence, the discount price might not matter to sCER spot prices. On the other hand, EUA spot contract has been more expensive by EUR1.89 than sCER spot contract on average.

Price disparity allows profit-maximizing firms to minimize costs associated with emission abatement. The exchange traded outright spreads, futures spreads and futures strips enable firms to arbitrage between prices. Interestingly, price disparity between EUA and sCER has been growing since the beginning of 2009. CER import limit might prevent prices of the two-emission credit from converging. Still, the interplay between markets for emission credits might significantly determine spot prices of sCER. Although studies on price spread between sCER and EUA usually assume sCER prices are determined by EUA (e.g. Mansanet-Bataller et al, 2011 and Chevallier, 2011), there has been no evidence to refute the possibility of reverse effects. Moreover, the lack of CER import limit in the ETS outside the EU ETS might boost market liquidity of CER; reduce correlation between two prices in the long.

2.3. Data

The empirical model is estimated for sample period August 12, 2008 to May 31, 2011, which is the longest available series for daily spot prices of sCER during Kyoto Protocol compliance period (i.e. from 2008 to 2012). This compliance period coincides with phase II the EU ETS allowing bankability and transferability of AAU within compliance period. Log return of sCER (*cer*) and EUA (*eua*) are calculated from daily spot prices of sCER and EUA, which are obtained from Bluenext, the largest spot market of sCER, in terms of volume. Other variables are based on the assumption that supply and demand sides of electricity are also influenced by technology switching cost and stage of the economy respectively. Thus, four dummy variables as exogenous variables and 8041 observation for 11 endogenous variables are estimated in VARMAX model framework. Summary statistics of all endogenous variables are detailed in table 1.

Table 1 Summary Statistics

	cpi	***ipi***	***cer***	***eua***	***cg***	***og***	***cds***	***cdso***	***css***	***epi***
Mean	111.09	96.02	-0.001	-0.001	-18.160	16.238	15.617	-4.722	1.950	-0.0003
Median	110.47	95.90	0.000	0.000	-17.232	15.771	12.081	-4.681	-0.630	-0.003
Max.	115.93	110.44	0.094	0.105	1.615	36.660	49.921	-2.210	32.225	0.351
Min.	108.24	86.20	-0.102	-0.103	146.152	2.587	-9.557	-7.819	-25.162	-0.365
Std. Dev.	1.945	5.776	0.022	0.023	10.00	8.176	11.428	0.922	13.537	0.077
Skewness	0.727	0.381	-0.350	-0.304	-0.274	0.591	0.499	-0.635	0.476	0.195
Ex. Kurtosis	-0.247	-0.626	3.131	2.833	-0.319	-0.428	-0.746	1.684	-0.852	3.281
Obs.	753	753	753	753	753	753	753	753	753	753

2.3.1. Electricity prices and energy prices

Power plants across Europe use different energy sources i.e. coal/peat, crude oil, oil products, natural gas, nuclear, hydro, biofuel and waste, wind, etc (IEA, 2011). Accordingly, production costs of electricity are determined by energy prices. Variable (*epi*) denotes log return on electricity prices. Since up-scaling electricity production calls for more energy, energy prices can be classified as variable cost of electricity production. Kurry and Harrington (2010) found that variable cost of power plants operating under emission cap-and-trade regime is also determined by cost associated with emission credits. The higher electricity output, the higher amount of energy being fired; hence, the amount of emission being emitted moves up as electricity production increase. As the power generators are allocated a certain amount of AAUs, they should ensure that electricity production does not emit GHGs above their emission cap. Otherwise, they should either buy emission credits or switch to low emission technology.

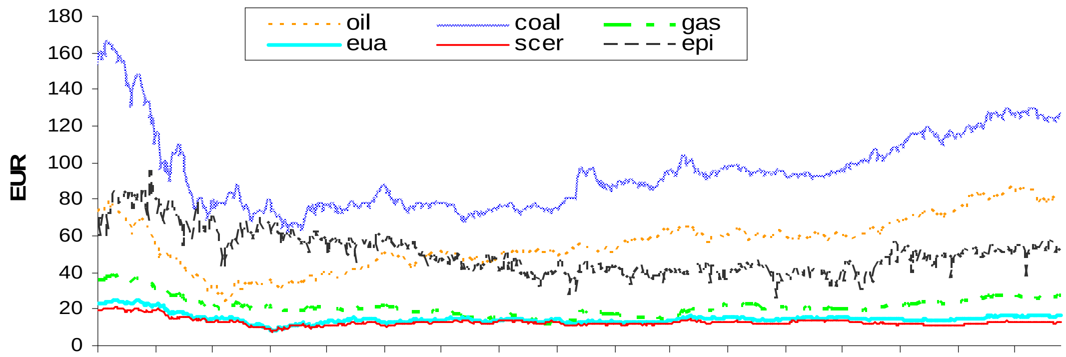
Assuming prices of emission credits could be fully passed on end buyer of electricity, electricity prices moves in accordance with prices of emission credits as well as energy. Nonetheless, for power plants do not use GHGs contained energy such as wind power plants, their production costs are independent of prices of emission credits. Thus, IPCC's 2006 list of emission factors is used to determine GHGs contained energy[13]. The list shows that oil (crude oil as well as oil production), natural gas and coal are classified as GHGs contained energies. Thus, daily average spot prices of the three energy types are specified as exogenous variables. Daily brent oil prices (P_{oil}) are daily brent price index calculated by Intercontinental Exchange (ICE). Spot prices of natural gas (P_{gas}) and coal (P_{coal}) are obtained from European Energy Exchange (EEX) which is the biggest spot market for energy in Europe. Richard Bay prices are proxy for coal prices since Richard Bay is the Europe's main sources for coal firing power plants).

As oil, natural gas and coal are among IPCC's list of GHGs contained energy, the three energy types are used as the basis identifying ten biggest electricity markets in EU region that might be significantly affected by emission credit prices. Among the ten electricity markets, UK, Germany, Spain and Italy rely heavily on coal, gas or oil. The fuels compose more than 50% of energy sources in electricity generators in the four markets (IEA, 2011). Thus, electricity price is calculated as daily average base load – electricity prices in the four markets weighted by trading volume (EEX, OMEL, Elexon,

[13] Emission factor is measured in gtCO_2-e/J. PCC (Intergovernmental Panel on Climate Change) is a sub body of United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) which assess current stage of climate change and its potential socio-economic and environmental impacts (IPCC)

GME). Under the assumption that all power producers are profit maximizing firms, electricity price index should move in tandem with prices of emission credits, P_{oil}, P_{gas} and P_{coal} as illustrated in figure 5.

Figure 5 Spot prices of energy, emission credits and electricity



Spot prices of coal and oil brent have moved altogether. Identical trend also appears in sCER and EUA prices. Thus, the four series might share common factors. Prices of energy and emission credits slipped during global financial crises before shifting the trend up around December 2008. Electricity prices appear to be lagged behind in following the price dynamics of energy and emission credits. Coal prices reached the through in March 2009, implying different structural break in the trend across series.

2.3.2. Clean dark spread and clean spark spread

Decision on production schedule of electricity is for the most part determined by cost of electricity generation, after taking into account cost of energy/fuel and emission credits. This cost is known as clean dark spread for coal firing plants and as clean spark spread for natural gas firing plants. Lets's $P_{electricity}$: electricity prices, TE : thermal efficiency, CO_2: tCO_2-e of GHGs emitted in producing per KWh electricity and P_{CO2}: prices of emission credits. Dark spread (*ds*) and spark spread (*ss*) are usually calculated in similar fashion as follows:

$$spread = P_{electricity} - \frac{P_{fuel}}{TE_{fuel}}$$

Thermal efficiency (*TE*) is the ratio between the produced heat and heat content of consumed fuel as follows:

$$TE = \frac{Q_{out}}{Q_{in}} \qquad 0 \le TE \le 1$$

For the calculation of the spread, average historical thermal efficiency of power plants in OECD countries is used. Thermal efficiency of natural gas, crude oil and brown coal is 0.4, 0.37 and 0.34 respectively (IEA, 2008). As prices of crude oil are in USD/barrel, oil prices are converted to EUR by using daily exchange rate from European Central Bank. Nonetheless, oil prices reflect prices of oil per barrel whilst coal prices are in EUR/ton. Thus, oil prices in EUR and coal prices are converted into the same unit as natural gas prices (i.e. in EUR/MWhtherm) by using IEA's default conversion factor. Thus, using electricity price index as proxy for electricity prices, *ds* and *ss* become while spark spread (*ss*) is

$$ds = epi - \frac{P_{coal}}{0.34} \times \frac{1}{6.993} \text{ kcal/kg}$$

$$ss = epi - \frac{P_{gas}}{0.4}$$

Then, clean dark spread (*cds*) is defined as

$$cds = ds - CO_2^{coal} \times P_{CO2}$$

and clean spark spread (*css*) is defined as

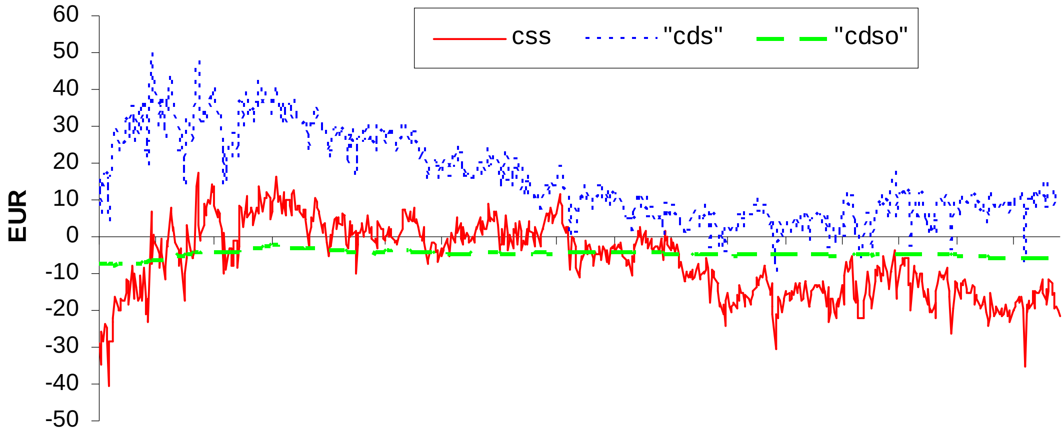
$$css = ss - CO_2^{gas} \times P_{CO2}$$

For oil firing power plants, synthetic spread is calculated in similar fashion. Let's denote *dso*: spread and *cdso*: clean spread.

$$dso = epi - \frac{P_{coal}}{0.37} \times \frac{1}{1.61} \text{ kcal/kg oil equivalent}$$

$$cdso = dso - CO_2^{oil} \times P_{CO2}$$

Figure 6 Clean dark spread, clean spark spread and clean spread of oil



Profit maximizing firms produce electricity on a baseload basis when the spread is positive. Figure 5 implies that taking into account prices of fuel and emission credits only, coal-firing plants were better off by producing electricity on a baseload basis. On the other hand, natural gas and oil power plants made losses by producing electricity on a baseload basis. It is important to note that the spreads exclude operational costs and other generating costs. Thus, negative spread does not necessarily show loss of revenue in producing baseload-electricity. Nonetheless, the spread might give signal that a mixed-technology power plant should switch from its normal running scenario to its alternative scenario such as running its wind turbine, or vice versa. Additionally, given common trend between oil and coal prices, common factors might influence clean spark spread and clean dark spread.

2.3.3. Cost of technology switching

Recalling the emission cap-and-trade scheme, the scheme aims a global technology switching to low emission technology. Technology switching of a power plant occurs when cost to generate low emission electricity is cheaper than generating cost in a normal running scenario. Thus, technology switching across power plants might influence prices of emission credits and energy. In switching technology, operators consider energy prices against the amount of produced energy. It is due to variation in energy content across types of energy. The most efficient energy will always be at top of technology choices in a power plant. According to Howell and Buckius (1987) the energy efficiency of a power plant is generally proxy as thermal efficiency. In addition to thermal efficiency, emission content also varies across types of energy. IPCC (2006) set default for emission factor representing the amount of tCO_2/MWh in each type of energy. Emission factor for oil-fired plants is 0.264tCO_2/MWh whilst factors for lignite coal fired and gas fired plants are 0.364tCO_2/MWh and 0.202tCO_2/MWh respectively. Therefore, the impact of technology switching is proxy as fuel switching cost.

Estimation of fuel switching cost follows Fehr and Hinz (2007) which principally is comparable to Tendances Carbone methodology introduced in Mansanet-Bataller (2011) and Chevallier (2011). If the heating rates of fuel *i* in kcal/kg h_i is defined as

$$h_i = \frac{1}{TE_i} \times conversion\ \ factor$$

and the amount of GHGs emitted in producing 1 MWh electricity for each type of fuel (CO_2^i) is

$$CO_2^i = \frac{EF_i}{TE_i}$$

where EF_i is emission factor of fuel *i*, then cost to switch from fuel *i* to fuel *j* (c_{ij}) is

$$c_{ij} = \frac{h_j \times P_j - h_i \times P_i}{CO_2^j - CO_2^i}$$

Figure 7 Fuel-switching, electricity and emission credits spot prices

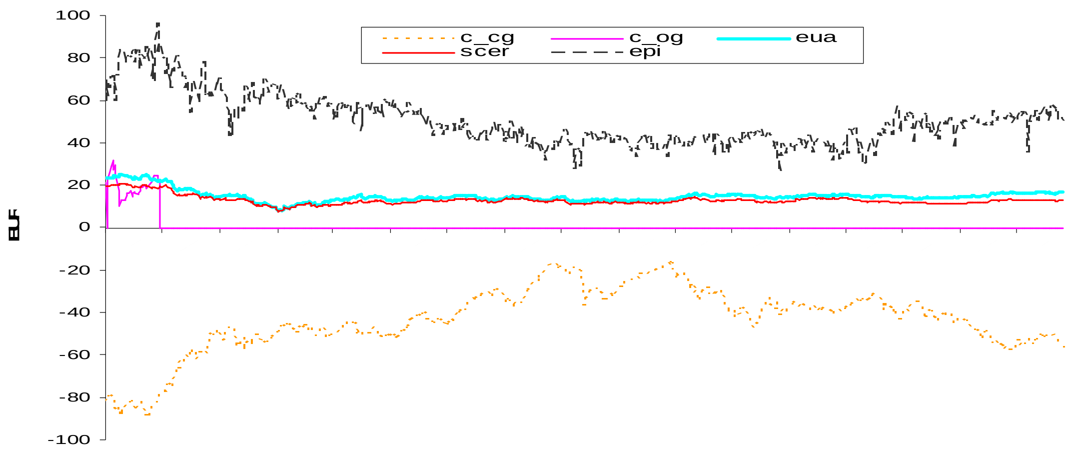


Figure 7 shows that switching cost from oil to gas (*c_og*) has been more expensive than emission credits prior to October 2008. During this period, buying emission credits incurs lower cost than abating emission in oil firepower generation. On the other hand, cost associated with emission is higher than cost to switch fuel from coal to gas 31) for some electricity producers. If high fuel-switching cost is found in most producers, high fuel-switching cost will push sCER and EUA demand up. Hence, in the long run sCER and EUA prices will move toward the fuel-switching cost (assuming electricity prices are stable).

2.3.4. Economic cycle

Emission intensive economic activity influences demand on emission intensive energy. Empirically, extreme high-energy prices slowed down the economy, decelerating accumulation of GHG emission. Thus, indexes are used as proxy of economic activity. The indexes are obtained from data of EU-27 member states since more than 95% global demand on emission credits coming from this region (UNFCCC). First index, harmonized index of consumer prices (*cpi*) of all goods and services is a weighted average of price indices of countries adopting the euro, aggregated by a harmonized methodology and using year 2005 as base year. The index describes inflation in member countries of European Union and used in assessing member countries compliance with convergence criteria on inflation[14]. The second index, industrial production index (*ipi*), index theoretically shows the evolution of adjusted output of main industry and uses year 2005 as base year. The index is a business cycle indicator measuring changes of production output level in the main industry. The main industry comprises intermediate goods, capital goods, consumer durable, consumer non-durable and energy sector.

Eurostat provides monthly data for the two variables. Thus, daily data for the two variables is reproduced by using Piecewise cubic Hermite interpolating polynomial procedure. The routine finds value of an underlying interpolating function *f(x)* at each

---

[14] The euro convergence criteria or the Maastricht criteria are four main criteria based on article 121(1) of the European Community Treaty for any member countries of European Union enter the third stage of European Economic and Monetary Union (EMU) and adopt the euro as their currency (Lipinska, 2008).

sub interval $x_k \le x \le x_{k+1}$, to the given values and certain slopes at the two endpoints. Let h_k denotes the length of k^{th} sub interval, its first divided difference δ_k

$$h_k = x_{k+1} - x_k$$

$$\delta_k = \frac{y_{k+1} - y_k}{h_k},$$

then, the slope of the interpolant at x_k is given by

$$d_k = P'(x_k)$$

P'(x) is continuous and *P"(x)* might be jumps at x_i. The slope d_k at x_i should ensure that the function *P(x)* keeps the monotonicity and shape of data. By using piecewise cubic Hermite interpolation, function *P(x)* on the k^{th} interval is

$$P(x) = \frac{3h_k s^2 - 2s^3}{h_k^3} y_{k+1} + \frac{h_k^3 - 3h_k s^2 + 2s^3}{h_k^3} y_k + \frac{s^2(s-h_k)}{h_k^2} d_{k+1} + \frac{s^2(s-h_k)^2}{h_k^2} d_k,$$

where $s = x - x_k$, y_{k+1} is daily data to be reproduced (Fritsch and Carlson, 1980). Oil prices in EUR is denoted as *x* since a wide range of dynamic general equilibrium models such as TIMER model in Ruijen and van Vuuren (2009) found that oil prices and economic growth/output move in tandem.

After deriving d_k, the interpolant is evaluated using $P(x) = y_k + sd_k + s^2 c_k + s^3 b_k$

c_k is coefficient of quadratic term given by

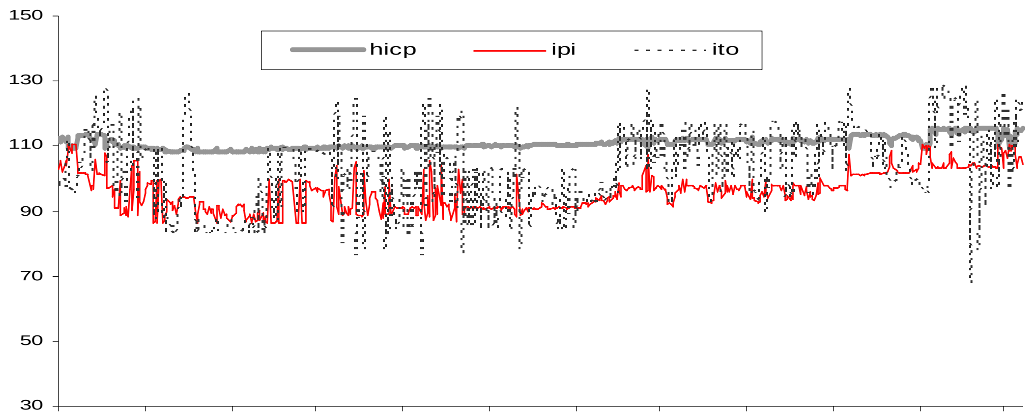
$$c_k = \frac{3\delta_k - 2d_k - d_{k+1}}{h},$$

and b_k is coefficient of quadratic term given by

$$b_k = \frac{d_k - 2\delta_k + d_{k+1}}{h^2}$$

The procedure could reproduce daily data closer to observation during sample period, than daily data reproduced by procedure such as linear or cubic spline interpolation.

Figure 8 Indicators of the economy

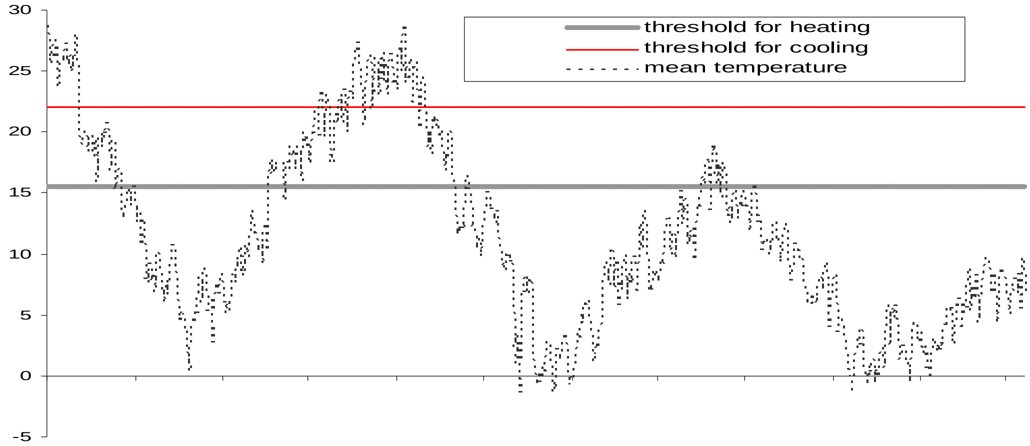


Industrial output and market activity dropped to the through during period December 2008 – March 2009, and have bounced back ever since. Considering energy prices started to pick up in December 2008, energy prices might give signals about the direction of the economy in the future. As demand on energy to fuel economic activity in the future increases, prices of emission credits expectedly increases.

2.3.5. Extreme temperature and the impact of climate change policy

Consumption of energy and electricity might vary across years due to temperature changes. During warm days, people consumption of energy and electricity picks up to operate air conditioning system. UK's default base temperature of 15.5°C and 22°C defines when heating and cooling systems are likely to operate (DEFRA).

Figure 9 Mean temperature in EU-27 countries



The heating system is assumed to operate when outside temperature falls below threshold for heating day (i.e. below 15.5°C). Simultaneously, cooling system is likely to run when outside temperature rises above threshold for cooling day (i.e. above 22°C). Variable heating days (*hdd*) takes value one whenever heating system is assumed to operate. Variable cooling day (*cdd*) takes value one when cooling system is likely to run. Daily outside temperature is retrieved from European Climate Agency, averaging temperature recorded by 22 stations scattered across the 27 member countries of EU. Figure 8 clearly shows that heating system operates only during winter while cooling system runs in summer in Europe. Thus, prices of energy, electricity and emission credits in Europe are expected to seasonally increase.

Aside from extreme temperature, announcement of EUA allocation to EU member countries and countries compliance with emission target might significantly determine prices of emission credits (Chevallier et al, 2009b; Bataller and Pardo, 2009). Intuitively, other factors associated with the changes in climate change policy and realization of global emission target should influence demand and supply of emission credits. Thus, a broader measure, *news* takes value one on any announcement of UNFCCC's climate policy as well as policy associated with AAU and CDM under ETS of EU, Australia, New Zealand, Japan, Canada and the USA. The variable also takes value one on the posting date of national action plan and GHGs monitoring data.

2.4. The Model

This section describes the econometric strategy used to estimate the parameters of the model and the identification method. The model is specified by using the Vector AutoRegressive Moving Average with eXogenous variables (VARMAX) procedure. The VARMAX could be partitioned into Vector AutoRegressive (VAR) and Vector Moving Average (VMA). VAR treats all variables in the model symmetrically by including for each variable an equation explaining its evolution based on its own lags and the lags of all the other variables in the model. No prior knowledge is required except for specifying which variables should enter the system. The VAR(p) refers to VAR model of order p with general form

$$Y_t = \sum_{i=1}^{p} A_i Y_{t-i} + u_t, \quad u_t \sim WN(0, \Sigma_u) \tag{2.4.1}$$

where Y_t is $n \times 1$ vector of endogenous variables, A_i is $n \times n$ matrix of parameter of lagged endogenous variables, and u_t is $n \times 1$ vector of white noise error terms that are called structural impulses or innovations. Innovations have zero mean, positive definite covariance matrix Σ_u and no serial correlation across time. Structural innovations are identified by assuming recursively contemporaneous interactions among variables, by imposing a certain ordering of the variables.

The moving average terms of VARMAX is denoted as VMA(q) where q is the order of moving average terms. The basic form of VMA(q) is as follows

$$Y_t = \mu_t + u_t + \sum_{j=1}^{q} \Theta_j u_{t-j} \tag{2.4.2}$$

where μ_t is the expectation of Y_t, and Θ_j is $n \times n$ matrix of parameter of moving average terms. Adding Eq.(2.4.2) and r exogenous variables into Eq.(2.4.1), generates the VARMAX (p,q,r) process as follows

$$Y_t = \sum_{i=1}^{p} A_i Y_{t-i} + u_t\left(1 + \sum_{j=1}^{q} \Theta_j u_{t-j}\right) + \sum_{m=1}^{r} \phi_m X_{m,t} \tag{2.4.3}$$

where X_t is $m \times 1$ vector of exogenous and ϕ_m is $n \times 1$ vector of coefficient of endogenous variables (Lütkepohl, 2005).

In some cases, variance of current innovation u is not a function of the actual size of previous innovation but a function of squared of previous innovation. Thus, the conditional model is written as the following VARX (p,r) form

$$Y_t = \sum_{i=1}^{p} A_i Y_{t-i} + \sum_{m=1}^{r} \phi_m X_{m,t} + u_t \tag{2.4.4}$$

and u_t follows AutoRegresive Conditional Heteroskedasticity (ARCH) process as in Engle (1982).

$$u_t = \sigma_t z_t$$

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^{s} \alpha_i u_{t-i}^2 \tag{2.4.5}$$

where $\alpha_0 > 0,\ \alpha_i \geq 0$.

$\sigma_t$denotes time dependent standard deviation, z_t is a random variable drawn from a Gaussian distribution such that $z_t \sim i.i.d(0,1)$, and s is the order of ARCH lag.

Eq.(2.4.4) is constructed under the assumption of stationary time series *I(0)*. Differencing *I(d)* variables *d* times is a common approach to work in VARMAX setting. Nonetheless, differencing often distorts the interplay between the original variables. If two or more variables might share a common stochastic drift, the linear combination between *I(d)* and *I(0)* variables are stationary. In section 2.3.1 and 2.3.2, graphical presentation of time series indicates that EUA, sCER, clean dark spread, and clean spark spread prices might be cointegrated. Thus, the possibility of the presence of cointegration should be taken into account instead of fitting VARMAX model upon differencing. Assuming multiple time series are cointegrated of order *d*, the data generating process can be represented as a vector error correction model (VECM) of the form

$$\Delta Y_t = \Pi Y_{t-1} + \sum_{b=1}^{d} \Gamma_b \Delta Y_{t-b+1} + \sum_{m=1}^{r} \phi_m X_{m,t} + u_t \qquad (2.4.6)$$

which also can be written as

$$Y_t = (1 + \Pi + \Gamma_1) Y_{t-1} - \sum_{i=2}^{d+1} (\Gamma_{i-1} - \Gamma_i) Y_{t-i} + \sum_{m=1}^{r} \phi_m X_{m,t} + u_t \qquad (2.4.7)$$

Eq.2.7 can be rearranged in VARX(*p*,*r*) representation

$$Y_t = (I + \alpha\beta') Y_{t-1} + \sum_{i=1}^{p} A_i Y_{t-i} - \sum_{j=i+1}^{p} A_j Y_{t-j} + \sum_{m=1}^{r} \phi_m X_{m,t} + u_t \qquad (2.4.8)$$

where $p = d + 1$.

Thus, Γ_i and Π in eq. 2.6 can be expressed as $\Gamma_i = -\sum_{j=i+1}^{p} A_j$

$$\Pi = \sum_{i=1}^{p} A_i - I$$

Matrix $\alpha\beta'$ represents error correction term and u_t is assumed to be ARCH(s) process. β is $n \times d$ cointegration matrix representing the long run behavior of endogenous variables whilst α is $n \times d$ marix of adjustment parameters. Matrix of Γ_i represents $n \times n$ matrix of the speed of short run adjustments of each endogenous variable to the long run equilibrium.

In the identification stage, preliminary estimates for d are obtained using Johansen (1995) cointegration test. The test does not need pre-test variables in the system to determine integration order of variables. The space of a cointegrating vector is spanned by stationary variables in the model. Thus, through the vector, a stationary variable will reveal itself that it is *I(0)* instead of *I(1)*. Defining $\Pi = (I + \alpha\beta' - \Gamma_1)$, four assumptions are considered as follows

$$H_1(d)\colon\ \Pi Y_{t-1} + \sum_{m=1}^{r} \phi_m X_{m,t} = \alpha\beta' Y_{t-1}$$

$$H_1(d)\colon\ \Pi Y_{t-1} + \sum_{m=1}^{r} \phi_m X_{m,t} = \alpha(\beta' Y_{t-1} + \rho_0)$$

$$H_1(d)\colon\ \Pi Y_{t-1} + \sum_{m=1}^{r} \phi_m X_{m,t} = \alpha(\beta' Y_{t-1} + \rho_0) + \alpha_{\perp}\gamma_0$$

$$H_1(d)\colon\ \Pi Y_{t-1} + \sum_{m=1}^{r} \phi_m X_{m,t} = \alpha(\beta' Y_{t-1} + \rho_0 + \rho_1 t) + \alpha_{\perp}\gamma_0$$

Theoretically, stationary variables in the system will not raise a problem albeit the methodology is usually used when all variables in the system are *I(1)*. The Johansen's test however is used in the setting where structural break does not present in the variables. In the previous section, structural breaks appear in some variables during global crisis in 2008. Thus, cointegration test introduced in Arai and Kurozumi (2010) is used to confirm results of Johansen's test. Arai and Kurozumi tested null hypothesis of cointegration with unknown structural break against no cointegration relationship. In this test, a dummy variable is defined as

$$\varphi_t = \begin{cases} 0 & if\ t \le [n\tau] \\ 1 & if\ t > [n\tau] \end{cases}$$

where $[n\tau]$ denotes break dates and τ represents break fraction.

Three forms of a structural break are considered

$$y_{1t} = \mu_1 + \mu_2\varphi_{t\tau} + \beta' y_{2t} + e_t, \qquad t = 1, \cdots, n$$

$$y_{1t} = \mu_1 + \mu_2\varphi_{t\tau} + \alpha t + \beta' y_{2t} + e_t, \qquad t = 1, \cdots, n$$

$$y_{1t} = \mu_1 + \mu_2\varphi_{t\tau} + \beta'_1 y_{2t} + + \beta'_2 y_{2t}\varphi_{t\tau} + e_t, \qquad t = 1, \cdots, n$$

For each assumption, $\Delta y_{2t} = v_{2t}$,

$$e_t = \gamma_t + v_{1t},$$

$$\gamma_t = \gamma_{t-1} + u_t,$$

$$\gamma_0 = 0.$$

The null hypothesis corresponds to $e_t = v_{1t}$

Subsequently residuals from the models undergo diagnostic checks to determine whether the residuals behave like white noise. In the case of autocorreleated or heteroskedastic residuals, preliminary estimates for s are obtained using simultaneous inspection of auto and partial correlations functions (Box and Jenkins,1976).

Based on the abovementioned preliminary values, the actual VARMAX(p,q,r) parameters are estimated using linear procedures by transforming Eq.(2.4.8) into state space model supported by MATLAB.

$FR(B)FS(B^{season})Y_t = G(B)u_t + AR(B)AS(B^{season})z_t$

B is the lag operator, u_t represents exogenous variables and z_t is innovation which are defined by

$G(B) = G_0 + G_1B^2 + G_2B^3 + \cdots + G_p(B^p)$

$AR(B) = I + AR_1B^2 + AR_2B^3 + \cdots + AR_qB^q$

$AS(B) = I + AS_1B^{season} + AS_2B^{2season} + \cdots + AS_{p-1}(B^{Qseason})$

while endogenous variables Y_t are defined by their lagged values

$FR(B) = I + FR_1B^2 + FR_2B^3 + \cdots + FR_p(B^p)$

and the seasonal effects

$FS(B) = I + FS_1B^{season} + FS_2B^{2season} + \cdots + FR_pB^{pseason}$

Thus, VMA term is represented as $AR(B)$ and $AS(B)$ represents seasonality in innovations. The conditional moment of innovations are also transformed into state space model in the same fashion.

To interpret the cointegrated VARMAX(p,q,r) model, structural form of the model is summarized in impulse response functions and variance decomposition. The impulse response function describes the in-sample effect of a typical shock to the system and can provide economic interpretation of the behaviour of the system. As deterministic terms and exogenous variables do not influence impulse response analysis, such terms do not have effects on the main results. The impulse response functions refer to the coefficient matrices of the vector moving-average (VMA) representation of the structural model. Thus, plotting the impulse response functions against time allow visual examination on the dynamic behaviour of variables in response to various structural shocks. In addition, the vector moving-average representations imply that the forecast errors are a linear combination of structural shocks. Variance decomposition on the other hand is typically used to decompose the forecast error variances into the proportions due to each structural shock to examine the roles played by structural shocks in causing the fluctuations of a variable at different time horizons. Thus, variance decomposition illustrates the importance or relative share of variance that each structural shock contributes to the total variance of each variable.

2.5. Results

2.5.1. Empirical model estimates

Stationarity of endogenous variables are tested under Augmented-Dickey Fuller and Phillip Perron unit root test, with null hypothesis that each variable is *I(1)*. The test results are confirmed by KPSS stationary test (Kwiatkowski et al, 1992), ERS Point Optimal (Elliot et al, 1996) and Ng-Perron test (Ng and Perron, 2001).

Table 2 Unit root and stationarity test

	cpi	**ipi**	**cer**	**eua**	**cg**	**og**	**cds**	**cdso**	**css**	**epi**
ADF	-5.272***	-4.220***	-3.152***	-2.960***	-1.190	-3.576***	-4.546***	-3.245***	-2.015**	-0.869963
ADF - c	-5.269***	-4.224***	-3.152**	-2.960**	-1.727	-3.576***	-4.544***	-3.245***	-2.008	-2.436442
ADF - t	-5.269***	-4.242***	-2.910	-2.780	-1.699	-3.582**	-4.548***	-3.249*	-2.555	-2.490850
Ng-Perron (MZa) - c	-2.076	-2.779	0.124	0.006	-1.908	-0.093	-2.882	-0.054	-7.878*	-3.23104
Ng-Perron (MZt) - c	-0.997	-1.103	0.112	0.005	-0.902	-0.094	-1.022	-0.051	-1.973*	-1.22273
Ng-Perron (MSB) - c	0.480	0.397	0.909	0.898	0.473	1.014	0.355	0.940	0.250*	0.37843
Ng-Perron (MPT) - c	11.596	8.590	48.875	46.562	11.988	56.012	8.085	49.664	3.157*	7.53855
Ng-Perron (MZa) - t	-5.614	-8.285	-2.363	-1.937	-6.164	-1.205	-10.801	-1.528	-8.26903	-12.2505
Ng-Perron (MZt) - t	-1.554	-2.012	-1.055	-0.952	-1.704	-0.691	-2.323	-0.829	-2.03008	-2.4072
Ng-Perron (MSB) - t	0.277	0.243	0.447	0.491	0.276	0.574	0.215	0.542	0.2455	0.1965
Ng-Perron (MPT) - t	15.985	11.077	37.197	44.927	14.766	63.046	8.441	55.092	11.0312	7.81858
KPSS - c	**0.403**	**0.538****	**0.567***	**0.380***	**1.473*****	**0.392****	**0.544****	**0.302**	**1.613*****	**1.707*****
KPSS - t	**0.403*****	**0.538*****	**0.284*****	**0.349*****	**0.625*****	**0.392*****	**0.544*****	**0.302*****	**0.437*****	**0.726*****

c: non zero mean in the test specification

t: deterministic time trend in the test specification

Ho: series has unit root

Ho: series is stationary

Reject Ho at 1% level of significance(***), 5%(**), 10%(*)

The ADF unit root contradicts results from KPSS stationarity tests except for *epi* and *css.* ADF unit root test indicates that all series except for *css* and *epi* are stationary. KPSS stationary test however suggests that all series are non stationary. Ng-Perron unit root test gives the same results as KPSS stationary tests that unit root presents in all series. Ng-Perron test works when structural breaks present in the series, but the test requires deterministic break points that sometimes could be tricky. Therefore, unit root test introduce in Zivot and Andrew (1992) is employed to confirm the three tests. This test assumes one data dependent – break, meaning “a priori” knowledge of position of break points is not necessary. The test is superior to test assuming two break points such as Lumisdaine and Papell (1997). Test assuming two break points do not specify break dates in null hypothesis, hence tends to accept alternative hypothesis of stationarity with breaks (Glynn *et al*, 2007). Moreover, the unit root test sufficiently minimizes failure to reject unit root hypothesis when the series is actually stationary around the structural breaks. The position of the break point is determined by the test equation as follows

- Mean shift at possible break dates

$$\Delta y_t = c + \alpha y_{t-1} + \beta t + \gamma DI_t + d\Delta y_{t-1} + e_t$$

- Trend shift at possible break dates

$$\Delta y_t = c + \alpha y_{t-1} + \beta t + \theta DT_t + d\Delta y_{t-1} + e_t$$

- Mean and trend shift at possible break dates

$$\Delta y_t = c + \alpha y_{t-1} + \beta t + \gamma DI_t + \theta DT_t + d\Delta y_{t-1} + e_t$$

where DI_t is dummy variable for a mean shift occurring at each possible break date and DT_t corresponds to trend shift at each possible break point.

$$DI_t = \begin{cases} 1 & if \ t > breakpoint \\ 0 & otherwise \end{cases}$$

$$DT_t = \begin{cases} t - breakpoint & if \ t > breakpoint \\ 0 & otherwise \end{cases}$$

Rudebusch (1993) argued that Zivot-Andrews test indecisiveness might occur when it is not possible to reject neither unit root null hypothesis nor alternative hypothesis of trend stationary with one unknown break. The following table summarizes t-statistics from Zivot-Andrews unit root test and shows that indecisiveness does not occur in this case.

Table 3 Unit root test (Zivot and Andrew, 1992)

	cer	eua	cpi	ipi	epi	og	cg	css	cds	cdso
Deterministic terms										
intercept										
test stat	-5.844***	-5.718***	-7.551***	-8.072***	-5.680***	-5.270**	-3.687	-5.781***	-7.283***	-5.838***
time trend										
test stat	-4.805**	-5.317***	-7.653***	-8.377***	-7.194***	-4.976***	-4.373*	-5.609***	-7.627***	-5.488**
intercept and time trend										
test stat	-8.200***	-5.794***	-7.646	-8.391***	-7.224***	-5.287**	-5.306**	-6.243***	-7.670***	-5.834**

Ho: time series are not stationary

H1: time series are trend strationary with one unknown structural break in the trend

Rejection of Ho at level of significance 10%(*), 5%(**), 1%(***)

The unit root test clearly indicates that all variables except *cg* are trend stationary with one time break in the trend dependently identified by data. The potential break point in October 2008 implies that prices of energy and emission credits fell following weaker purchasing power of consumers. The lower gross profit generated by electricity producers also slowed down emission intensive economic activity, pushing prices for emission credits down. As economic started to pick up in early 2009, prices of energy and emission credits bounced back afterward.

The cointegration test on the ten variables indicates that some variables are cointegrated assuming an unknown structural break in the series as summarized in table 4. The table also summarizes preliminary estimates of cointegration rank *d*.

Table 4 Preliminary estimates of cointegration rank *d* (Johansen, 1995; Arai and Kurozumi, 2010)

Test Specification	Cointegration rank	Unrestricted cointegration rank test (trace)		Unrestricted cointegration rank test (Max eigenvalue)	
		Trace-stat	***Critical value***	***Max. Eigenvalue***	***Critical value***
no intercept & trend	5	48.2690	60.0614	20.0578	30.43961
intercept in VEC	5	71.4089	76.9728	26.5658	34.80587
intercept in VEC & VAR	4	101.6671	95.7537	37.2851	40.07757
	5	64.3820	69.8189		
intercept & trend in VEC, no intercept in VAR	3	172.7776	150.5585	48.9740	50.59985
	5	83.1672	88.8038		

Notes:
r : number of cointegration equation
*Prob**: MacKinnon-Haug-Michelis (1999) p-value*

Assuming there is no deterministic terms in VARX and vector error correction, trace statistics and maximum eigenvalue indicates cointegration rank of 5. However, figure 4 in section 2 indicates drift and linear trend in the VARX and vector error correction. Trace statistics suggests cointegration rank of 5 if linear trend and drift are specified in vector error correction while VARX does not contain linear trend. For the same assumption, maximum eigenvalue indicates cointegration rank of 3. Stability test on cointegrated VARMAX is summarized in table 5.

Table 5 Stability test

Specification	**AR Stable**
VARMAX(4,0,3) - diag	1
VARMAX(4,0,3) - full	1
VARMAX(6,0,3) - diag	1
VARMAX(6,0,3) - full	1
VARMAX(7,0,3) - diag	1
VARMAX(7,0,3) - full	1

1: Autoregression is stable
0: autoregression is not stable
diag: diagonal autoregressive and covariance matrix
full: full autoregressive and covariance matrix

VARMAX(*4,0,3*) is in favour as indicated in AIC results.

Table 6. Akaike information criteria (AIC)

Specification	Log likelihood ratio
VARMAX(4,0,3) - diag	18.475
VARMAX(4,0,3) - full	10.295
VARMAX(6,0,3) - diag	18.619
VARMAX(6,0,3) - full	10.422
VARMAX(7,0,3) - diag	18.674
VARMAX(7,0,3) - full	10.425

diag: diagonal autoregressive and covariance matrix
full: full autoregressive and covariance matrix

The process of innovations of VARMAX(*4,0,3*) is tested by using Ljung-Box and ARCH-LM tests which indicate autocorrelation and heterosckedasticity in the innovations.

Table 7 Residuals test on VARMAX(*4,0,3*)

Lag order	Q-stat
lag =1	2.257***
lag =2	8.720***
lag =3	20.949***
lag =4	33.969***
lag =5	124.422*
lag =6	222.935
Chi-sq ARCH LM test	**Jarque Bera**
8008.464***	1430.737***

Ho (Q-stat): no autocorrelation in residuals
Ho (LM-stat): residuals are multivariate homoskedastic
Ho (Jarque Bera): residuals are multivariate normal
Reject Ho at level of significance 1%(***), 5%(**), 10%(*)

Thus, it can be inferred that current innovation u is a function of squared of previous innovation. Residual tests on the model after specifying conditional variance are summarized in table 8, indicating ARCH(4) process of innovations.

Table 8 Residuals test on VARMAX(*4,0,3*) – ARCH(4)

Equation	Q-stat (lag order = 16)	Chi-sq ARCH LM test (lag order 10)	Jarque Bera
cer	13.065	0.470536	181.304***
ipi	26.455	1.112701	285.783***
eua	9.3135	0.998839	18.516***
cer	19.363	1.789514	175.639***
cds	12.953	0.762072	146.620***
css	13.738	0.24914	175.484***
cdso	7.339	0.889618	5.854***
cg	8.4364	0.377086	315.647***
og	2.8511	0.642047	10.031***
epi	13.19	0.58047	204.822***

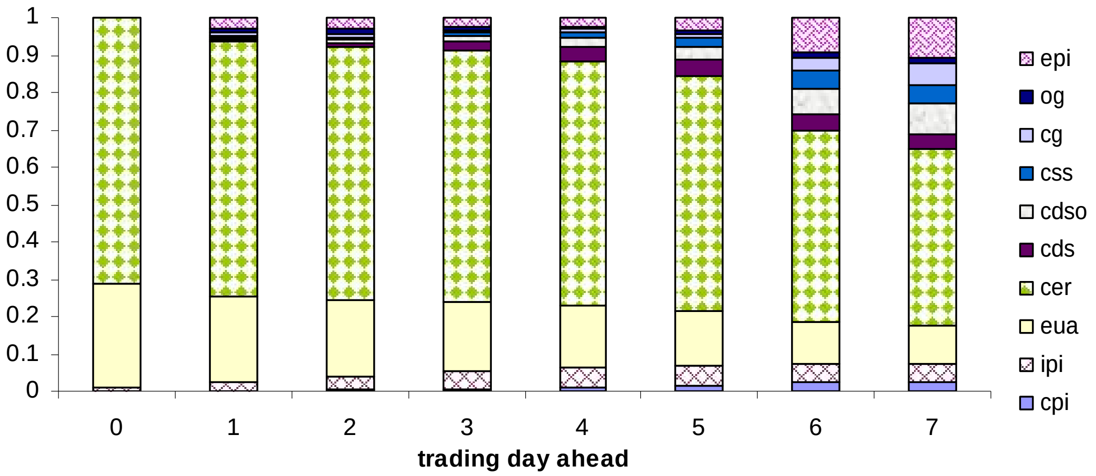
Ho (Q-stat): no autocorrelation in residuals
Ho (LM-stat): residuals are homoskedastic
Ho (Jarque Bera): residuals are normally distributed
Reject Ho at level of significance 1%(***), 5%(**), 10%(*)

The estimates of parameters are detailed in appendix. The results show that extreme temperature and changes in climate policy are not significant in explaining business cycle as well as dynamics of emission credits, clean dark spread, clean spark spread, fuel switching cost and electricity prices. The interplay between emission credits, clean dark spread, clean spark spread, fuel switching cost and electricity prices is analyzed from forecast error variance decomposition and impulse response function.

2.5.2. Forecast error variance decomposition

Forecast error variance decomposition measures the proportion of forecast variance of a particular variable due to shocks in the variables of the VARMAX model at different time horizons. As such, variance decomposition is used to estimate the significance of energy prices and technology and shocks as well as economic cycle as a source of variability in prices of emission credits. Figures 9 to 18 summarize the variance decompositions. Variance decomposition measures the proportion of forecast variance of a particular variable due to shocks in the variables of the VARMAX model at different time horizons. As such, variance decomposition is used to estimate the significance of energy prices and technology and shocks as well as economic cycle as a source of variability in prices of emission credits. The decomposition is shown for a forecast horizon of 90-th trading day ahead to reflect the long run effects of shocks to various variables on emission credits. The portion of variance in sCER due to shocks to various variables is depicted in figure 10.

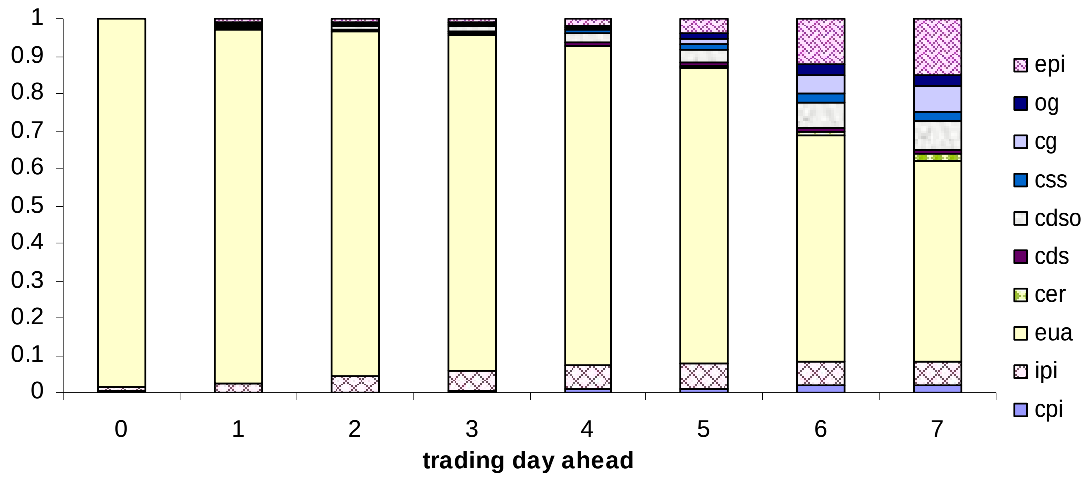
Figure 10 . Variance decomposition of sCER



The result shows that each variable explains only a small portion of sCER innovations. About 10% - 60% of sCER innovation is explained by its own shocks. Business cycle coupled with shocks to gross margin for electricity producers are as important as EUA shocks in explaining sCER innovations. Business cycle counts for 1% - 6% of the variability in sCER. Import limit on sCER might diminish the impact of shocks to the EU-27 economy on sCER fluctuation. The allocation of EUA might also too much that growing economy does not significantly influence demand side of sCER. Shocks to clean dark spread and clean spark spread explain 8% - 22% of the variability in sCER. In contrast, EUA shocks count for 8% - 28% of fluctuation in sCER. This result suggests that EUA is not exogenous in the regression on sCER. Technology shocks explain about 2% - 10% of variation in sCER. Shocks to switching cost from oil to gas appear to be as important as shocks to switching cost from coal to gas in explaining sCER innovations. The possible explanation would be that switching to low emission technology takes months to influence demand side of sCER. Variance decomposition is also used to gauge which emission credit shocks is important to the variability of another emission credits.

Figure 11 shows the percentage of variance of the *t*-th trading day ahead forecast error of the level of EUA that is attributable to each structural shocks for t = 1, 2, …, 90. More than half of variation in EUA is explained by its own shocks. The shocks to sCER count for less than 3% of variability in EUA due to the EU's import limit on sCER. Thus, demand on sCER is considerably sensitive to the fluctuation of EUA prices in the EU–ETS market. Demand on EUA on the other hand is less sensitive to the fluctuation of sCER prices in the EU–ETS market.

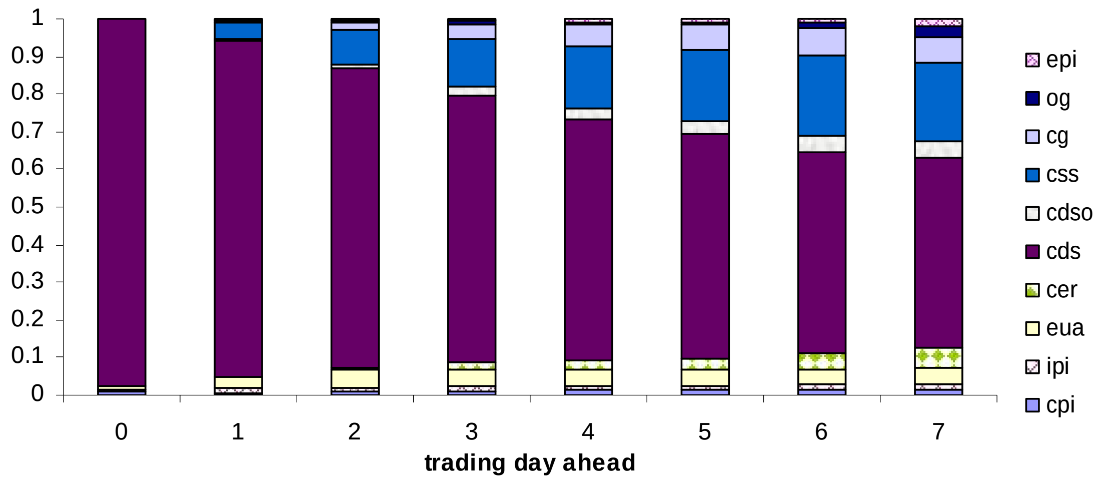
Figure 11. Variance decomposition of EUA



Shocks to the economy explain about 2% - 8% of variation in EUA. Theoretically, economic growth accelerates GHGs emission, which in turn increases demand on emission credits. It follows that macroeconomic shocks should have a large share in the variation of emission credits. Thus, the small impact of macroeconomic shocks indicates that the allocation of EUA has made demand on emission credits less responsive to the state of emission intensive economic activity. Shocks to clean dark spread and clean spark spread count are as important as technology shocks in explaining EUA innovations. Shocks to clean dark spread and clean spark spread count for 7% - 10% of variability in EUA. Shocks to fuel switching cost explain EUA innovations by the same magnitude. The shocks to switching cost from coal to gas are more important to EUA innovation than shocks to switching cost from oil to gas. The costlier oil fired plants causes changes in switching cost from oil to gas does not count much on the demand side of EUA.

Clean dark spread (CDS) takes into prices of emission credits, coal and gas. Thus, shocks to prices of emission credits are important in forecasting clean dark spread and electricity production schedule. Variance decomposition of clean dark spread in figure 12 specifically measures how important shocks to prices of emission credits to the variability of clean dark spread.

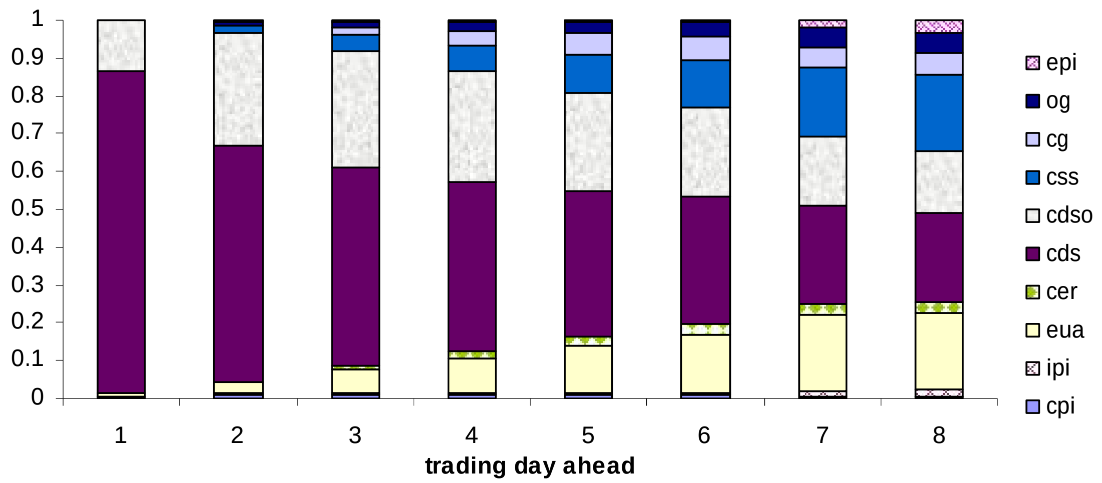
Figure 12. Variance decomposition of CDS



Variability in clean dark spread is more responsive to its own shocks than shocks to other variables. About 50% - 90% of variation in clean dark spread is explained by its own shocks. Shocks to emission credits on the other hand, explain 3% - 10% of the variation in clean dark spread, indicating that cost associated with emission credit is fully pass on electricity buyers. Technology shocks are more important than shocks to the economy in explaining variation in clean dark spread. Technology shocks count for about 5% - 24% of fluctuation in clean dark spread. More than 90% of this portion belongs to shocks to switching cost from coal to gas as switching cost from coal to gas and clean dark spread are influenced by coal prices. Shocks to the economy explains only about 2% - 3% of variation in clean dark spread, suggesting that shocks on demand side do not count much in gross margin for coal fired plants.

Clean spark spread also takes into prices of emission credits, coal and gas. It is expected that shocks to prices of emission credits are also significant to forecast of clean spark spread and electricity production schedule. Figure 13 shows the long run effects of shocks to emission credits and other variables on innovations of clean spark spread. Emission credits count for 3% - 23% of the variability in clean spark spread. The result is in lined with variance decomposition of clean dark spread. Electricity producers in the EU-27 region have market power to pass cost associated with emission credits on electricity buyers.

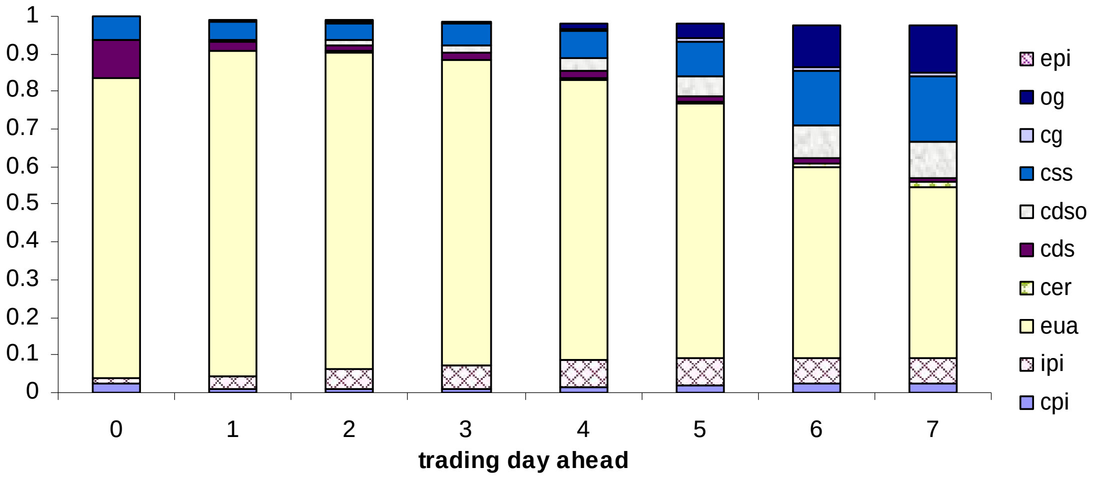
Figure 13. Variance decomposition of CSS



About 16% - 62% of variation in clean spark spread is explained by its own shocks. Shocks to clean dark spread explain about 20% - 60% of variation in clean dark spread as some power producers use mixed-coal-and-gas technology. Shocks to the economy are less important than shocks to emission credits and fuel switching cost in explaining variation in clean spark spread. Shocks to the economy explain only about 2% - 3% of variation in clean spark spread. This means that business cycle, which influence demand side of electricity, does not matter much for gross margin of oil-fired plants. Technology shock counts for 3% - 26% of variation in gross margin for gas fired plants. More than 80% of this portion belongs to shocks to switching cost from coal to gas.

The oil is relatively costlier than coal and gas for producing electricity. Accordingly, oil is less popular energy sources for power generation than coal and gas in EU-27 area. Emission and energy content of oil makes gross margin for oil fired plants is more sensitive to fluctuation in prices of emission credits than to other variables. Figure 14 shows that the results support this view.

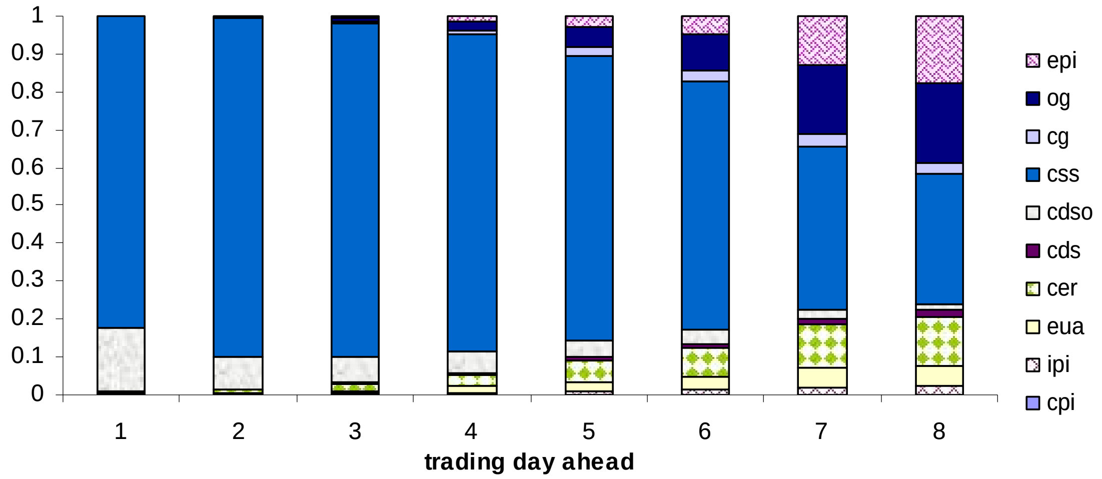
Figure 14. Variance decomposition of CDSO



The portion of shocks to emission credits count for 47% - 86% of variability in gross margin for oil fired power generators. Only about 5% - 17% of variation in gross margin for oil fired power generators is explained by its own shocks. The shocks to technology switching cost are less important than macroeconomic shocks to the innovations of synthetic clean dark spread. Technology shocks explain about 1% - 4% of fluctuation in gross margin for oil fired power generators. Recalling variance decomposition of clean dark spread and clean spark spread, technology shocks apparently take longer time to influence gross margin of oil-fired plants than gross margin of coal and gas fired plants. Simultaneously, macroeconomic shocks count for about 4% - 9% of variation in gross margin for oil fired power generators.

The importance of shocks to other variables to the variation in switching cost from coal to gas is depicted in figure 15. About 34% - 90% of variation in switching cost from coal to gas is explained by its own shocks. Shocks to clean dark spread and clean spark spread counts for about 7% - 9% of variation in switching cost from coal to gas. More than half of this portion comes from the shocks to clean dark spread and clean spark spread. This result corresponds to coal and gas prices that influences clean dark spread, clean spark spread and switching cost from coal to gas.

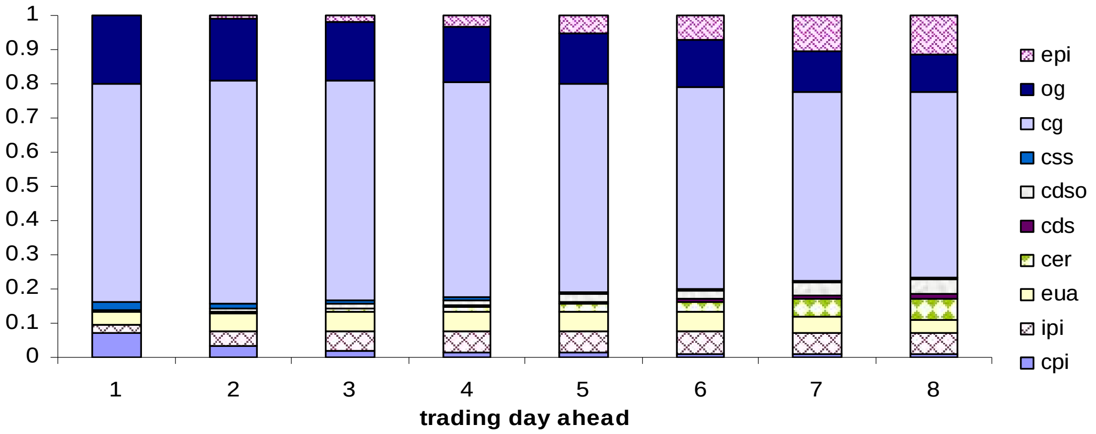
Figure 15. Variance decomposition of CG



Shock to emission credits explains about 1% - 18% of variability in switching cost from coal to gas. More than two third of this portion comes from sCER shocks. Macroeconomic shocks counts for less than 2% of variability in switching cost from coal to gas. The low degree of technology switching in coal-fired plants might explain that macroeconomic fluctuation does not count much in the changes of switching cost from coal to gas.

Results of variance decomposition of switching cost from oil to gas (OG) are depicted in figure 16. Shocks to switching cost from oil to gas count for 10% - 63% of variability in this variable. Shocks to clean dark spread and clean spark spread are more important than shocks to the economy and emission credits in explaining variability in switching cost from oil to gas.

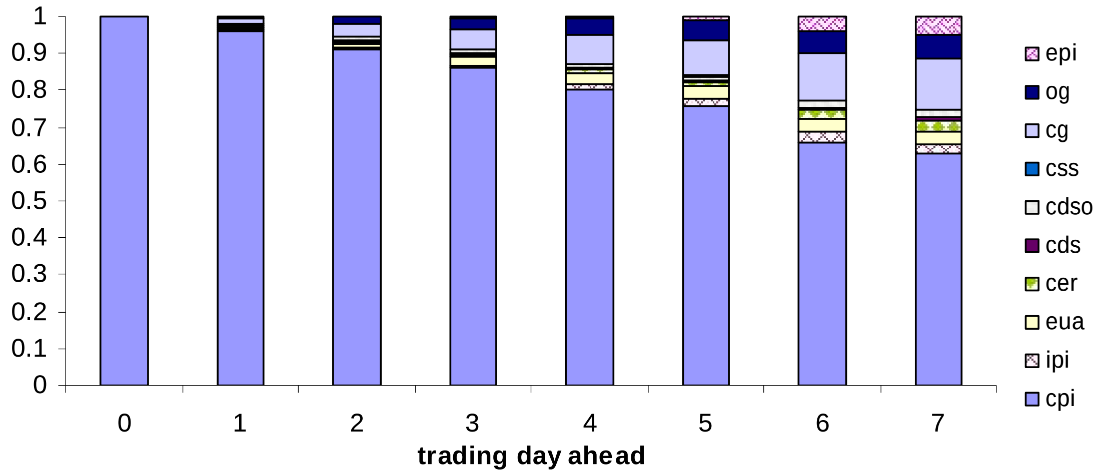
Figure 16. Variance decomposition of OG



Shocks to clean dark spread and clean spark spread explain for 19% - 60% in the fluctuation of switching cost from oil to gas. Naturally, more than 90% of this portion comes from shocks to synthetic clean dark spread for oil fired plants. This result corresponds to the fact that fuel-switching cost from oil to gas and gross margin for oil-fired power plant is determined by oil prices. Shocks to emission credits count for 6% - 10% of variability in the switching cost from oil to gas. Shocks to the economy explain 6% - 8% of variation in the switching cost from oil to gas. Interestingly, shocks to electricity prices could explain 1% - 5% of fluctuation in the switching cost from oil to gas. The possible explanation for this result is that the expected electricity prices influence firm's decision to switch fuel from oil to gas.

Variance decomposition of consume price index is depicted in figure 17. More than a half of variation in consumer price index is explained by its own shocks. Shocks to clean dark spread and clean spark spread count for 2.6% - 16.5% of the innovations of consumer price index. More than a half of this portion comes from shocks to gross margin for oil-fired plants. Shocks to emission credits explain only about 0.4% - 6.7% of variation in consumer price index. Technology shocks counts for only 1% of consumer price index variation and about two third of this is attributable to shocks to switching cost from oil to gas. The impact of shocks to electricity prices is not significant.

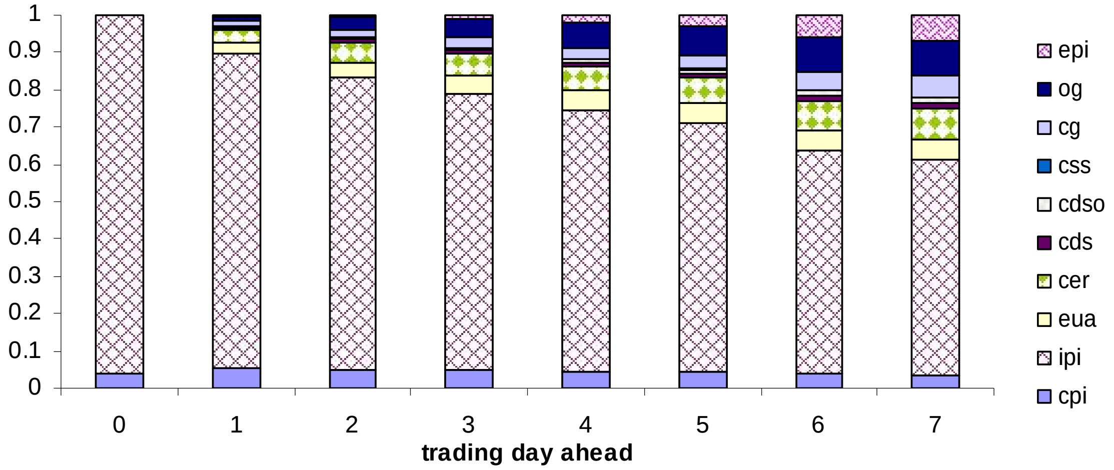
Figure 17. Variance decomposition of CPI



The results shows that shocks to clean dark spread and clean spark spread is more important than shocks to emission credits to the variability in consumer price index. This implies directional causality from energy prices to macro economy during sample period. Shocks to gross margin of oil fired power plant dominates the portion of shocks to clean dark spread and clean spark spread in the variation of consumer price index. Shocks EUA is as important as shocks sCER shocks to the fluctuation in consumer price index. The small share of the two shocks in the innovations of consumer price index suggests that emission cap-and trade regime does not hamper economic growth. The small portion of shocks to fuel switching cost in the variability of consumer price index suggests that the impact of technology shocks to the economy takes more than three months.

Similar result is also found in the variance decomposition of industrial productivity index in figure 18. More than half of variation in industrial productivity index is explained by its own shocks. Shocks to clean dark spread and clean spark spread count for 6% - 13% of IPI innovations. Shocks to emission credits explain about 2.5% - 13% of the variance in productivity index, and two third of that portion comes from sCER shocks. The impact of technology shocks counts for about 1% - 9.6% of variability productivity index. The shocks to switching cost from oil to gas make up for more than 98% of the portion of technology shocks.

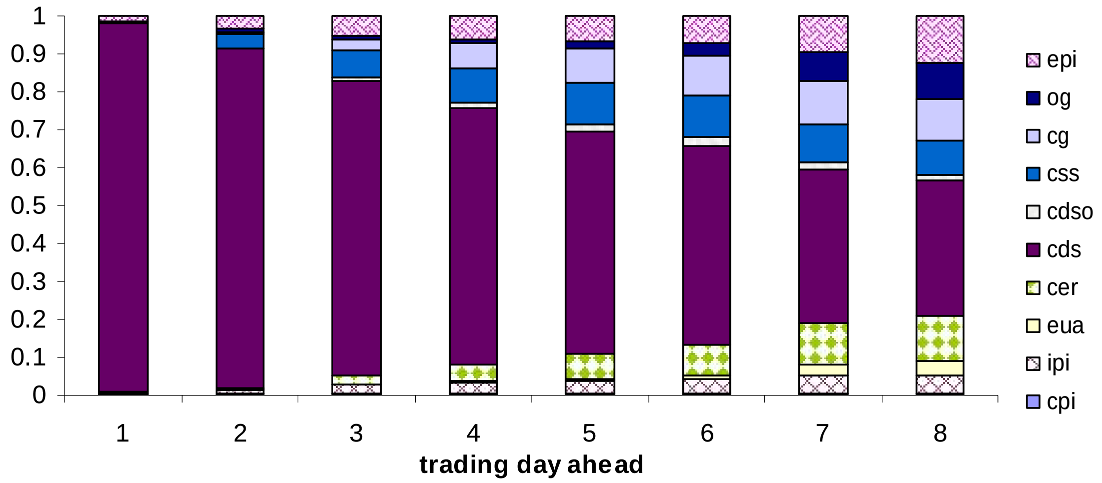
Figure 18. Variance decomposition of IPI



The result supports findings in the variance analysis on consumer price index. First, shocks to clean dark spread and clean spark spread are more important than shocks to emission credit to variation in industrial productivity index. Second, directional causality exists from energy prices (particularly oil prices) to the macro economy during sample period. Third, shocks to electricity prices also do not matter to the fluctuation in industrial productivity index, counting less than 1% of innovations of industrial productivity index. Lastly, shocks are EUA is as important as sCER shocks to the variation in industrial price index.

Variance decomposition analysis on electricity prices should provide evidence whether fluctuation in electricity prices is responsive to shocks to gross margin for electricity installation, emission credits and macro economy. Figure 19 shows that shocks to electricity prices are less important than shocks to emission credit, clean dark spread, cleans spark spread and fuel switching cost. Electricity own shocks explain only 1.3% - 12.3% variation in electricity prices. On the other hand, shocks to clean dark spread and clean spark spread count for 48% - 90% variation in electricity prices. Expectedly, about 75% of this portion comes from shocks to clean dark spread as electricity production in EU-27 countries is still dominated by coal-fired plants.

Figure 19. Variance decomposition of EPI



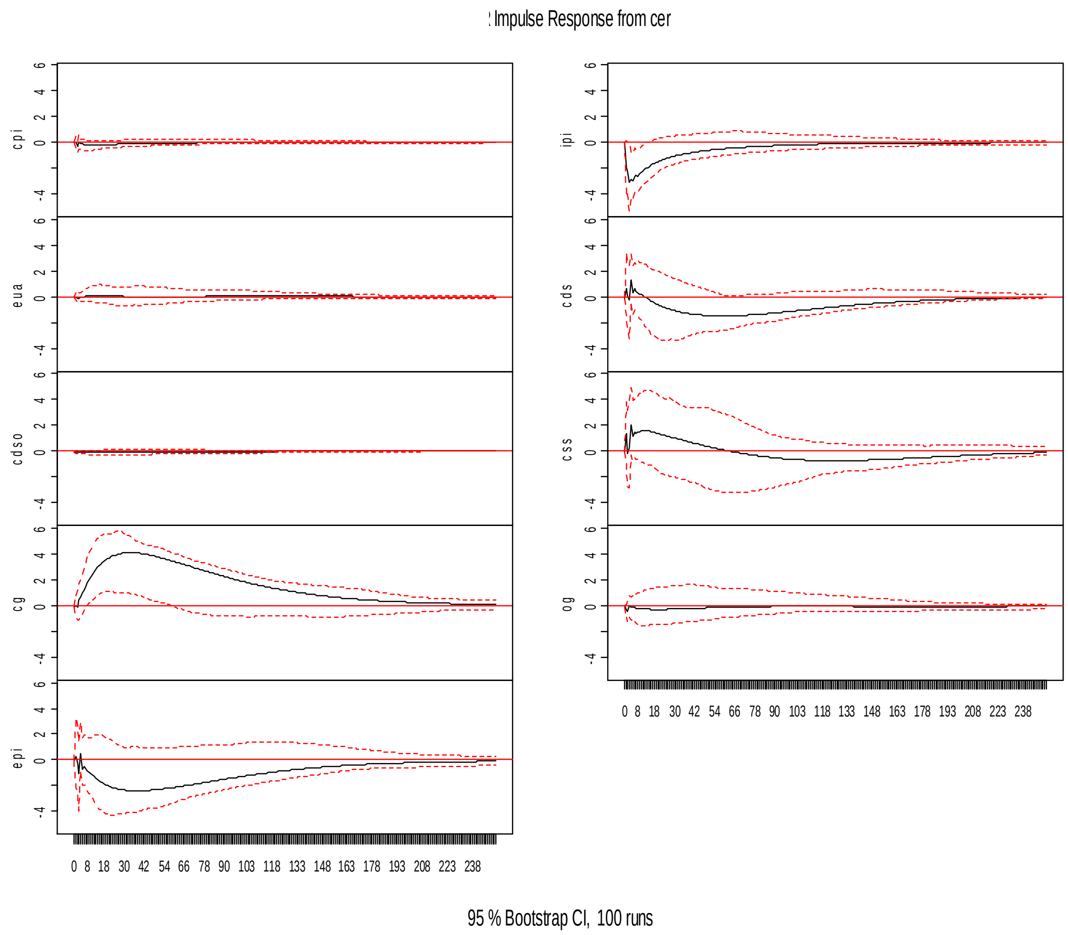
Shocks to emission credits explain about1% - 15% of variability in electricity prices, implying that cost associated with emission credits is fully passed on electricity buyers. Noticeably, about third quarter of shocks to emission credits is attributable to sCER shocks. The importance of sCER shocks to the variation in electricity prices suggests that demand on sCER in EU-27 area mostly comes from power installation. The portion of shock to emission credit, which is smaller than portion of shocks to gross margin for producing electricity, implies that fluctuation in gross margin for power producers is likely to be more affected by energy price shocks than shocks to emission credits.

Technology shocks count for 4% - 8% to the variation in electricity prices. Shocks to switching cost from oil to gas appear as important as shocks to switching cost from coal to gas to the variation in electricity prices. The low portion of the effect of technology shock indicates the low level of technology switching to low emission technology across power installation in the EU-27 area. Shocks to consumer price index and industrial productivity index explain only about 1% - 5% of variability in electricity prices. The small portion of macroeconomic shocks to innovation of electricity prices implies price rigidity of electricity to the economy activity.

2.5.3. Impulse response

The impulse responses are used to assess the signs and magnitudes of responses to specific shocks in a two-year horizon as illustrated in figure 19 to 28. By using bootstrapping based on 100drawn, one standard deviation of confidence bands around the point estimates have been estimated (depicted by the two dashed lines). Figure 20 shows the responses of consumer price index, industrial production index, clean dark spread, clean spark spread, fuel switching cost, EUA and electricity prices to one standard deviation shock in sCER.

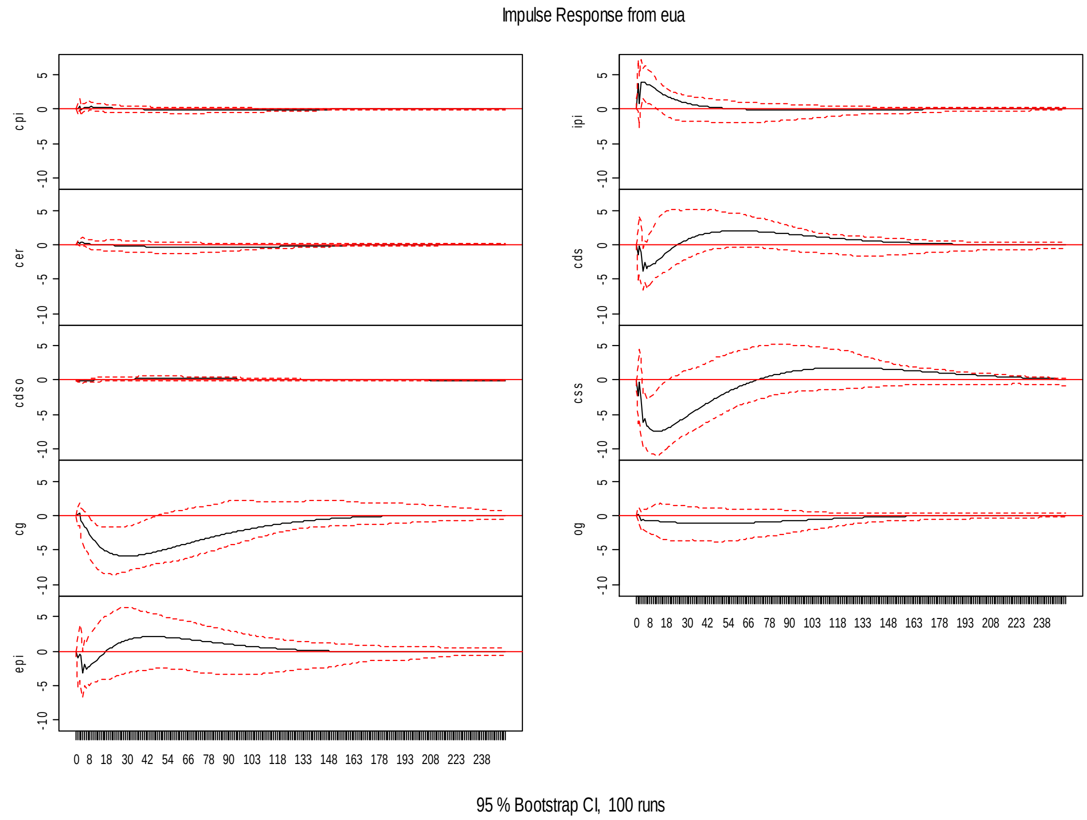
Figure 20. Impulse response function of the variables to
one standard deviation of sCER shocks



The figure reveals that EUA response to sCER shock is negligible. Consumer price index and industrial productivity responded negatively to a one-standard-deviation shock in sCER, suggesting emission cap-and-trade regime hampers the economic activity. The impact of sCER shocks is more profound for business than for household as response of industrial productivity index is stronger than response of consumer price index. Clean dark spread and clean spark spread respond negatively to sCER shocks. Thus, an increase in the price of emission credit put pressure on the gross margin for electricity producers by small magnitude. The response of technology switching cost to sCER shock depends on the type of fuel. Switching cost from coal to gas responds positively to sCER shock while switching cost from oil to gas show the opposite response to the same shock. This could be explained by difference in emission content as well as energy content between coal and oil. Interestingly, electricity price responds negatively to sCER shock as cost associated with emission credits compose production cost of electricity.

Similar to EUA response to sCER shocks, sCER response to EUA shocks is also insignificant as indicated by the error band. Clean dark spread and clean spark spread respond negatively to sCER shocks. The EU ETS’s limit on CER import leads the magnitude of the clean dark spread and clean spark spread to respond to EUA shocks by greater than response of the two variables to sCER shocks.

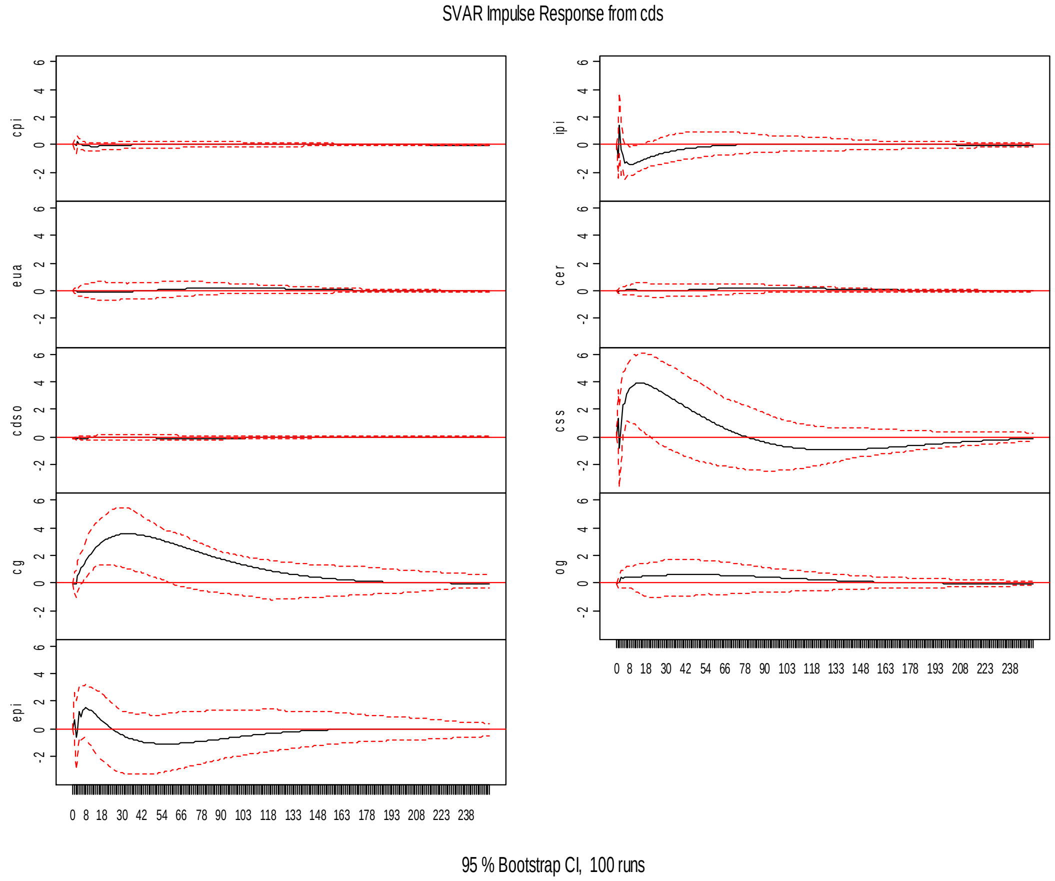
Figure 21. Impulse response function of the variables to
one standard deviation of EUA shocks



Fuel switching cost negatively responds to EUA shocks with magnitude depending on fuel type. The impact of EUA shocks is more profound on switching cost from coal to gas than switching cost from oil to gas. Thus, it is far cheaper to switch from coal to gas than from oil to gas when EUA prices increases. Industrial productivity index and consumer price index respond positively to EUA shocks for the firs 40 trading days but in the long run the index negatively respond to the shocks. The result support finding in the impulse response from sCER that emission cap-and-trade hurts business rather than household. Electricity prices respond negatively to EUA shocks in the first 15 trading days respond negatively to the shocks in the long run. This could be reflective of market power of electricity producers to pass EUA prices to electricity buyers.

Fuel switching cost responds positively to shocks to clean dark spread as the increase of gross margin for coal fired plants increases opportunity cost to adopt low emission technology. The response of emission credits to shocks to clean dark spread is not discernible as shown by the error band. The electricity prices respond positively in the first 30 trading days, implying that market power of electricity producers are able to keep gross margin high in the short run by increasing electricity prices. In the long run, the shocks will hurt demand side of electricity which is translated into negative response of electricity prices to the shocks.

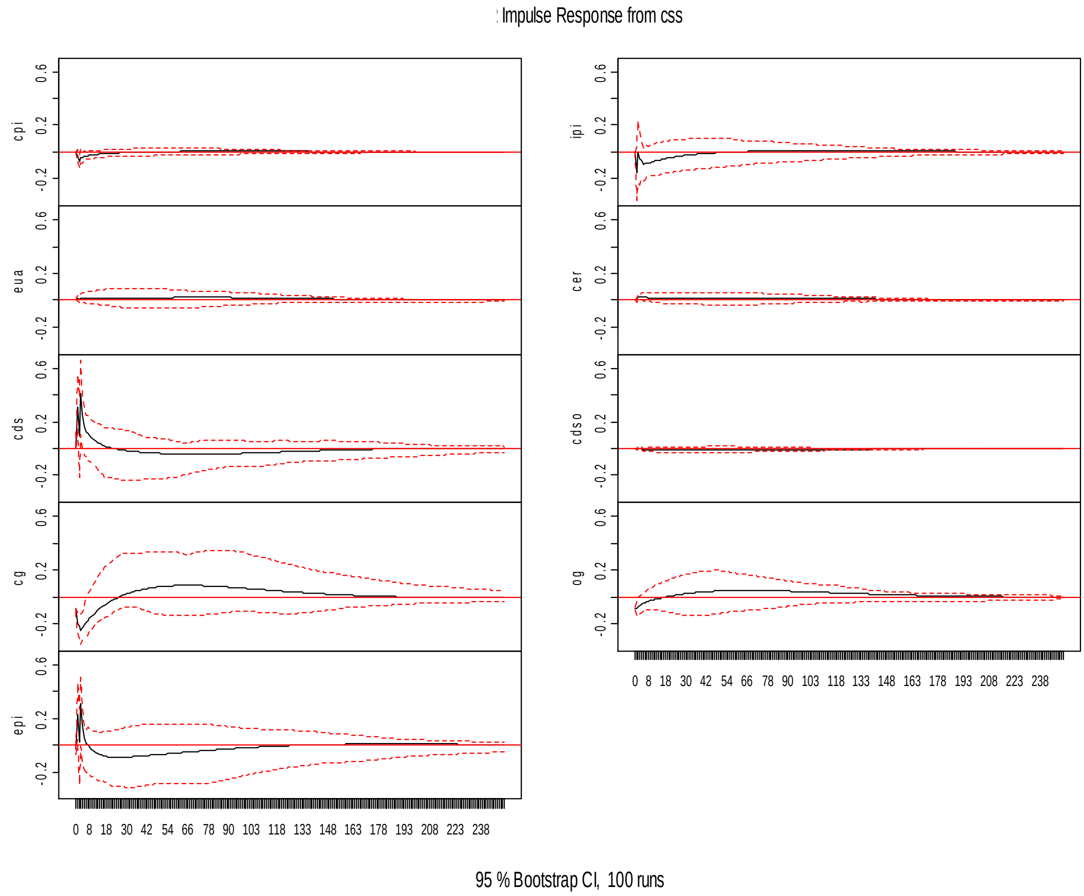
Figure 22. Impulse response function of the variables to
one standard deviation of CDS shocks



Industrial productivity index and consumer price index have positive-immediate response to shocks to clean dark spread although by small magnitude. Positive shocks to gross margin for coal-fired plants surely increase price-adjusted output from sector, pushing industrial productivity index for all sectors up. As high gross margin puts pressure on electricity price in the long run, the same occur to industrial productivity index, particularly index of energy sector.

Figure 23 shows contradictory response of macroeconomic indicators to the shocks to clean spark spread. Consumer price index and industrial productivity index have immediately negative response to shocks to clean spark spread. In the long run, both variables respond positively but negligibly to the same shocks. Other variables respond to shocks to clean spark spread in the same fashion as their response to shocks to clean dark spread.

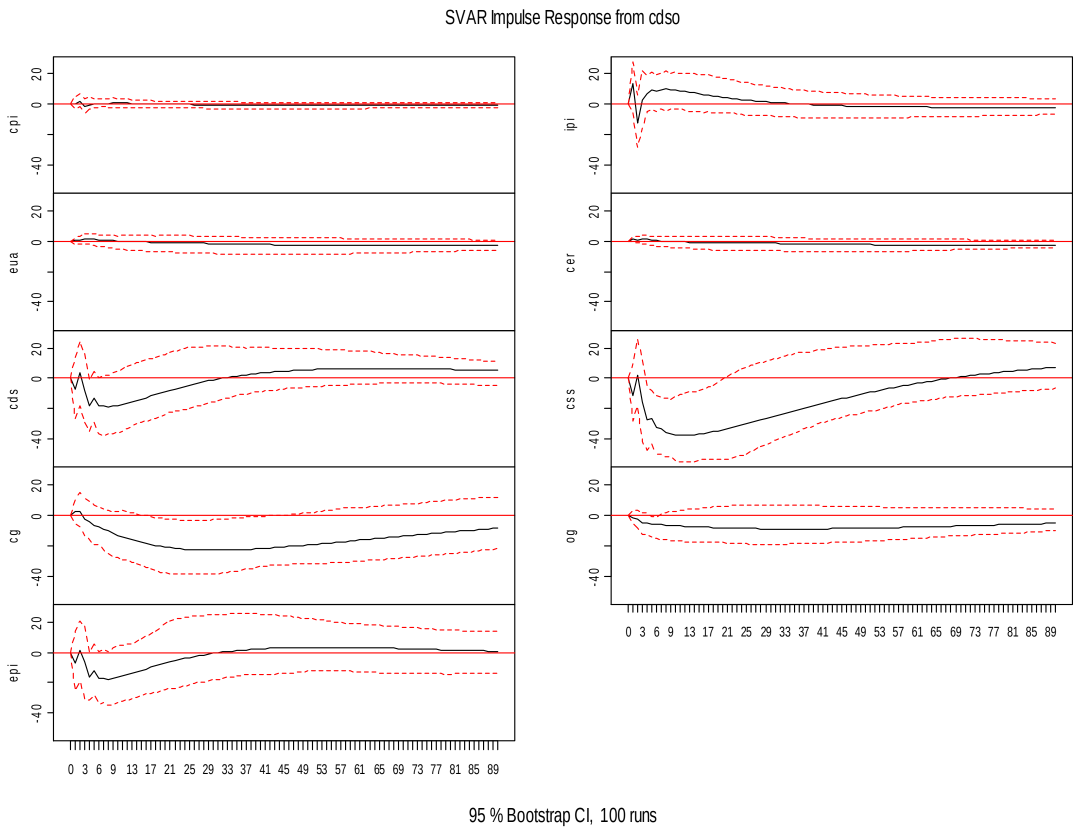
Figure 23. Impulse response function of the variables to
one standard deviation of CSS shocks



Fuel switching cost responds positively to shocks to clean spark spread. The magnitude of the response is significantly smaller than its response to shocks to clean dark spread. The response of emission credits to shocks to clean dark spread is not discern 59 i shown by the error band. The electricity prices respond positively in the first eight trading days, and turn to negative response afterward. This result support previous finding that in the long run the shocks will hurt demand side of electricity.

The response of variables to the shocks to gross margin for oil-fired plants is summarized in figure 24. It is important to note that the sign of synthetic clean dark spread CDSO is negative and oil fired plants share a very small portion in electricity production in the EU-27 area.

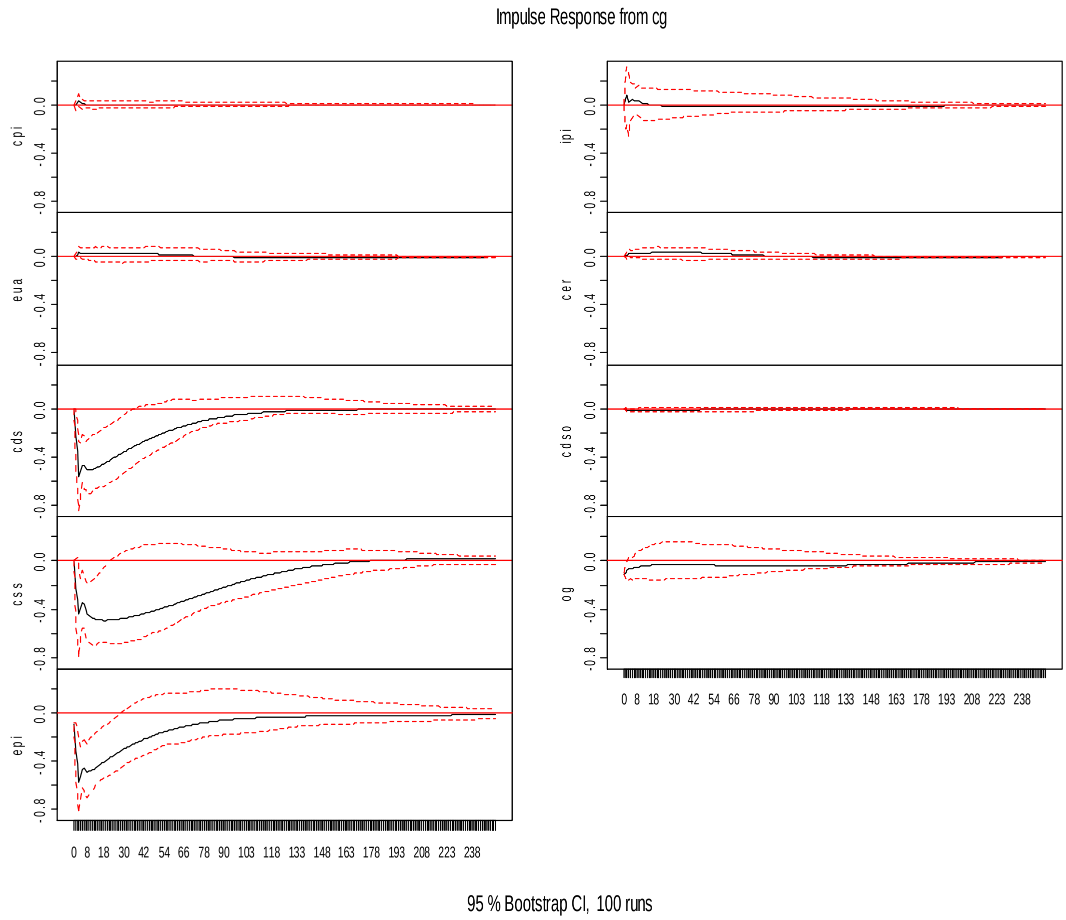
Figure 24. Impulse response function of the variables to
one standard deviation of CDSO shocks



Electricity prices respond positively to the shocks to synthetic clean dark spread to make up increasing negative gross margin. The increasing price however put pressure on the demand side of electricity in the long run that is translated to negative response of electricity prices. The response of macroeconomic indicators corresponds to the response of electricity prices. Response of electricity prices is immediately transmitted to prices of goods acquired by household and price adjusted output. Thus, in tl 60 ; run, increasing negative profit margin of oil-fired plants put pressure on industrial productivity index and prices of goods acquired by household. Shocks to gross margin for oil-fired plants dampen emission intensive economic activity, which in turn decreases demand on emission credits. The response of fuel switching costs to the shocks to synthetic clean dark spread is close to their response to the shocks to clean dark spread. The opposite sign corresponds to negative gross margin for oil-fired plants.

All variables except for clean spark spread and emission credits respond negatively to the shocks to switching cost from coal to gas. Figure 25 shows that Emission credits respond positively to the shocks, implying that equilibrium prices of emission credits are about cost for switching technology.

Figure 25. Impulse response function of the variables to one standard deviation of CG shocks



Under emission cap-and-trade regime, increasing fuel switching cost squeeze gross margin for electricity producers, which is transmitted to price adjusted output and demand side of electricity.

Figure 26. Impulse response function of the variables to
one standard deviation of OG shocks

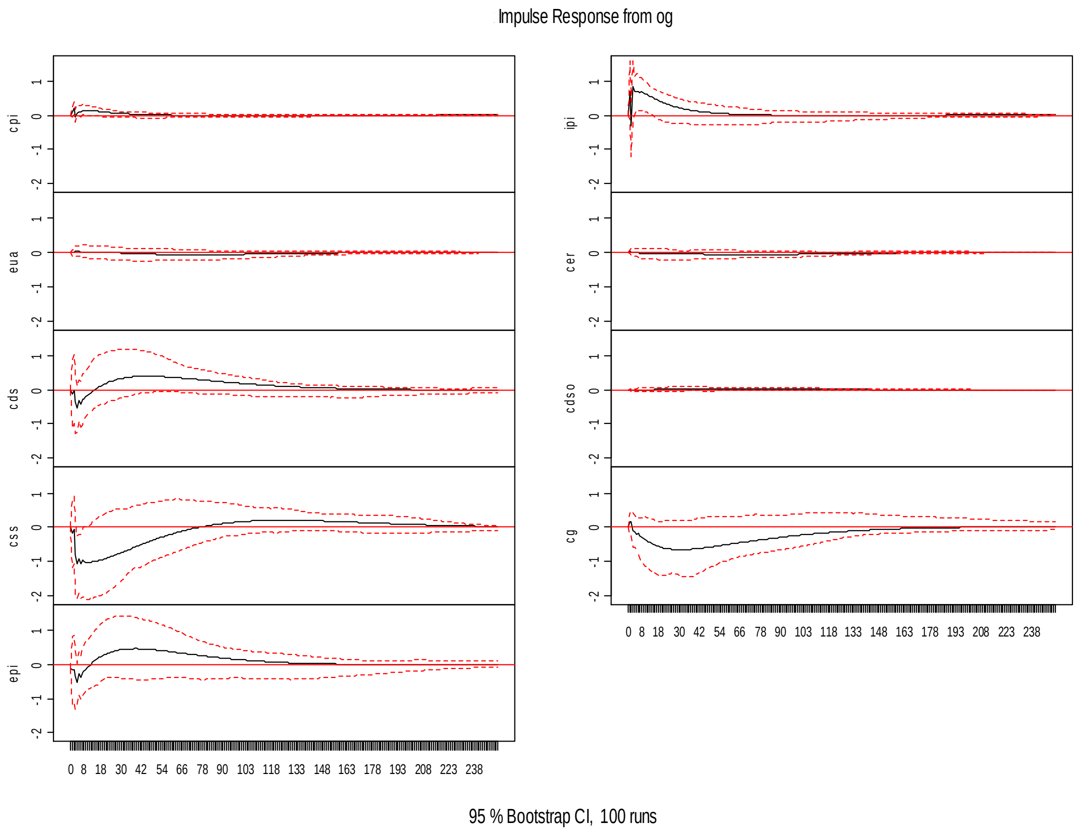
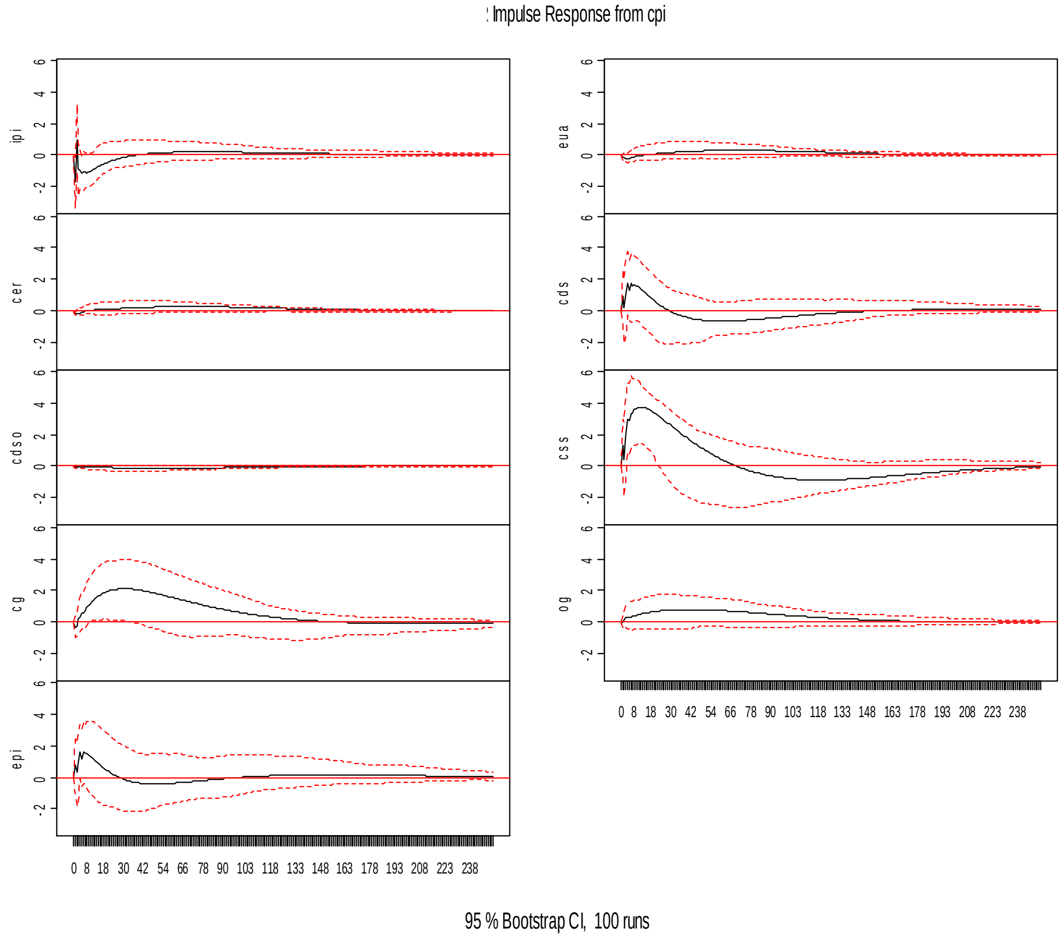


Figure 26 illustrates the response of variable to the shocks to switching cost from oil to gas. The impact of the shocks is negligible except for industrial productivity index, clean dark spread, clean spark spread, switching cost from coal to gas and electricity prices. Industrial productivity index and consumer price index respond positively to the shocks. The possible explanation is that oil fired plants are almost as expensive as gas fired plants; hence the shocks do not put pressure on price adjusted output and prices of goods acquired by household. In the long run clean dark spread and clean spark spread positively respond to the shocks, suggesting that high switching cost induces electricity producers to keep up emission intensive - electricity production. The response is also reflected in positive response of electricity prices.

Emission credits respond positively but insignificantly to the shocks to consumer price index. This result supports the notion that economic expansion increases emission production, hence increasing demand on emission credits. Accordingly, shocks to consumer prices index are negatively responded by clean dark spread and clean spark spread in the long run. The response is very strong since increasing energy prices also puts pressure on gross margin for electricity producers as illustrated in figure 27.

Figure 27. Impulse response function of the variables to one standard deviation of CPI shocks



On the other hand, growing economy increases demand on electricity, increasing electricity prices. In the end, price adjusted output picks up as shrinking gross margin is off set by increasing sales volume. Additionally, positive response of emission credits coupled with increasing energy prices yields positive response of fuel switching cost to the shocks to consumer price index.

Figure 28 shows that variables have the same response to the shocks on industrial price index as shocks on consumer price index.

Figure 28. Impulse response function of the variables to one standard deviation of IPI shocks

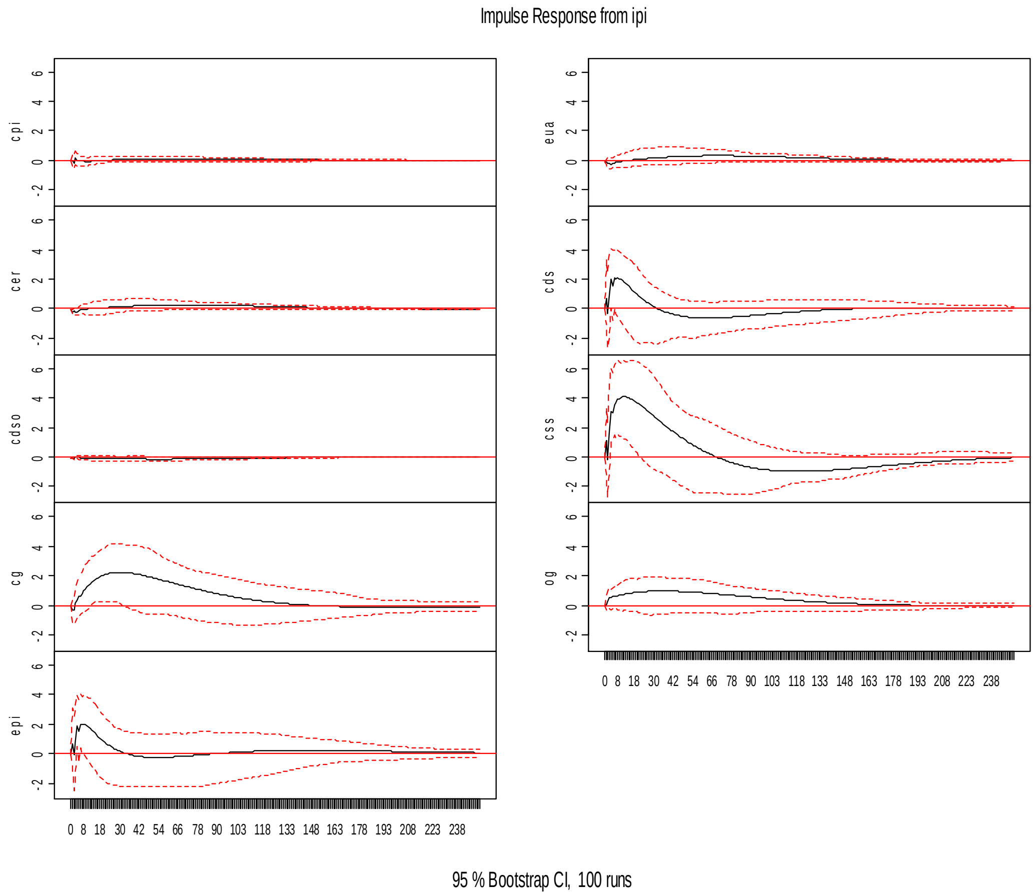
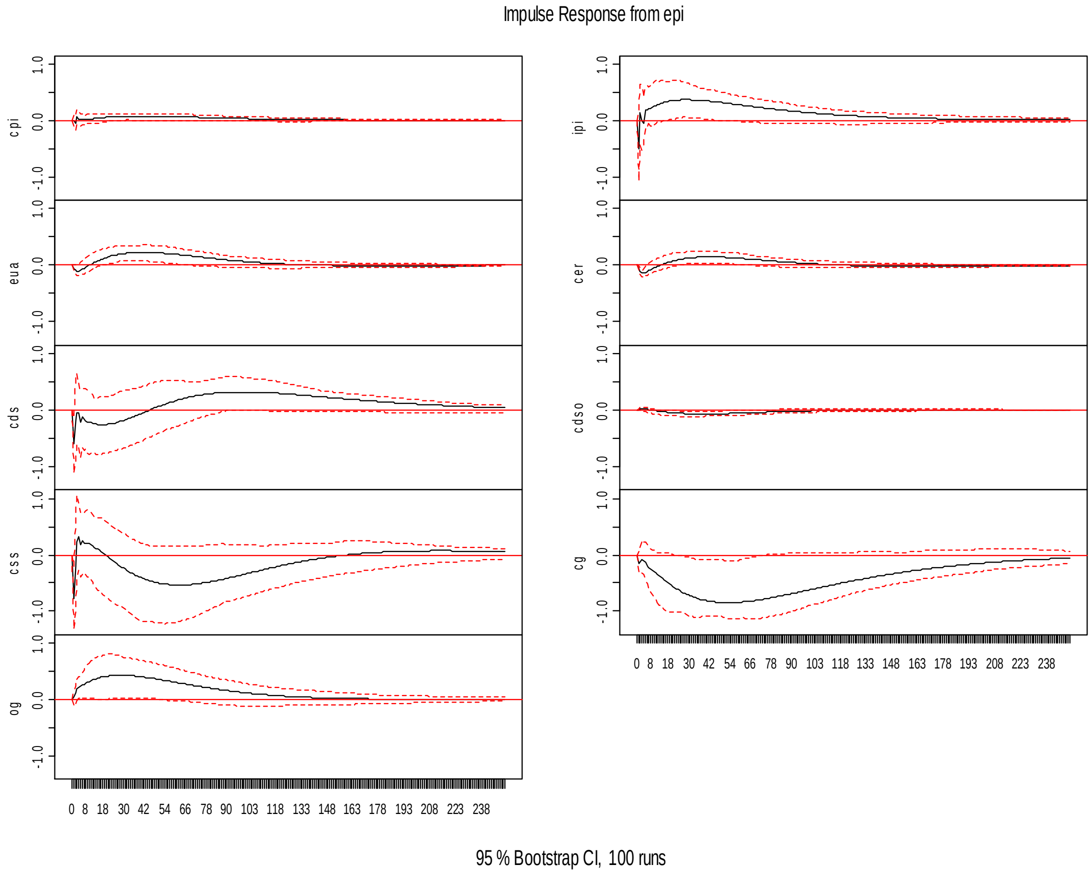


Figure 28 shows that economic expansion increases demand on emission credits. As emission credits are counted in clean dark spread and clean spark spread, economic expansion is negatively responded by clean dark spread and clean spark spread in the long run. Electricity prices respond positively to the shocks to industrial productivity index. Apparently, economic expansion boosts demand on electricity. Positive shocks to adjusted price of output appear to move up fuel switching cost, which is possibly triggered by higher prices for energy and emission credits.

Figure 29 shows that all variables except for switching cost from coal to gas respond positively to the shocks to electricity prices. This result implies that electricity producers are "compensated" from switching to low emission fuel when electricity prices are high.

Figure 29. Impulse response function of the variables to
one standard deviation of EPI shocks



A jump in electricity prices naturally increases price-adjusted output for main industry and prices of goods acquired by household. As the economy expands, shocks to electricity prices also increases demand on emission credits. Therefore, EUA and sCER respond positively to the shocks to consumer price index. Lastly, shocks to electricity prices take months to positively influence gross margin for electricity producers.

2.6. Conclusion

The primary interest of this study lies in the description of the response of emission credits to variables. Estimation technique of structural cointegrated VARX with conditional variance is used. The techniques allows interdependency of the variables and for exogenous shocks. This has been a critical issue in the empirical investigation of prices of emission credits. Some of the resent research concerned with the macroeconomic effects on sCER prices rule out the possibility of bidirectional causality between some variables. The technique is also not theoretic which can be used when theory does not yield a clear prediction, but its estimated parameters have structural interpretation and economic meaning. Using VARX with conditional variance requires the decomposition of the estimated variance-covariance matrix of innovations.

In order to assess the empirical significance of recursivity assumption, reasonable contemporaneous structures of relationship between variables is defined. The basic purpose of the research is not to establish the validity of any particular set of structural priors but to explore the sensitivity of conclusions to identifications of matrix A. The structures implied by matrix A are exactly identified and recoverable from the estimated variance-covariance matrix of the cointegrated VARX residuals. Spot prices of emission credit are assumed to have no automatic response to changes in gross margin for electricity producers, electricity prices, and fuel switching costs. The automatic response of macroeconomic indicators to changes in prices of emission credits, gross margin for electricity producers, electricity prices, and fuel switching costs also does not exist.

The empirical analysis carried out on spot prices seems somewhat not supporting conclusion from analysis does of future prices in Mansanet-Bataller et al (2011) and Chevallier (2011). Economic expansion has the same effect on EUA and sCER. Economic expansion increase emission production that in turn boosts demand on EUA and sCER. On the other hand, sCER and EUA respond differently to the shocks to the economy. A jump in sCER prices moves up price adjusted output and prices of goods acquired by household. A jump in EUA prices however put pressure on price adjusted output and prices of goods acquired by household. Interdependent relationship between EUA and sCER exists. EUA responds negatively to the shocks to sCER and vice versa. This implies that demand on one emission credits influences demand on another emission credit. Extreme weather and changes in climate policy are not significant in the price dynamics of emission credits.

EUA and sCER prices respond positively to technology shocks, suggesting that equilibrium price for emission credit mimic dynamics of fuel switching cost. Another important finding is that clean dark spread and clean spark spread are most important in the fluctuation of electricity prices. Further, technology shocks put pressure on electricity prices shocks while shocks to emission credits are fully passed on electricity buyers. Economic expansion expectedly moves up demand on electricity up and energy prices that are translated into higher fuel switching cost.

Briefly, prices of EUA and sCER are influenced by the state of the economy in the EU-27 are since the EU ETS is the biggest market for sCER and EUA. Thus, any investment decision associated with sCER needs to take into account business cycle in the EU ETS member countries. Second, price dynamics of sCER move in conformity with market expectation about fuel switching cost. Thus, spot prices of sCER could be reference prices of projects associated with CER. Third, profit maximizing electricity producers should take into account interdependency between emission credits and dynamics of fuel switching cost.

CHAPTER 3 ON THE PRICE DETERMINANTS OF BANK LOANS

3.1. Introduction

Banking regulation in Indonesia requires banks to set loss provision to absorb environmental and social impact of lending activities. Thus, environmental and social performance of borrowing firms influences loan prices through loan provision. Loans prices are widely studied under banking firm and dealership framework. The latter has been increasingly popular in empirical studies on European banks and banks operating in emerging countries. Dealership approach was introduced by Ho and Saunders in 1981 and had been extended to portfolio effect on the asset side of banks (Allen, 1998; Maudos and Guevara, 2004).

To identify whether dealership model represents banking practice in the Indonesia, banking survey was carried out in April 2011. The respondents are 66 banks accounted for 97% of total loans in Indonesia that comprises state owned banks, local banks, branches and subsidiaries of foreign banks (Bank Indonesia, 2011). The results show that dealership model mimics product pricing and liquidity management in Indonesian banks. However, the existing dealership model can not capture the fact that some respondents have earned more by heavily depending on non interest-bearing deposits. Previous works using dealership models assume single deposit i.e. term deposit. In practice, some banks prefer to depend heavily on non-maturity deposit such as demand deposit and saving, through marketing strategy and investment in payment system. Such banks bear high operating cost but pay very low cost of fund. In other word, deposit portfolio might be important in wealth maximizing-loan prices.

Considering the significance of non-maturity deposit in some bank respondents, this study contemplates portfolio effect of deposits in wealth maximization of a bank. The wealth maximization problem in Allan (1998) and Maudos and Guevara (2004) is extended to non-interest bearing deposits as so-called non-maturity deposits in this study. The first order condition should imply wealth-maximizing prices of loan and other banks' products. This extended theoretical model is tested on unbalanced quarterly data of contractual prices, accounting based prices and other data of 51 banks in Indonesia from March 2005 to December 2010. The use of Indonesian banking data is for the following reasons. First, some banks have involved in climate finance. Second, there has been massive merger and increasing foreign ownership on Indonesian banks during the sample period. As a result, banks' pricing model as well as asset and liability management tends to converge to that of parent banks operating in other developing or developed countries. In other word, what has been observed on product pricing and portfolio effect of deposit in Indonesia is likely to occur in other developing and developed countries.

One of the focuses of this study is determining whether non-maturity deposits could yield higher wealth than maturity deposits. The second objective is to identify whether competitive advantage of loans suggested by Maudos and Saunders (2004) holds when portfolio effect of deposit enters wealth maximization problem. The third objective is to demonstrate whether accounting data of interest income and expenses biases the estimation, and whether contractual prices of bank products could negate the problem. Accounting revenues and expenses are typically used to derive prices of banks' products in many dealership models. However, accounting revenue and cost recognition is often come later than that of price determinants of bank's products. For instance, interest income and expense is likely to be recorded later while determinants of loan prices such as loan size are recognized when loans are disbursed.

Clearly, the contribution of this study takes two folds. First, it introduces competitive advantage of non-maturity deposit into dealership model. By doing this, dealership model could accommodate potential high earnings from non-maturity deposits or technology based payment service. The second contribution is to provide empirical evidence that using accounting data of income and expenses to derive product prices could raise potential bias estimation. Contractual prices of bank products are proposed to eliminate bias estimation. The problem of using accounting data has been highlighted in some papers such as Demirgüç-Kunt and Huizinga (1999). Nonetheless, empirical evidence supporting this argument barely exists.

The results about the impact of non-maturity deposit are presented in section 3.3.1.2. The non-maturity deposits give competitive advantage to banks whose per unit operating cost is lower than return on money market fund. The introduction of non-maturity deposit into the wealth maximization problem does not change competitive advantage of loans specified in Maudos and Saunders (2004). Loans make banks better off when per unit operating cost of non-loan earning assets is higher than relative immediacy fees of non-loan earning assets. This extended model is tested on the data set by using static and dynamic panel model with standard errors robust to heteroskedasticity.

The results indicate that the spread between loan prices and deposit prices (i.e. the intermediation margin), increases with market power, credit risk and interest rate risk, degree of risk aversion, opportunity cost of regulatory capital, expected profit margin, and size of new interest bearing earning assets as well as total earning assets. The margin is negatively related to operating cost, deposit insurance premium, opportunity cost or reserve requirement, lower bound of deposit price under deposit insurance scheme, past value of intermediation margin, and size of new loans. The results are robust to time dummies. The sign of estimators however are not consistent and standard error of coefficients is high when accounting margin is used as proxy for intermediation margin. This result supports the argument that accounting margin raises potential bias estimation and contractual prices should avoid such problem.

3.2. Literature review

3.2.1. Microeconomics of the banking-firm approach and dealership approach

Dealership model was developed from microeconomic of the banking firm model. The banking firm model views banks as administrators of a country’s payment system that attract funds from surplus spending unit and transmit funds to deficit spending units. Banks hold loans, liability deposits, and reserves. Central bank influences loan supply schedule by changing its reserve. Although banks might finance themselves with non-deposit source of funds to insulate their loan supply from reserve changes, capital market imperfection makes shocks to banks' deposit is not frictionless counteracted by other sources of financing. Thus, reserve changes still influences loan supply in imperfect capital market setting associated with barrier to entry.

In the environment characterized by risk or uncertainty, banks seek to maximize their utility of profit (wealth). Banks set loan size and deposit size to influence loan and deposit prices. This implies that banks are monopolist and banks can make decision on optimal deposit prices independent of loan prices and vice versa. Bank intermediary exists when positive risk premium for loans and negative premium for deposits present (Pyle, 1971 and 1972; Baltensperger, 1980; Stanhouse and Stock, 2004). Klein (1971) suggested that such risk premium represents minimum price to induce banks to provide intermediary services and bear risks such as funding risk (Zarruck, 1989), credit risk (Zarruck and Madura, 1992), interest rate risk (Wong, 1997), and prepayment risk (Stanhouse and stock, 2004) .

Dealership model retains some assumption in the banking firm model but extends the later to the adjustment of risk premium to the volatility of market interest rates. Ho and Saunders (1981) suggested that the size of risk premium, called as immediacy fees in their paper, increases with the volatility of interest rate in money market. The effect of volatility of market interest rate could be explained by hedging behavior of banks. Banks tend to match their maturity of their asset and liability, and enter money market for any surplus or deficit. This exposes banks to reinvestment and financing risk. Therefore, risk premium or immediacy fees are required to compensate bank as financial intermediary. The financial intermediary exists as long as sufficient immediacy fees make up loan and deposit prices. The sum of immediacy fees of loans and deposits is called as intermediation margin. This margin is assumed interdependent with banks' financial constraints and financial management problem.

Clearly, the dealership model implies that as dealers who demand one type of deposit, supply one type of loan, and bear interest rate risk. Bank hold either long or short position in the short term money market, and demand positive interest spread for bearing risks. Therefore, banks' decision problem is determining utility of wealth-maximizing loan and deposit prices.

It is important to note that model in Ho and Saunders (1981) is constructed under the assumption that deposit is consists of interest bearing deposit only. Thus, non-interest bearing deposit such as demand deposit is not taken into account. Other models extended model of Ho and Saunders (1981) are also built on the same assumption. Allen (1988) extended Ho and Saunders (1981) model by assuming heterogeneous loans. His model incorporates two types of loans and one type of deposit i.e. maturity deposit. He demonstrates cross-elasticity demand across types of loans. For instance, if b of loan 1 increases, interest rate charged on loan 2 will increase. He found that interest rate spread as so-called intermediation margin, depends on monopoly power of a bank, risk premium and multi loan product diversification.

Different setting for dealership model is introduced by Angbazo (1996). He incorporates interaction between default risk and interest risk, and investigates the effect of off balance sheet exposures on intermediation margin. His model defines deposit as maturity deposit. He suggests that credit risk premium on loan is higher and margin is lower when periods of tight credit market coincides with increasing aggregate risk. This credit rationing drives interest rate on loans less sensitive to market interest rates. He also argues that off balance sheet activities might affect risk exposure of a bank, hence influence bank’s intermediation margin. He found that margin increases with credit risk, liquidity risk, and interest rate risk exposure. Evidently, barriers to branch expansion reduces margin and off balance sheet exposure does not increase default risk.

Dealership model in multi-country analysis is introduced in Saunders and Schumacher (2000). Instead of default risk premium, capital requirement for credit risk exposure is used in a two-step model. The first step is to focus on the behavior of pure intermediation margin by controlling institutional cost, regulatory cost and credit risk exposure cost. The second step uses dealership model to relate adjusted measure of pure intermediation margin to competitive structure of different countries and interest rate volatility. Maudos and Guevara (2004) extends this model by introducing operating costs, direct measure of market power, and alternative measure of risk aversion. Their model defined deposit as maturity deposit.

Most variables in the abovementioned dealership models are integrated in Valverde and Fernández (2007). They expand Ho and Saunders (1981) by mixing traditional measure of intermediation margin, wider accounting margin, and broader measure of margin and product diversification. They also expand Allen (1988) model by assuming bank's asset portfolio is composed of loan, other earning assets, and fee income activities. The deposit is assumed to be maturity deposit. In this setting, bank seeks to match deposit supply, loan demand, other earning assets, and fee income activities across period. They find that financial innovation, market power and risk parameter appear to alter interest margin. Banks with low operating efficiency tend to operate with higher margin. Banks specialized in lending activities tend to offer low margin. Additionally, market power decreases with ratio of deposit to total liabilities. Using the same model framework, Lepetit et al (2006) investigate the impact of earning asset diversification on lending rates. They also investigate whether potential cross selling induces diversified banks to under price loans. They find that borrowers' default risk is underpriced in the lending rates of banks having higher fee based income. Moreover, more diversified banks reveal weaker link between expected loan losses and provision for expected loan losses.

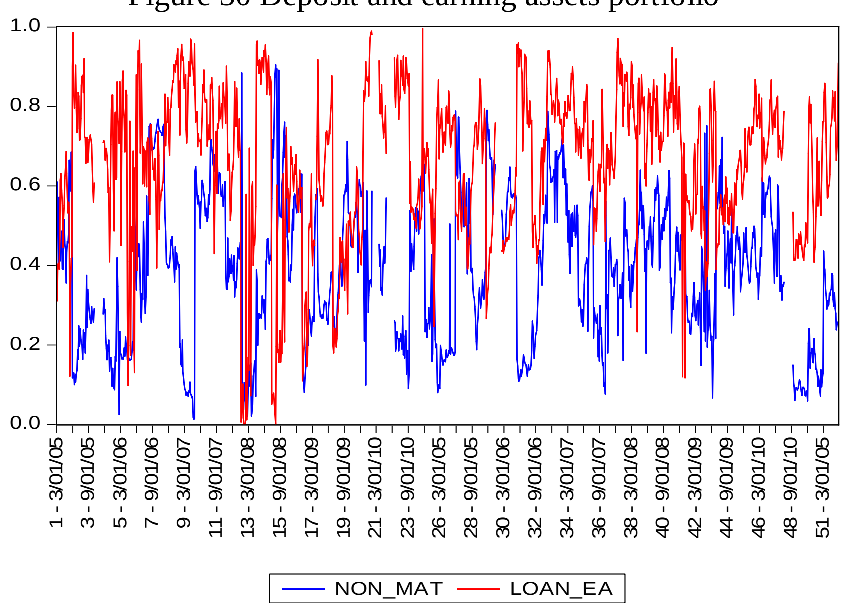
Maud's and Solis (2009) suggest a more comprehensive setting. They adopt interest and gross margin specification of Valverde and Fernández (2007), and operating cost function of Maudos and Guevara (2004). They also adopt explanatory variables in Ho and Saunders (1981), Angbazo (1997) and Saunders and Schumacher (2000). The model also incorporates variables controlling possible effect of macroeconomic variables on intermediation margin referring to Demirgüç-Kunt and Huizinga (1999), Brock and Rojas (2000), Drakos (2002), Martínez and Mody (2004), Gelos (2006), and Claeys and Venner (2008). It is important to note that all studies explained in this section use accounting based interest margin as proxy for intermediation margin.

3.2.2. The impact of non-maturity deposit, ex-post margin and upper bound deposit rates on the intermediation margin

The previous sub section revealed that the existing dealership models assume single deposit i.e. term deposit. However, in real world application, non-maturity deposit might matter in maximizing banks' utility of wealth. For the purpose of this study, term deposit in the only type of maturity deposit. Non-maturity deposits are composed of demand deposit and saving account. Non-maturity deposits do not have maturity date and pay very low interest rates. However, non-maturity deposit is attractive to banks' customers who are in need of payment services or electronic banking. Thus, motive for depositing fund as well return on one type of deposit relative to other influences customers' choice on banks' deposit. This could be represented as cross elasticity of demand or marginal rate of substitution (MRS) between non-maturity and maturity deposit.

Figure 30 shows that deposit portfolio might influence and asset selection. Non-maturity deposit reduces cost of fund of banks but exposes them to high liquidity risk. The deposit could be withdrawn anytime driving banks to invest it in liquid assets such as fixed income securities and money market fund. Expectedly, Indonesian banks are less likely to supply loans when they are more dependent of non-maturity deposits.

Figure 30 Deposit and earning assets portfolio



Sources: Bank Indonesia (2011)

The red line (*LOAN_EA*) is the ratio of loan over total earning assets while the blue line (*NON_MAT*) is the ratio of non-maturity deposits over total deposits. Thus, earning assets allocation corresponds to deposit portfolio. In other word, marginal rate substitution between maturity and non-maturity deposits should be taken into account in the dealership model framework.

Another problem observed from existing dealership model is the use of ex-post margin as proxy for intermediation margin. The ex-post intermediary margin is not inconformity with the assumption in Ho and Saunders (1981) that banks presumably set interest rate before a transaction enters the planning horizon. Demirgüç-Kunt and Huizinga (1999) argue that ex-post margin is easy to observed and more consistent. The margin might also explain that risky loans are more likely to default in banks with high yield. Nevertheless, they acknowledge the fact that interest income typically does not materialize in the same period as loss on the associated loan. Therefore, ex-ante intermediation margin such as contractual margin should be considered to test robustness of model specification. Contractual margin, which is derived from product prices on the contract, implies bank's expectation on profit, risk premium and other factors associated with intermediary activities.

When ex-ante margin is used as proxy for intermediation margin, loan administration cost (Wong, 1997) might be more relevant than operating cost (Maudos and Guevara, 2004; Maudos and Solis, 2009) in the analysis of margin determinants. Nevertheless, data on loan administration cost is not easily observable. Moreover, Lepetit et al (2006) Found evidence that diversified banks tend to set low margin. Thus, ex-ante margin does not exclusively correspond to loan administration cost. Instead costs on supporting functional activities such as IT, legal and accounting division are also allocated accordingly to lending, other earning assets and fee based activities. Therefore, operating cost proxy in Maudos and Guevara (2004), and Maudos and Solis (2009) might prove more relevant in the analysis of ex-ante margin determinants.

Lastly, deposit insurance agencies often impose restriction on which deposits will be fully covered by the insurance. Such restriction is often ignored in the empirical studies on bank margin. The restriction might be an upper bound for either deposit prices or deposit sizes. The former should directly influences prices of bank products since any deposits paying interest rates higher than the upper bound, will not be covered by the insurance scheme. In other word, banks always pay interest rates not higher than the upper bound to the risk-averse savers. Thus, the empirical model in this study illustrates how the upper bound of deposit prices influences intermediation margin and identifies whether the upper bound composes cost of fund or cost of loanable fund. If the upper bound composes cost of fund, the upper bound puts pressure on bank margin. In contrast, the bank margin increases with the upper bound if the upper bound could be fully passed on borrowers (i.e. if the upper bound composes cost of loanable fund).

3.3. The Model

3.3.1 Theoretical model

3.3.1.1.Dealerships model

This section explains multi-product framework in Allen (1998) as well as Maudos and Guevara (2004) which will be extended in this study. Model in Allen (1998) extended Ho-Saunders model to two types of loans whilst model in Maudos and Guevara (2004) suggested that operating costs influences wealth of banks. The two extended models used the same assumption as in Ho-Saunders model. Bank is an intermediary between deposit suppliers and loan demanders. Supply and demand function is assumed linear for at least two reasons. First, marginal effect of price changes in a product and its competing product, and other factors are allowed to be constant. Second, elasticity of demand or supply might change at different points along linear demand or supply curve. Other forms of demand and supply function such as log-linear function do not have this property. Furthermore, bank products are not in the category of absolute necessity. Thus, the proper combination rule is utility maximization, using the ceteris paribus condition as in Ho and Saunders (1981).

There are many forms of utility function, but the expected utility is the most convenient form for the following reason. The expected utility in the context of choice under uncertainty is the expected value form. The additive form representation will not be destroyed when the expected utility function is subjected to an affine transformation e.g. $v(u) = au + b$ where $a > 0$. The new expected utility function will represent the same preferences. The most compelling reason of choosing the expected utility in the context of choice under uncertainty is that the outcome of random choices are products to be demanded or supplied in different state implies only of the outcomes will actually occur. When one considers the tradeoff between wealth now and one of the possible outcomes, the decision should be independent of how much he will demand or supply in other states (Gollier, 1999). The assumption might be violated when people consider a choice between two things, the amount of third thing matters. Gollier (1999) suggests that this independence leads to special structure of utility for contingent assumption i.e. additive utility function across different contingent wealth bundles. Thus, utility can be written as a sum of utility function in each state, weighted by probabilities. If marginal rate of substitution (MRS) between goods 1 and 2 takes form

$$MRS_{12} = -\frac{\Delta U(c_1, c_2, c_3)/\Delta c_1}{\Delta U(c_1, c_2, c_3)/\Delta c_2} = -\frac{\pi_1 \Delta u(c_1)/\Delta c_1}{\pi_2 \Delta u(c_2)/\Delta c_2}$$

then the expected utility function satisfies the property that MRS between two goods is independent of third good.

Banks always seek to maximize their expected utility of terminal wealth whilst being risk averse. The risk aversion of banks is due to randomness of the flow of loans and deposits. Bank borrows from money market to supply new loans when there is no inflow of deposits. On the other hand, banks invest deposit incoming when there is no new demand on loans. By taking this position in money market, banks exposing themselves to refinancing risk i.e. risk of borrowing cost in money market at the end of period is higher than deposit price. Aside from refinancing risk, taking position in money market raises reinvestment risk i.e. risk of return in money market at the end of period is lower than loan prices. Therefore, banks require immediacy fee to compensate them for bearing interest rate risk. Prices of loans and deposits depend on this immediacy fee as follows

$$r_D = r + a \qquad (3.3.1.1.1)$$

$$r_L = r - b$$

where r_D, r and a are prices of maturity deposit, interest rates in money market and immediacy fee respectively. If intermediation margin is defined as the spread between loan price and deposit price (s), then the intermediation margin is calculated as

$$s = r_L - r_D$$

$$s = (r + a) - (r - b) = a - b$$

This implies that bank intermediation runs as long as the margin s is positive.

The probability of that outgoing loans and incoming deposits depends on factors influencing savers and borrowers' willingness to buy the bank products. The savers (borrowers) will supply (demand) deposit (loan) when the ratio of marginal utility over price (MU/P) of deposit (loan) is greater than or equal to their personal MU/P indifference point. Therefore, Ho and Saunders (1981) assumed that arrival rate of new loan and deposit follows Poison distribution with immediacy fee dependent parameter. Nonetheless, Allen (1998) showed that customers' willingness to buy is also influenced by marginal rate of substitution (MRS) between two products when two products are perfect substitute. Therefore, rate arrival of one product also depends on immediacy fees of its substitute as follows

$$\lambda(b_m) = \alpha_m - \beta b_m + \delta_n b_n$$

$$\lambda(b_n) = \alpha_n - \beta b_n + \delta_m b_m$$

Demand on loan type m is influenced by prices of loan type n. Similarly, demand on loan type n is influenced by prices of loan type m. Thus, arrival rate of new loan is influenced by cross elasticity of demand on loan m and n. Instead of two types of loans, banks might have one type of loan and non-loan earning assets in their asset portfolio. Thus, Maudos and Guevara (2004) constructed model classifying earning assets into loan and non-traditional activities. Thus, the rate of arrival of new loan becomes

$$\lambda(b_L) = \alpha_L - \beta b_L + \delta_N b_N \qquad (3.3.1.1.2)$$

Where δ denotes cross elasticity of demand between two products. Subscript L indicates loan while subscript N is associated with non-traditional activities

Accordingly, arrival rate of new non-traditional activities is estimated as

$$\lambda(b_N) = \alpha_N - \beta b_N + \delta_L b_L$$

Allen (1998) as well as Maudos and Guevara (2004) used the same definition of bank wealth as in Ho-Saunders model. Initial wealth of a bank (W_0) is composed of net position in money market (M_0) and net credit inventory (I_0) whereas I_0 is calculated as follows

$$I_0 = L_0 - D_0$$

L_0 is initial loan size and D_0 is initial deposit size. Assuming new deposit and new loan has the same size Q, net credit inventory after new flow of deposit (I) becomes

$$I = I_0 - Q$$

Net credit inventory after new flow of loan (I) becomes

$$I = I_0 + Q$$

Accordingly, net position in money market (M) changes with new arrival of deposit

$$M = M_0 + Q$$

New demand on loan changes net position in money market (M) into

$$M = M_0 - Q$$

Wealth at the end of period (W) is determined by return on credit inventory (r_I) and interest rate in money market (r), interest rate risk in money market ($\tilde{z}_M$) and the risk that counterparties fail to repay the loans or non-loan activities ($\tilde{z}_I$).

$$W = I_0(1 + r_I + \tilde{z}_I) + M_0(1 + r + \tilde{z}_M)$$

where $r_I = r_L \frac{L_0}{L_0 - D_0} - r_D \frac{D_0}{L_0 - D_0}$

$$\tilde{z}_I = \tilde{z}_L \frac{L_0}{L_0 - D_0} - \tilde{z}_D \frac{D_0}{L_0 - D_0}$$

$\tilde{z}_L$, $\tilde{z}_D$ and $\tilde{z}_M$ represent randomness of flow of loan, deposit and money market fund. From bank perspective, credit risk of deposits ($\tilde{z}_D$) is assumed to be negligible.

Maudos and Guevara (2004) proposed that wealth at the end of period is also influenced by operating cost of initial credit inventory $C(I_0)$.

Thus, wealth at the end of period (W) becomes

$$W = I_0(1 + r_I + \tilde{z}_I) + M_0(1 + r + \tilde{z}_M) - C(I_0) \qquad (3.3.1.1.3)$$

where $C(I) = C(L) + C(D)$

C(L) is operating cost of supplying loans while *C(D)* is operating cost of receiving deposit. It follows that the inflow of new deposit with size Q generates wealth at the end of period as follows

$$W = I_0(1 + r_I + \tilde{z}_I) - Q(1 + r_D) + (M_0 + Q)(1 + r + \tilde{z}_M) - C(I_0) - C(Q)$$

Similarly, the outflow of new loan with size Q generates terminal wealth as follows

$$W = I_0(1 + r_I + \tilde{z}_I) + Q(1 + r_L) + (M_0 - Q)(1 + r + \tilde{z}_M) - C(I_0) - C(Q)$$

Recall that banks always try to maximize their expected utility of wealth or profit. Expected utility of banks' wealth is summation of product between probability and expected utility of banks' wealth associated with each type of banks' products. Using Taylor expansion to express expected utility of wealth, first order condition with respect to immediacy fee of each type of banks' products produces wealth-maximizing prices of banks' products.

Clearly, the extended dealership model particularly in Allen (1998) as well as in Maudos and Guevara (2004) consider portfolio effect on the asset side of banks. In practice, portfolio effect on deposit side might also influence prices of bank products and intermediation margin. Recalling figure 1, maturity profile appears to be important in earning assets and deposit allocation. The higher the weight of long maturity deposits in the deposit portfolio of a bank, the higher is the weight of long maturity earning assets such loan in banks' asset portfolio. Further, non-maturity deposit such as saving and demand deposits appear to be cheaper than maturity deposit such as term deposit. Table 9 indicates that banks having more maturity deposits than non-maturity deposits tend to have higher weighted average deposit prices and lower marketing costs.

Table 9 Deposit price, intermediation margin, and marketing expenditure

	Weighted average deposit price	**Gross margin (spread of contractual prices between earning assets and deposits)**	**Marketing cost/total asset**
Full size sample (51 Banks)			
Mean	0.0724	0.0741	0.0012
Median	0.0663	0.0770	0.0008
Sub sample: Non-maturity deposits > maturity deposits			
Mean	0.0584	0.0829	0.0047
Median	0.0565	0.0854	0.0008
Sub sample: Maturity deposits > non-maturity deposits			
Mean	0.0695	0.0750	0.0023
Median	0.0782	0.0793	0.0007

Sources: Bank Indonesia (2011)

Thus, banks heavily depending on maturity deposits might use deposit price and immediacy to raise deposits while others leaning on their marketing strategy to raise deposits. Therefore, in the next section, dealership model is proposed to consider the effect of cross elasticity of demand between non-maturity and maturity deposits on the arrival rate of new deposits. The extended model proposed in the next section should be able to explain how intermediation margin differs across banks with different earning asset and deposit portfolio.

3.3.1.2.The extended dealership model: The impact of non-maturity deposit

This section aims to extend dealership model in the previous section. The proposed model in this section retains assumption in Ho and Saunders (1981). Banks are risk averse and seek to maximize their utility of wealth. The utility function is monotonic increasing and twice differentiable. The utility function is expressed as expected utility by using Taylor expansionTo match earning asset portfolio across bank in the sample, earning assets portfolio is assumed be consist of three types of loans and non-loan earning assets. The three types of loans are investment loans, working-capital loans, and consumer loans. Investment loans are loans to finance borrowers' capital purchases, construct factory, investment outlay, and so on. Therefore, investment loans are often associated with term loans. Working-capital loans on the other hand are disbursed for borrowers' operational purchases such as raw materials in production process. Working-capital loans have shorter time maturity than investment loans and typically revolving. Consumer loans are loans disbursed to borrowers purchasing consumption goods. Other earning assets such as fixed income securities, bank guarantee, and financial derivatives are classified as non-loan earning assets.

Now, the loan prices in Eq.(3.3.1.1.2) are defined as follows

$$r_{inv} = r + b_{inv} \tag{3.3.1.2.1}$$

$$r_{work} = r + b_{work} \tag{3.3.1.2.2}$$

$$r_{cons} = r + b_{cons} \tag{3.3.1.2.3}$$

Prices of non-loan earning assets are

$$r_{fi} = r + b_{fi} \tag{3.3.1.2.4}$$

Subscript *inv*, *work*, *cons*, and *fi* represent prices of investment loans, working-capital loans, consumer loans, and non-loan earning assets. Interest rates in money market and immediacy fees are denoted as *r* and *b* respectively. Assuming portfolio effect of deposit presents, deposit portfolio is classified into non-maturity deposits (D_n) and maturity deposit (D_i). Non-maturity deposits comprise demand deposit and non-interest bearing saving that is not locked up for a certain period. Maturity deposits are term deposits and other interest bearing deposits. Then, price of maturity deposit (r_d) replicates Eq.(3.3.1.1.1) as follows

$$r_d = r - a_i \tag{3.1.2.5}$$

where a_i is immediacy fee of maturity deposit.

As a starting point, the arrival rate of each product is assumed to follow Poisson distribution with immediacy fee dependent parameter.

$$Pr(D_i = d_i) = \frac{e^{-\lambda}\lambda^{d_i}}{d_i!}, \qquad d_i = 0,1,2,\cdots$$

$$\lambda_j(D_i) = e^{\alpha_i - \beta a_i}, \quad j = 1,\cdots,n \tag{3.3.1.2.6}$$

$$\lambda_j(D_n) = e^{\alpha_n + \delta_i r}, \quad j = 1,\cdots,n \tag{3.3.1.2.7}$$

$$\lambda_j(FI) = e^{\alpha_{fi} - \beta b_{fi} + \delta_{inv}(b_{inv} - s) + \delta_{work}(b_{workv} - s) + \delta_{cons} b_{cons}}, \quad j = 1,\cdots,n \tag{3.3.1.2.8}$$

$$\lambda_j(L_{cons}) = e^{\alpha_{fi} - \beta b_{cons} + \delta_{inv}(b_{inv} - s) + \delta_{work}(b_{workv} - s) + \delta_{fi} b_{fi}}, \quad j = 1,\cdots,n \tag{3.3.1.2.9}$$

$$\lambda_j(L_{inv}) = e^{\alpha_{fi} - \beta(b_{inv} - s) + \delta_{work}(b_{workv} - s) + \delta_{cons} b_{cons} + \delta_{fi} b_{fi}}, \quad j = 1,\cdots,n \tag{3.3.1.2.10}$$

$$\lambda_j(L_{work}) = e^{\alpha_{fi} - \beta(b_{workv} - s) + \delta_{inv}(b_{inv} - s) + \delta_{cons} b_{cons} + \delta_{fi} b_{fi}}, \quad j = 1,\cdots,n \tag{3.3.1.2.11}$$

Unlike model in Allen (1998) as well as in Maudos and Saunders (2004), the assumption about size of transaction is relaxed in this study. Initial net credit inventory I_0 comprises three types of loans, non-loan earning assets and two types of deposits.

$$I_0 = L_{inv,0} + L_{work,0} + L_{cons,0} + FI_0 - D_{i,0} - D_{n,0} \quad (3.1.2.12)$$

Thus, returns on net credit inventory are the weighted average prices of the six products.

$$r_I = r_{inv}\frac{L_{inv,0}}{I_0} + r_{work}\frac{L_{work,0}}{I_0} + r_{cons}\frac{L_{cons,0}}{I_0} + r_{fi}\frac{FI_0}{I_0} - r_d\frac{D_{i,0}}{I_0}$$

Recalling that Eq.(3.3.1.1.3) assumes that deposits do not bear credit risk, then credit riskiness of net credit inventory is expressed in the following way.

$$\tilde{z}_I = \tilde{z}_{inv}\frac{L_{inv,0}}{I_0} + \tilde{z}_{work}\frac{L_{work,0}}{I_0} + \tilde{z}_{cons}\frac{L_{cons,0}}{I_0} + \tilde{z}_{fi}\frac{FI_0}{I_0} \quad (3.3.1.2.13)$$

If wealth of bank at the end of one period (W) is influenced by operating cost $C(I_0)$ associated with net earning asset inventory I_0 as in Maudos and Guevara (2004), and influenced by interest rate risk ($\tilde{z}_M$) as well as credit risk of net credit inventory, W is calculated as follows

$$W = I_0(1 + r_I + \tilde{z}_I) + M_0(1 + r + \tilde{z}_M) - C(I_0)$$

W can be written as

$$W = W_0(1 + r_W) + I_0\tilde{z}_I + M_0\tilde{z}_M - C(I_0) \quad (3.3.1.2.14)$$

where $r_W = r_I\frac{I_0}{W_0} + r\frac{M_0}{W_0}$; and

$$W_0 = I_0 + M_0.$$

When new non-maturity deposit with size D_n comes, I and M becomes

$$I = I_0 - D_n$$

$$M = M_0 + D_n$$

Wealth at the end period with D_n new inflow of non-maturity deposit is calculated as

$$W = W_0(1 + r_W) + rD_n + I_0\tilde{z}_I + (M_0 + D_n)\tilde{z}_M - C(I_0) - C(D_n) \quad (3.3.1.2.15)$$

However, wealth at the end period with D_i new inflow of maturity deposit is influenced by r_i as follows

$$W = I_0(1 + r_I + \tilde{z}_I) - D_i(1 + r_d) + (M_0 + D_i)(1 + r + \tilde{z}_M) - C(I_0) - C(D_i) \quad (3.3.1.2.16)$$

By substituting Eq.(3.3.1.2.5) into Eq.(3.3.1.2.16) W can be written as

$$W = W_0(1 + r_W) + a_i D_i + I_0 \tilde{z}_I + (M_0 + D_i)\tilde{z}_M - C(I_0) - C(D_i) \quad (3.3.1.2.17)$$

The outflow of new loan L_{inv} changes net earning asset inventory I and net position in money market M into

$$I = I_0 + L_{inv}$$

$$M = M_0 - L_{inv}$$

Net earning asset inventory and net position money market also change in similar way when each earning asset is outgoing.

Wealth at the end period with the *inv* outflow of credit lines for seed capital or investment outlay is calculated as

$$W = W_0(1 + r_W) + I_0 \tilde{z}_I + M_0 \tilde{z}_M - L_{inv}(1 + r) + L_{inv}(1 + r_{inv}) - C(I_0) - C(inv) \quad (3.3.1.2.18)$$

Substituting Eq. (3.3.1.2.1) into Eq. (3.3.1.2.18) will generate

$$W = W_0(1 + r_W) + b_{inv} L_{inv} + (I_0 + L_{inv})\tilde{z}_I + (M_0 - L_{inv})\tilde{z}_M - C(I_0) - C(L_{inv})$$

Accordingly, W with new outflow of other earning assets is defined as follows

$$W = W_0(1 + r_W) + b_{work} L_{work} + (I_0 + L_{work})\tilde{z}_I + (M_0 - L_{work})\tilde{z}_M - C(I_0) - C(L_{work})$$

$$W = W_0(1 + r_W) + b_{cons} L_{cons} + (I_0 + L_{cons})\tilde{z}_I + (M_0 - L_{cons})\tilde{z}_M - C(I_0) - C(L_{cons})$$

$$W = W_0(1 + r_W) + b_{fi} FI + (I_0 + FI)\tilde{z}_I + (M_0 - FI)\tilde{z}_M - C(I_0) - C(FI)$$

Using Taylor expansion, expected utility of wealth at the end of period *E[U(W)]* is derived as

$$EU(W) = U(\overline{W}) + U'(\overline{W})E[W - \overline{W}] + \frac{1}{2} U''(\overline{W})E[W - \overline{W}]^2 \quad (3.3.1.2.19)$$

Following assumption in Maudos and Guevara (2004), utility function is continuously doubly differentiable with $U' > 0$

$U'' < 0$,

$\overline{W} = E(W)$; and

$W - \overline{W} = L_0 \tilde{z}_L + M_0 \tilde{z}_M$.

Substituting Eq.(3.3.1.2.14) to Eq. (3.3.1.2.19) produces

$$EU(W) = U(\bar{W}) + \frac{1}{2} U''(\bar{W})(I_0^2\sigma_I^2 + M_0^2\sigma_M^2 + 2I_0M_0\sigma_{IM}) \qquad (3.3.1.2.20)$$

where $I_0\tilde{z}_I = L_{inv,0}\tilde{z}_{inv} + L_{work,0}\tilde{z}_{work} + L_{cons,0}\tilde{z}_{cons} + FI_0\tilde{z}_{fi}$

Accordingly, expected utility of wealth at the end of period when there is new flow of a product, is written as follows

$$EU(W|D_n) = U(\bar{W}) + U'(\bar{W})[rD_n - C(D_n)] + \frac{1}{2} U''(\bar{W})[I_0^2\sigma_I^2 + (M_0 + D_n)^2\sigma_M^2 2(M_0 + D_n)I_0\sigma_{IM}] \qquad (3.3.1.2.21)$$

$$EU(W|D_i) = U(\bar{W}) + U'(\bar{W})[a_iD_i - C(D_i)] + \frac{1}{2} U''(\bar{W})[I_0^2\sigma_I^2 + (M_0 + D_i)^2\sigma_M^2 + 2(M_0 + D_i)I_0\sigma_{IM}] \qquad (3.3.1.2.22)$$

$$EU(W|L_{inv}) = U(\bar{W}) + U'(\bar{W})[b_{inv}L_{inv} - C(L_{inv})] + \frac{1}{2} U''(\bar{W})[(I_0 + L_{inv})^2\sigma_I^2 + (M_0 - L_{inv})^2\sigma_M^2 + 2(I_0 + L_{inv})(M_0 - L_{inv})\sigma_{IM}] \qquad (3.3.1.2.23)$$

$$EU(W|L_{work}) = U(\bar{W}) + U'(\bar{W})[b_{work}L_{work} - C(L_{work})] + \frac{1}{2} U''(\bar{W})[(I_0 + L_{work})^2\sigma_I^2 + (M_0 - L_{work})^2\sigma_M^2 + 2(I_0 + L_{work})(M_0 - L_{work})\sigma_{IM}] \qquad (3.3.1.2.24)$$

$$EU(W|L_{cons}) = U(\bar{W}) + U'(\bar{W})[b_{cons}L_{cons} - C(L_{cons})] + \frac{1}{2} U''(\bar{W})[(I_0 + L_{cons})^2\sigma_I^2 + (M_0 - L_{cons})^2\sigma_M^2 + 2(I_0 + L_{cons})(M_0 - L_{cons})\sigma_{IM}] \qquad (3.3.1.2.25)$$

$$EU(W|FI) = U(\bar{W}) + U'(\bar{W})\big[b_{fi}FI - C(FI)\big] + \frac{1}{2} U''(\bar{W})[(I_0 + FI)^2\sigma_I^2 + (M_0 - FI)^2\sigma_M^2 + 2(I_0 + FI)(M_0 - FI)\sigma_{IM}] \qquad (3.3.1.2.26)$$

The changes of expected utility of wealth at the end of period due to new flow of each product (i.e. $\Delta E[U(W)]$) is derived as follows

$\Delta EU(W|D_n) =$ Eq. (3.3.1.2.21) – Eq. (3.3.1.2.20)

$$= U'(\bar{W})[rD_n - C(D_n)] + \frac{1}{2} U''(\bar{W})[D_n(D_n + 2M_0)\sigma_M^2 + 2I_0D_n\sigma_{IM}] \qquad (3.3.1.2.27)$$

$\Delta EU(W|D_i)$ = Eq. (3.3.1.2.22) – Eq. (3.3.1.2.20)

$$= U'(\bar{W})[a_i D_i - C(D_i)] + \frac{1}{2} U"(\bar{W})[D_i(D_i + 2M_0)\sigma_M^2 + 2I_0 D_i \sigma_{IM}] \quad (3.3.1.2.28)$$

$\Delta EU(W|L_{inv})$ = Eq. (3.3.1.2.23) – Eq. (3.3.1.2.20)

$$= U'(\bar{W})[b_{inv}L_{inv} - C(L_{inv})] + \frac{1}{2} U"(\bar{W})X_1 \quad (3.3.1.2.29)$$

$\Delta EU(W|L_{work})$ = Eq. (3.3.1.2.24) – Eq. (3.3.1.2.20))

$$= U'(\bar{W})[b_{work}L_{work} - C(L_{work})] + \frac{1}{2} U"(\bar{W})X_2 \quad (3.3.1.2.30)$$

$EU(W|L_{cons})$ = Eq. (3.3.1.2.25) – Eq. (3.3.1.2.20)

$$= U'(\bar{W})[b_{cons}L_{cons} - C(L_{cons})] + \frac{1}{2} U"(\bar{W})X_3 \quad (3.3.1.2.31)$$

$\Delta EU(W|FI)$ = Eq. (3.3.1.2.26) – Eq. (3.3.1.2.20)

$$= U'(\bar{W})\big[b_{fi}FI - C(FI)\big] + \frac{1}{2} U"(\bar{W})X_4 \quad (3.3.1.2.32)$$

and $X_1 = L_{inv}(I_0 + 2L_{inv})\sigma_I^2 + L_{inv}(L_{inv} - 2M_0)\sigma_M^2 + 2L_{inv}(M_0 - I_0 - L_{inv})\sigma_{IM}$

$$X_2 = L_{work}(I_0 + 2L_{work})\sigma_I^2 + L_{work}(L_{work} - 2M_0)\sigma_M^2 + 2L_{work}(M_0 - I_0 - L_{work})\sigma_{IM}$$

$$X_3 = L_{cons}(I_0 + 2L_{cons})\sigma_I^2 + L_{cons}(L_{cons} - 2M_0)\sigma_M^2 + 2L_{cons}(M_0 - I_0 - L_{cons})\sigma_{IM}$$

$$X_4 = FI(2I_0 + FI)\sigma_I^2 + FI(FI - 2M_0)\sigma_M^2 + 2FI(M_0 - I_0 - FI)\sigma_{IM}$$

Expected utility maximization problem is expressed as follows

$$Max_{a_i,b_{fi},b_{cons},b_{work},b_{inv},}EU(W) = \Pr D_i\, \Delta EU(W|D_i) + \Pr D_n\, \Delta EU(W|D_n) + \Pr FI\, \Delta EU(W|FI) + \Pr L_{cons}\, \Delta EU(W|L_{cons}) + \Pr L_{work}\, \Delta EU(W|L_{work}) + \Pr L_{inv}\, \Delta EU(W|L_{inv})$$

First order condition of $E[U(W)]$ with respect of immediacy fees gives intermediation margin that maximizes the expected utility of wealth.

$$\frac{\partial EU(W)}{\partial a_i} = -\beta_i Eq.\,(3.3.1.2.27) + (\alpha_i - \beta_i a_i)U'(\bar{W})D_i + \delta_i Eq.\,(3.3.1.2.28) = 0$$

$$\frac{\partial EU(W)}{\partial b_{inv}} = U'(\bar{W})inv\big(\alpha_{inv} - \beta_{inv}b_{inv} + \delta_{work}b_{work} + \delta_{cons}b_{cons} + \delta_{fi}b_{fi}\big) - \beta_{inv}Eq.\,(3.3.1.2.29) + \delta_{inv}(Eq.\,(3.3.1.2.30) + Eq.\,(3.3.1.2.31) + Eq.\,(3.3.1.2.32)) = 0$$

$$\frac{\partial EU(W)}{\partial b_{work}} = U'(\bar{W})work\big(\alpha_{work} - \beta_{work}b_{work} + \delta_{inv}b_{inv} + \delta_{cons}b_{cons} + \delta_{fi}b_{fi}\big) - \beta_{work}Eq.(3.3.1.2.30) + \delta_{work}(Eq.(3.3.1.2.29) + Eq.(3.3.1.2.31) + Eq.(3.3.1.2.32)) = 0$$

$$\frac{\partial EU(W)}{\partial b_{cons}} = U'(\bar{W})cons\big(\alpha_{cons} - \beta_{cons}b_{cons} + \delta_{inv}b_{inv} + \delta_{work}b_{work} + \delta_{fi}b_{fi}\big) - \beta_{cons}Eq.(3.3.1.2.31) + \delta_{cons}(Eq.(3.3.1.2.29) + Eq.(3.3.1.2.30) + Eq.(3.3.1.2.32)) = 0$$

$$\frac{\partial EU(W)}{\partial b_{fi}} = U'(\bar{W})n\big(\alpha_{n} - \beta_{fi}b_{fi} + \delta_{inv}b_{inv} + \delta_{work}b_{work} + \delta_{cons}b_{cons}\big) - \beta_{n}Eq.(3.3.1.2.32) + \delta_{n}(Eq.(3.3.1.2.29) + Eq.(3.3.1.2.30) + Eq.(3.3.1.2.31)) = 0$$

If $-\frac{U''(\bar{W})}{U'(\bar{W})} = R$ is absolute risk aversion, then

$$a_i = \frac{1}{2}\frac{\alpha_i}{\beta} + \frac{1}{2}\frac{C(D_i)}{D_i} + \frac{R}{4}\{(D_i + 2M_0)\sigma_M^2 + 2I_0\sigma_{IM}\} + \frac{1}{2}\frac{\delta_i}{\beta}\left(\frac{D_n}{D_i}\left\{r - \frac{C(D_n)}{D_n} - \frac{R}{2}\left((D_n + 2M_0)\sigma_M^2 + 2I_0\sigma_{IM}\right)\right\}\right) \quad (3.3.1.2.33)$$

$$b_{inv} = \frac{1}{2}\frac{\alpha_{inv}}{\beta_{inv}} + \frac{1}{2}\frac{C(L_{inv})}{L_{inv}} + \frac{R}{4}\frac{X_1}{L_{inv}} + \frac{\delta_{inv}}{2\beta_{inv}}\left\{b_{work}\left(\frac{\delta_{work}}{\delta_{inv}} - \frac{L_{work}}{L_{inv}}\right) + b_{cons}\left(\frac{\delta_{cons}}{\delta_{inv}} - \frac{L_{cons}}{L_{inv}}\right) + b_{fi}\left(\frac{\delta_{fi}}{\delta_{inv}} - \frac{FI}{L_{inv}}\right) - \frac{C(L_{work})+C(L_{cons})+C(FI)}{L_{inv}} - \frac{1}{2}\frac{R}{L_{inv}}(X_2 + X_3 + X_4)\right\} \quad (3.3.1.2.34)$$

$$b_{work} = \frac{1}{2}\frac{\alpha_{work}}{\beta_{work}} + \frac{1}{2}\frac{C(L_{work})}{L_{work}} + \frac{R}{4}\frac{X_2}{L_{work}} + \frac{\delta_{work}}{2\beta_{work}}\left\{b_{inv}\left(\frac{\delta_{inv}}{\delta_{work}} - \frac{L_{inv}}{L_{work}}\right) + b_{cons}\left(\frac{\delta_{cons}}{\delta_{work}} - \frac{L_{cons}}{L_{work}}\right) + b_{fi}\left(\frac{\delta_{ea}}{\delta_{work}} - \frac{FI}{L_{work}}\right) - \frac{C(L_{inv})+C(L_{cons})+C(FI)}{L_{work}} + \frac{1}{2}\frac{R}{L_{work}}(X_1 + X_3 + X_4)\right\} \quad (3.3.1.2.35)$$

$$b_{cons} = \frac{1}{2}\frac{\alpha_{cons}}{\beta_{cons}} + \frac{C(L_{cons})}{2L_{cons}} + \frac{R}{4}\frac{X_3}{L_{cons}} + \frac{\delta_{cons}}{2\beta_{cons}}\left\{b_{inv}\left(\frac{\delta_{inv}}{\delta_{cons}} - \frac{L_{inv}}{L_{cons}}\right) + b_{work}\left(\frac{\delta_{work}}{\delta_{cons}} - \frac{L_{inv}}{L_{cons}}\right) + b_{fi}\left(\frac{\delta_{fi}}{\delta_{cons}} - \frac{FI}{L_{cons}}\right) - \frac{C(L_{inv})+C(L_{work})+C(FI)}{L_{cons}} - \frac{R}{2}\frac{(X_1+X_2+X_4)}{L_{cons}}\right\} \qquad (3.3.1.2.36)$$

$$b_{fi} = \frac{1}{2}\frac{\alpha_n}{\beta_n} + \frac{C(FI)}{2FI} + \frac{R}{4}\frac{X_4}{FI} + \frac{\delta_{fi}}{2\beta_{fi}}\left\{b_{inv}\left(\frac{\delta_{inv}}{\delta_{fi}} - \frac{L_{inv}}{FI}\right) + b_{work}\left(\frac{\delta_{work}}{\delta_{fi}} - \frac{L_{inv}}{FI}\right) + b_{cons}\left(\frac{\delta_{cons}}{\delta_{fi}} - \frac{L_{cons}}{FI}\right) - \frac{C(L_{inv}) + C(L_{work}) + C(L_{cons})}{FI} - + \frac{R}{2}\frac{(X_1+X_2+X_3)}{FI}\right\} \qquad (3.3.1.2.37)$$

where degree of risk aversion $R = -U"(W)/U'(W)$

Intermediation margin is summation of price spread across the six products. Thus, intermediation margin that maximizes expected utility of banks' terminal wealth is *margin* = Eq.(3.3.1.2.33) + Eq.(3.3.1.2.34) + Eq. (3.3.1.2.35) + Eq. (3.3.1.2.36) + Eq. (3.3.1.2.37) (3.3.1.2.38)

This implies that non-maturity deposits makes bank better off when per unit operating cost and risk premium of non maturity deposit is higher than return on money market fund.

$$r > \frac{R}{2}\left((2M_0 + D_n)\sigma_M^2 + 2I_0\sigma_{IM}\right) + \frac{C(D_n)}{D_n}$$

Introducing non-maturity deposits does not change condition of competitive advantage of non-loan earning assets gives. Non-loan earning assets give bank competitive advantage if relative immediacy fee of loans is lower than summation of per unit operating cost and risk premium of loan.

$$b_{inv}\left(L_{work} + \frac{\delta_{inv}}{\delta_{fi}}\right) + b_{work}\left(L_{work} + \frac{\delta_{work}}{\delta_{fi}}\right) + b_{cons}\left(L_{cons} + \frac{\delta_{cons}}{\delta_{fi}}\right) < C(L_{inv}) + C(L_{work}) + C(L_{cons}) + \frac{R}{2}(X_1 + X_2 + X_3)$$

3.3.2 Banking survey

The proposed model that is summarized in Eq.(3.1.2.38) is tested on unbalance panel data derived from quarterly data of 51 Indonesian banks, representing 90% of total loans in the country. To identify proxies for variables specified in the proposed model and variables overlooked in the proposed model, a banking survey was carried out from March 2011 to April 2011 on 66 bank respondents. The survey becomes important since literatures concerning intermediation margin imply that margin determinants might vary across countries.

The 66 bank respondents represent 97% of total loans in Indonesia. The respondents consist of three state owned banks, branches of ten foreign banks, subsidiaries of 16 foreign banks, and 37 national banks. The foreign banks operate in Europe, USA, Australia, New Zealand, South Asia, and Japan. Survey is designed as explanatory research to determine variables influencing intermediary margin and bank’s decision on loan disbursement during period 2005 - 2010. Method to collect data is email survey and personal interview. Information about the objective of survey, definition of terminology and motivation to answer is provided in the questioner. The quality of the questionnaire was tested in February 2011 on ten banks representing state owned banks, branches of foreign banks, subsidiaries of foreign banks, national banks and regional banks. Results of the survey are summarized in table 2 and 3. Table 2 shows financial products, which are frequently used in managing liquidity of a bank. Thus, uncertainty in money market should regard volatility of interest rates of financial instruments in table 10.

Table 10 Financial instrument used in liquidity management

Liquidity Management Intruments	**Number of Respondents**	
	Lending/ Investment	Borrowing
Interbank call money	66	57
T-bills (SBI)	54	N/A
Government bonds	21	N/A
SBI reverse repo/repo	12	18
Gov. bonds reverse repo/repo	9	24
Other central bank's liquidity facility	48	45

Sources: Indonesian banking survey (March-April 2011)

Table 11 summarizes factors influencing banks' pricing decision on loan and deposit. Evidently, holding liquidity reserves is also considered loosing opportunity to make profit. Interest rate published by deposit insurance agency, which is called Lembaga Penjamin Simpanan (LPS), also influences deposit prices. The deposit insurance scheme insures or guarantees deposit to be paid back only if the interest on the deposit is not higher than interest rate published by LPS. It is important to note that more than 75% of branches and subsidiaries of foreign banks in the sample adopt pricing methodology, which is designed by their parent banks.

Table 11 Determinants of deposit rates and loan rates

Determinants/Factors	**Number of banks**
Deposit prices:	
LPS's rate in the previous period	45
Interest rate in money market	42
Loan and deposit prices in the previous quarter	15
Cost of funds:	
Deposit prices	51
Deposit insurance premium	51
Cost of liquidity reserve requirement	39
Cost of cash reserve	3
Cost of loanable funds:	
Cost of fund	51
Cost of capital charge	9
Operating cost	51
Risk premium	54
Loan prices:	
Cost of loanable fund	51
Required profit margin (including premium for indirect risks)	9

Sources: Indonesian banking survey (March-April 2011)

Concerning criteria for project bankability, all respondents agree that financial capacity and credit worthiness of prospective borrowers are the main factors in credit approval. 48 respondents consider tradability and value of collateral in the credit approval. Two interesting findings are the effects of size and novelty of project/investment on bank decision. 18 respondents said that size of prospective project or investment determines bankability of project or investment. Three respondents said that they do not disburse loans to projects or investments in need of venture capital. Additionally, only 12 banks involve in projects or investments associated with emission abatement initiatives.

3.3.3 Empirical model

Finding of Indonesian banking survey, which is summarized in table 11, shows that some banks consider loan and deposit prices in the previous quarter. This implies that past value of intermediation margin i.e. spread between earning asset prices and deposit might be relevant to current value of intermediation margin. Therefore, dynamic panel model and static panel model are estimated and compared. Section 3.3.3.1 explains empirical application of Ho and Saunders (1981) model by Saunders and Schumacher (2000). Empirical application of Maudos and Guevara (2004) using regression model in Maudos and Solis (2009) is also described. The two empirical models are compared with empirical application of extended dealers model previously described in section 3.3.1.2.

Three static panel data models are considered to test the extended model i.e. pooled regression, fixed effects model, and random effects model, with heteroskedasticity-consistent standard errors and cluster robust standard errors. Model selection is based on specification test of Hausman and Taylor (1981) and of Breush-Pagan (1971). Section 3.3.3.2 illustrates panel data model used in Maudos and Solis (2009). The results are compared with results from system GMM for extended dealership model described in section 3.3.1.2. Techniques to reduce instrument count in this system GMM are also described. The condensed instrument set should avoid overfit endogenous variables and strengthen instrument-joint validity test of Hansen (1982) and two step Sargan test (Arellano and Bond, 1991).

Time dummies are included in the static and dynamic panel model to pick out and control for seasonal variation in data. Time dummy variables for each quarter, which will net out the average change in a variable resulting from any seasonal fluctuations. Hence, Q1 is 1 if data belong to the first quarter of year and 0 otherwise, and so on.

Seasonal movements in series such as asset building and restated unused loss provision in Q4 of each year might occur and influence the results.

3.3.3.1 Static panel data model

A two-step pooled ordinary least square (pooled OLS) is suggested in Ho and Saunders (1981). The first step pooled OLS estimates the following regression.

$$PS_{it} = \gamma_t + \beta_1 IMPLICIT_{i,t} + \beta_2 RR_{i,t} + \beta_3 CAP_{i,t} + e_{it},$$
$$i = 1,\ldots,N;\ t = 1,\ldots,T \qquad (3.3.3.1.1)$$

where *i* denotes individual bank and *t* denotes time. *PS* denotes pure margin (i.e. spread between interest income and interest expense), *IMPLICIT* denotes implicit interest rate, and *CAP* denotes opportunity cost of capital. β is 3×1 coefficient matrix. The second step pooled OLS estimates

$$PS_{it} = \alpha + \beta_1 MP_t + \beta_2 MR_{i,t} + \beta_3 R_{i,t} + \beta_4 Q_{i,t} + e_{it} \qquad (3.3.3.1.2)$$

where *MP* is the estimated deterministic term γ_t in Eq.(3.3.3.1.1), *MR* is market risk exposure, *R* is degree of risk aversion, and *Q* is size of new loan.

If unitary pooled disturbance e_{it} is decomposed in the following way

$$e_{it} = \mu_i + v_{it} \qquad (3.3.3.1.3)$$

with time invariant unobservable individual-specific effect μ_i and remainder disturbance v_{it} and individual specific effect (μ_i) is correlated with the explanatory variables, fixed effect or random effect model should be considered (Batalgi, 2005). Saunders and Schumacher (2000) eliminates μ_i by using within transformation as follows

$$PS_{it} - \overline{PS}_i = \alpha + \beta_1(MP_{it} - \overline{MP}_i) + \beta_2(MR_{it} - \overline{MR}_i) +$$
$$\beta_3(R_{it} - \bar{R}_i) + \beta_4(Q_{it} - \bar{Q}_i) + \ddot{v}_{it} \qquad (3.3.3.1.4)$$

where $PS_i = \frac{1}{T_i}\sum_{t=1}^{T_i} PS_{it}$

Maudos and Solis (2009) used more variables in their fixed effect model. One of variables in the fixed effect model i.e. market power (*MP*) calculated as the spread between product price and marginal cost, divided by product price. Marginal cost is estimated by using OLS as follows.

$$\ln TC_{i,t} = \alpha + \alpha_j \sum_{j=1}^{3} w_{i,t}^{j} + \frac{1}{2}\sum_{j=1}^{3}\sum_{k=1}^{3} \alpha_{jk} \ln w_{i,t}^{j} w_{i,t}^{k} + \beta_1 \ln Y_{i,t} + \frac{1}{2}\beta_2\left(\ln Y_{i,t}\right)^2 + \sum_{j=1}^{3} \beta_{3j} \ln Y_{i,t} \ln w_{i,t}^{j} + \gamma_{1t}T + \frac{1}{2}\gamma_{2t}T^2 + \sum_{j=1}^{3} \gamma_{3t} \ln w_{i,t}^{j} + \gamma_{4t} \ln Y_{i,t} + \mu_i + v_{it} \quad (3.3.3.1.5)$$

Where *TC* is total cost, w_1 is labor price, w_2 is price of loanable fund, w_3 is other operating cost, *Y* is total asset, *T* is time trend capturing technical progress, and μ caputres individual fixed effect. Market power (*MP*) is calculated as The second step is to include *MP* into four equation which is estimated by using OLS with fixed effect.

$$IM_{it} = \alpha + \beta_1 MP_{i,t} + \beta_2 C_{i,t} + \beta_3 R_{i,t} + \beta_4 MR_{i,t} + \beta_5 CR_{i,t} + \beta_6 Q_{i,t} + \beta_7 CCM_{i,t} + \beta_8 IMPLICIT_{i,t} + \beta_9 RR_{i,t} + \beta_{10} MGT_{i,t} + e_{i,t} \quad (3.3.3.1.6)$$

$$IM_{it} = \alpha + \beta_1 MP_{i,t} + \beta_2 C_{i,t} + \beta_3 R_{i,t} + \beta_4 MR_{i,t} + \beta_5 CR_{i,t} + \beta_6 Q_{i,t} + \beta_7 CCM_{i,t} + \beta_8 IMPLICIT_{i,t} + \beta_9 R_{i,t} + \beta_{10} MGT_{i,t} + \beta_{11} TRADE_{i,t} + \beta_{12} FEE_{i,t} + e_{it} \quad (3.3.3.1.7)$$

$$IM_{it} = \alpha + \beta_1 MP_{i,t} + \beta_2 C_{i,t} + \beta_3 R_{i,t} + \beta_4 MR_{i,t} + \beta_5 CR_{i,t} + \beta_6 Q_{i,t} + \beta_7 CCM_{i,t} + \beta_8 IMPLICIT_{i,t} + \beta_9 R_{i,t} + \beta_{10} MGT_{i,t} + \beta_{11} LEV_{i,t} + e_{i,t} \quad (3.3.3.1.8)$$

$$IM_{it} = \alpha + \beta_1 MP_{i,t} + \beta_2 C_{i,t} + \beta_3 R_{i,t} + \beta_4 MR_{i,t} + \beta_5 CR_{i,t} + \beta_6 Q_{i,t} + \beta_7 CCM_{i,t} + \beta_8 IMPLICIT_{i,t} + \beta_9 R_{i,t} + \beta_{10} MGT_{i,t} + \beta_{11} LEV_{i,t} + \beta_{12} GDP_t + \beta_{13} INF_t + \beta_{14} FEE_{i,t} + \beta_{15} TRADE_{i,t} + e_{it} \quad (3.3.3.1.9)$$

where *C* denotes operating cost, *CR* denotes credit risk, *CCM* denotes interaction between market risk and credit risk, *MGT* denotes management efficiency, *LEV* is leverage, *GDP* is gross domestic product, *FEE* is fee based income, *TRADE* is net income from trading portfolio, *INF* is inflation.

Considering fixed effect model might be the appropriate structure of the model (Saunders and Schumacher, 2000; Maudos and Solis, 2009), the proposed model Eq.(3.3.1.2.38) is estimated by using regression with fixed effects and robust estimates of standard errors. The estimates of standard errors are obtained by using method as in Arellano (1987) allowing a general variance-covariance matrix on v_{it} as in White (1980). The general form of regression for Eq.(3.3.1.2.38) is written as follows

$$PURE_{it} = \alpha_i + \beta_1 MP_{it} + \beta_2 COST_{it} + \beta_3 RA_{it} + \beta_4 MR_{it} + \beta_5 CRL_{it} + \beta_6 LOAN_{it} + \beta_7 IMPLICIT_{it} + \beta_8 LPS_{it} + \beta_9 CASH_{it} + \beta_{10} CAPITAL_{it} + \beta_{11} PM_{it} + \beta_{12} Q1_{it} + \beta_{13} Q2_{it} + \beta_{14} Q3_{it} + \beta_{15} Q4_{it} + e_{it} \qquad (3.3.3.1.10)$$

$$NIM_{it} = \alpha_i + \beta_1 MP_{it} + \beta_2 COST_{it} + \beta_3 RA_{it} + \beta_4 MR_{it} + \beta_5 CREA_{it} + \beta_6 IEA_{it} + \beta_7 IMPLICIT_{it} + \beta_8 LPS_{it} + \beta_9 CASH_{it} + \beta_{10} CAPITAL_{it} + \beta_{11} PM_{it} + \beta_{12} Q1_{it} + \beta_{13} Q2_{it} + \beta_{14} Q3_{it} + \beta_{15} Q4_{it} + e_{it} \qquad (3.3.3.1.11)$$

$$GM_{it} = \alpha_i + \beta_1 MP_{it} + \beta_2 COST_{it} + \beta_3 RA_{it} + \beta_4 MR_{it} + \beta_5 CREA_{it} + \beta_6 EA_{it} + \beta_7 IMPLICIT_{it} + \beta_8 LPS_{it} + \beta_9 CASH_{it} + \beta_{10} CAPITAL_{it} + \beta_{11} PM_{it} + \beta_{12} Q1_{it} + \beta_{13} Q2_{it} + \beta_{14} Q3_{it} + \beta_{15} Q4_{it} + e_{it} \qquad (3.3.3.1.12)$$

Each variable is transformed in the same way as Eq.(3.3.3.1.4), so β and estimators $(\alpha + \mu_i)$ are the best linear unbiased estimators given that v_{it} is the standard classical disturbance with zero mean and variance-covariance matrix σ_v^2. Q_i is 1 if data belong to the i-th quarter of year and 0 otherwise, for i = 1,2,3,4..

The Eq.(3.3.3.1.10), Eq.(3.3.3.1.11), and Eq.(3.3.3.1.12) are viewed as a set of individual equation with the following general form

$$y_i = z_i \delta + \mu_i \iota_T + v_i \qquad (3.3.3.1.13)$$

with $E[v_i v_i'] = \Omega_i,\ i = 1, \cdots, N$

$E[v_i v_j'] \neq 0$ for $i \neq j$

$PURE_i$ is $T \times 1$ vector, $z_i = [\iota_T, x_i]$, x_i is $T \times k$ matrix of exogenous variables, v_i is $T \times 1$ vector, μ_i is a scalar and $\delta = [\alpha, \beta']$. The asymptotic results are performed for T fixed and $N \rightarrow \infty$. The Within transformation on the equation gives

$$\hat{y}_i = \hat{x}_i \beta + \hat{v}_i \qquad (3.3.3.1.14)$$

with $\hat{y} = Qy$, $\hat{x} = Qx$, and $\hat{v} = Qv$

$\hat{y} = (\hat{y}_1', \cdots, \hat{y}_N')'$, $\hat{y}_i = (I_T - \bar{J}_T) y_i$ and $\hat{x}_i = (I_T - \bar{J}_T) x_i$.

By restricting that individual equations have the same β, the asymptotic distribution of the Within estimator of β is

$$N^{1/2}(\hat{\beta}-\beta)\sim N(0, M^{-1}VM^{-1})$$

where $M = plim(\hat{x}'\hat{x})/N$

$V = plim\sum_{i=1}^{N}(\hat{x}_i'\Omega_\mathrm{i}\hat{x}_i)/N$

$\hat{V} = \sum_{i=1}^{N}(\hat{x}_i'\hat{e}_i\hat{e}_i'\hat{x}_i)/N$

$\hat{e}_i = \hat{y}_i - \hat{x}_i\beta$

$\hat{x}'Qdiag[\Omega_\mathrm{i}]Q\hat{x} = \hat{x}'diag[\Omega_\mathrm{i}]\hat{x}$

Thus, the robust asymptotic variance-covariance matrix of β is estimated as

$$VCE(\hat{\beta}) = (\hat{x}'\hat{x})^{-1}(\textstyle\sum_{i=1}^{N}\hat{x}_i'\,\hat{e}_i\hat{e}_i'\hat{x}_i)(\hat{x}_i'\hat{x}_i)^{-1}.$$

while cluster robust variance-covariance matrix of β is

$$VCE(\hat{\beta}) = (\hat{x}'\hat{x})^{-1}\left(\sum_{j=1}^{n_c}\hat{u}_j'\hat{u}_j\right)(\hat{x}_i'\hat{x}_i)^{-1}$$

where $\hat{u}_j = \sum_{j_{cluster}}\hat{e}_i\hat{x}_i$ and n_c is the total number of clusters

The cluster robust covariance matrix relaxes the i.i.d. assumption of independent errors by allowing for arbitrary correlation between errors within clusters of observations. Cameron and Miller (2010) suggested that the estimation of covariance matrix without controlling for clustering might lead to understated standard errors and overstated statistical significance.

Fixed effect estimators are consistent and efficient when individual groups/times have different intercept in the regression equation. The estimators however are not efficient when individual groups/time have different disturbance. The model can not estimate the effect of any time-invariant variables since such variables are wiped out by the deviations from means transformation (Batalgi, 2005). If individual groups/times have different disturbance, regression with random effect should be considered to estimate Eq.(3.3.3.1.2) and equation from Eq.(3.3.3.1.6) to Eq.(3.3.3.1.9), and Eq.(3.3.3.1.10) to Eq.(3.3.3.1.12). If the general form of regression is written as follows

$$y_{it} = X_{ti}\beta + \mu_i + v_{it} \qquad (3.3.3.1.13)$$

μ_i are assumed to be random that $\mu_i \sim i.i.d(0, \sigma_\mu^2)$ with $v_{it} \sim i.i.d(0, \sigma_v^2)$ and μ_i are independent of v_{it}. Explanatory variables is assumed to be independent of μ_i and v_{it} for all i and t. To obtain generalized least square (GLS) estimator of the regression coefficients, variance of covariance matrix Ω^{-1}.

$$\Omega = T\sigma_\mu^2(I_N \otimes \bar{J}_T) + \sigma_v^2(I_N \otimes E_T) + \sigma_v^2(I_N \otimes \bar{J}_T) = \sigma_1^2 P + \sigma_v^2 Q$$

where $E_T \equiv (I_T - \bar{J}_T)$ and $\sigma_1^2 = T\sigma_\mu^2 + \sigma_v^2$

The best quadratic unbiased estimators of the variance components are

$$\hat{\sigma}_v^2 = \frac{\sum_{i=1}^{N}\sum_{t=1}^{T}(u_{it} - \bar{u}_i)^2}{N(T-1)}$$ and

$$\hat{\sigma}_1^2 = \frac{T\sum_{i=1}^{N}\bar{u}_i^2}{N}$$

Following Swamy and Arora (1972), two regressions are run to get estimates of the variance components from the corresponding mean square error of the regression. The first regression is

$$s^2 = \hat{\hat{\sigma}}_v^2 = \frac{y'Qy - y'Qx(x'Qx)^{-1}x'Qy}{N(T-1)-k}$$

The second regression is the Between regression running regression of average across time

$$\bar{y}_i = \alpha + \bar{x}_i\beta + \bar{u}_i, \quad i = 1, \cdots, N$$

which produces

$$s^2 = \hat{\hat{\sigma}}_1^2 = \frac{y'Py - y'Pz(z'Pz)^{-1}z'Py}{N-k-1}$$

Thus, the two regressions are transformed into

$$\binom{Qy}{Py} = \binom{Qz}{Pz}\delta + \binom{Qu}{Pu}$$

with zero mean transformed error and variance covariance matrix $\begin{pmatrix}\sigma_v^2 Q & 0 \\ 0 & \sigma_1^2 P\end{pmatrix}$.

It follows that $\hat{\beta}_{GLS}$ is weighted average of $\hat{\beta}_{Within}$ and $\hat{\beta}_{Between}$ (i.e. each estimator is weighted by the inverse of its corresponding variance) that

$$\hat{\beta}_{GLS} = W_1\hat{\beta}_{Within} + W_2\hat{\beta}_{Between}$$

with $\quad W_1 = (W_{xx} + \phi^2 B_{xx})^{-1}W_{xx}$

$\quad\quad\quad W_2 = I - W_1$

$$W_{xx} = x'Qx$$
$$B_{xx} = x'(P - \bar{J}_{NT})x$$
$$\phi^2 = \sigma_v^2 / \sigma_1^2$$

Then, $var(\hat{\beta}_{GLS}) = \sigma_v^2(W_{xx} + \phi^2 B_{xx})^{-1}$

The likelihood function under normality of disturbances can be written as

$$L(\alpha, \beta, \phi^2, \sigma_v^2) = const - \frac{NT}{2} log\sigma_v^2 + \frac{N}{2} log\phi^2 - \frac{1}{2\sigma_v^2} u'\Sigma^{-1}u$$

$\phi^2 = \frac{\sigma_v^2}{\sigma_1^2}, \Omega = \sigma_v^2$ and $\Sigma = Q + \phi^{-2}P$. The likelihood with respect to α and σ_v^2 as in Breusch (1987) is

$\hat{\alpha}_{MLE} = \bar{y} - \bar{x}'\hat{\beta}_{MLE}$, and $\sigma_{v,MLE}^2 = (\frac{1}{NT})\hat{u}'\hat{\Sigma}^{-1}\hat{u}$

$\hat{\Sigma}$ and $\hat{u}$ are based on maximum likelihood estimates of β, ϕ^2 and α.

If $= y - x\hat{\beta}_{MLE}$, $\hat{\alpha}_{MLE} = (\frac{1}{NT})\iota_{NT}'d$ and $\hat{u} = d - \bar{J}_{NT}d$. Thus, $\sigma_{v,MLE}^2$ can be expressed as $\sigma_{v,MLE}^2 = \frac{d\prime\left(Q+\phi^2(P-\bar{J}_{NT})\right)d}{NT}$, hence the concentrated likelihood is expressed as

$L_C(\beta, \phi^2) = const - \frac{NT}{2} log\left(d'\left(Q + \phi^2(c)\right)d\right) + \frac{N}{2} log\phi^2$.

Maximizing $L_C(\beta, \phi^2)$ with respect to ϕ^2 and β produces

$$\hat{\phi}^2 = \frac{\sum\sum\left(d_{it} - \bar{d}_i\right)^2}{T(T-1)\sum\left(d_i - \bar{d}_i\right)^2}$$

$$\hat{\beta}_{MLE} = \left(x'\left(Q + \phi^2(P - \bar{J}_{NT})\right)x\right)^{-1} x'\left(Q + \phi^2(P - \bar{J}_{NT})\right)y$$

The possibility of a local maximum is negated by starting iteration from $\hat{\beta}_{Within}$ and $\hat{\beta}_{Between}$. The global maximum is reached when the two sequences converge to the same maximum.

Hausman and Taylor (1981) proposed specification test to select between pooled OLS and fixed effect model by partitioning explanatory variables into time variant variables (X) and time invariant variables (Z). The assumption of the test is at least one X and one Z are not correlated with individual effect μ_i. The null hypothesis is as follows

$$H_0 : \mu_i \perp X_{it}, Z_i$$

If null hypothesis is true, fixed effect and random effect estimators are consistent. However, only random effect estimators are efficient.

$$\hat{Q} = \hat{\beta}_{RE} - \hat{\beta}_{FE}$$

$$H\hat{T} = T\hat{Q}'\left(\mathrm{var}\left(\hat{\beta}_{FE}\right) - \mathrm{var}\left(\hat{\beta}_{RE}\right)\right)\hat{Q} \rightarrow \chi^2_K$$

$$K = \dim(Q)$$

In the case that null hypothesis is rejected, a Lagrange Multiplier test is proposed by Breusch and Pagan (1978).

$$LM = \frac{\left(\sum_{i=1}^{N} T_i\right)^2}{2\sum_{i=1}^{N} T_i\,(T_i - 1)}\left[\frac{\sum_{i=1}^{N}\left(\sum_{t=1}^{T_i}\hat{e}_{it}\right)^2}{\sum_{i=1}^{N}\sum_{i=1}^{T_i}\hat{e}_{it}^2} - 1\right]^2 \sim\chi^2(1)$$

$$H_0\!: \sqrt{LM} \sim N(0{,}1)$$

Fixed effect estimators are consistent and efficient if null hypothesis is rejected. Otherwise, pooled OLS should be the model structure.

3.3.3.2 Dynamic panel data model

In the beginning of previous section, it is noted that past value of intermediation margin influences current value of intermediation margin in some banks. Arrellano and Bond (1991) suggested a two step GMM estimator with lagged values of explanatory variables in levels as instrumental variables. The estimators are estimated using GMM framework by reproducing static model of 11 independent variables as follows

$$\begin{aligned} PURE_{it} = {} & \alpha_i + \beta_1 PURE_{it} + \beta_2 MP_{it} + \beta_3 COST_{it} + \beta_4 RA_{it} + \beta_5 MR_{it} + \beta_6 CRL_{it} + \\ & \beta_7 LOAN_{it} + \beta_8 IMPLICIT_{it} + \beta_9 LPS_{it} + \beta_{10} CASH_{it} + \beta_{11} CAPITAL_{it} + \\ & \beta_{12} PM_{it} + \beta_{13} Q1_{it} + \beta_{14} Q2_{it} + \beta_{15} Q3_{it} + \beta_{16} Q4_{it} + e_{it} \end{aligned} \qquad (3.3.3.2.1)$$

$$\begin{aligned} NIM_{it} = {} & \alpha_i + \beta_1 PURE_{it} + \beta_2 MP_{it} + \beta_3 COST_{it} + \beta_4 RA_{it} + \beta_5 MR_{it} + \beta_6 CRI_{it} + \\ & \beta_7 IEA_{it} + \beta_8 IMPLICIT_{it} + \beta_9 LPS_{it} + \beta_{10} CASH_{it} + \beta_{11} CAPITAL_{it} + \\ & \beta_{12} PM_{it} + \beta_{13} Q1_{it} + \beta_{14} Q2_{it} + \beta_{15} Q3_{it} + \beta_{16} Q4_{it} + e_{it} \end{aligned} \qquad (3.3.3.2.1)$$

$$GM_{it} = \alpha_i + \beta_1 PURE_{it} + \beta_2 MP_{it} + \beta_3 COST_{it} + \beta_4 RA_{it} + \beta_5 MR_{it} + \beta_6 CRE_{it} +$$
$$\beta_7 EA_{it} + \beta_8 IMPLICIT_{it} + \beta_9 LPS_{it} + \beta_{10} CASH_{it} + \beta_{11} CAPITAL_{it} +$$

$$\beta_{12}PM_{it} + \beta_{13}Q1_{it} + \beta_{14}Q2_{it} + \beta_{15}Q3_{it} + \beta_{16}Q4_{it} + e_{it} \qquad (3.3.3.2.1)$$

The three abovementioned regressions can be written in the following general form

$$y_{it} = \alpha y_{it-1} + \beta x'_{it} + \gamma Z'_i + u_{it} \qquad (3.3.3.2.3)$$

where α and γ are $q \times 1$ matrix and β is $K \times 1$ matrix. x_{it} varies over time and individuals while Z_i vary over time. Disturbance u_{it} is a one way error component of $u_{it} = \mu_i \iota_T + v_{it}$.

$E[u_i u'_i / w_i]$ depends on w_i. $w_i = [x'_{i0}, \cdots, x'_{iT}, Z'_i]'$ whereas $t = 0$ is the first observation. The cross-sectional homoskedasticity is defined as $E[u_i u'_i] = \Omega$ where $\Omega = \sigma_v^2 I_T + \sigma_\mu^2 \iota_T \iota'_T$. The T system of equation in (3.3.2.3) is transformed by using the following nonsingular transformation.

$$H = \begin{bmatrix} C \\ \iota'_T / T \end{bmatrix}$$

C is $(T-1) \times T$ matrix with rank $(T-1)$ such that $C_{\iota T} = 0$. Thus, C could be the first $(T-1)$ rows of the Within group operator or of the first difference operator. The transformed disturbances $u_i^+ = Hu_i = \begin{bmatrix} Cu_i \\ \bar{u}_i \end{bmatrix}$ with the first $(T-1)$ free of μ_i. Therefore, all exogenous variables are valid instruments for the first $(T-1)$ equations. If m_i is subset of w_i which is uncorrelated in level with μ_i, a valid IV for the transformed system is as follows

$$M_i = \begin{bmatrix} (w'_i, y_{i0}) & \cdots & & 0 \\ \vdots & \ddots & & \vdots \\ & & (w'_i, y_{i0}, y_{i1}, \cdots, y_{iT-2}) & \\ 0 & & & m'_i \end{bmatrix}$$

with moment condition $E[M'_i H u_i] = 0$. If N is number of individuals, $= (y'_1, \cdots, y'_N)'$, $y_{i(-1)} = (y_{i0}, \cdots, y_{iT-1},)'$, $M = (M'_1, \cdots, M'_N)$, $\bar{H} = I_N \otimes H$ and $\bar{\Omega} = I_N \otimes \Omega$, the product between $M'\bar{H}$ and equation (3.3.2.3) produces

$$M'\bar{H}y = M'\bar{H}\left(\alpha y_{(-1)} + \beta x' + \gamma Z_i\right) + M'\bar{H} \qquad (3.3.3.2.4)$$

If $W_i = \left(y_{i(-1)}, x_i, \iota_T Z'_i\right)$ and $\eta = (\alpha, \beta, \gamma)$, running GLS on Eq.(3.3.3.2.4) will generate estimators proposed in Arellano and Bover (1995)

$$\hat{\eta} = [W'\bar{H}'M(M'\bar{H}\bar{\Omega}\bar{H}'M)^{-1}M'\bar{H}W]^{-1}W'\bar{H}'M(M'\bar{H}\bar{\Omega}\bar{H}'M)^{-1}M'\bar{H}y$$

Replacing covariance matrix of the transformed system (i.e.$\bar{H}\bar{\Omega}\bar{H}$) by consistent estimator $\widehat{\Omega}^{+} = \sum_{i=1}^{N} \hat{u}_i^{+} \hat{u}_i^{+\prime} / N$ will get estimators given by

$$\hat{\eta} = \left[W'\bar{H}'M\left(M'\widehat{\Omega}^{+}M\right)^{-1}M'\bar{H}W\right]^{-1} W'\bar{H}'M\left(M'\widehat{\Omega}^{+}M\right)^{-1}M'\bar{H}y.$$

Nonetheless such approach had been criticized to exacerbate measurement error bias (Griliches and Hausman, 1986). Blundell and Bond (1997) suggested the use of regression in differences jointly with regression in levels such in Arellano and Bover (1995). The estimator could reduce potential biases in finite samples as well as reduces asymptotic imprecision due to difference estimator. The regression for the proposed theoretical model If matrix of instrument set in the difference GMM (Arellano and Bover, 1995) for Eq.(3.3.3.2.1) is written in the following way

$$\begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 & \cdots \\ PURE_{i1} & 0 & 0 & 0 & 0 & 0 & \cdots \\ 0 & PURE_{i2} & PURE_{i3} & 0 & 0 & 0 & \cdots \\ 0 & 0 & 0 & PURE_{i3} & PURE_{i2} & PURE_{i1} & \cdots \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \ddots \end{pmatrix}$$

then the system GMM (Blundell and Bond, 1997) adds instruments to the set as follows

$$\begin{pmatrix} 0 & 0 & 0 & 0 & \cdots \\ \Delta PURE_{i2} & 0 & 0 & 0 & \cdots \\ 0 & \Delta PURE_{i3} & 0 & 0 & \cdots \\ 0 & 0 & 0 & \Delta PURE_{i4} & \cdots \\ \vdots & \vdots & \vdots & \vdots & \ddots \end{pmatrix}$$

This implies that the system GMM has additional orthogonality condition

$$E[\Delta PURE_{it-1}e_{it}] = E[\Delta PURE_{it-1}\mu_i] + E[PURE_{it-1}v_{it}] - E[PURE_{it-2}v_{it}] = 0$$

Arellano and Bond (1991) proposed two step Sargan test for over-identifying restriction as follows

$$m = \Delta\hat{v}'W\left[\sum_{i=1}^{N} W'_i(\Delta\hat{v}_i)(\Delta\hat{v}_i)'^{W_i}\right]^{-1} W'(\Delta\hat{v}) \sim \chi^2_{p-K-1}$$

where $\Delta\hat{v}$ is $\hat{\eta}$ and p is number of column in W. Other tests being proposed are Wald joint test, first order serial correlation test and second order serial correlation test. Batalgi (2005) suggested that first order serial correlation test does not matter. Attention should be centered on Wald joint test and second order serial correlation test. The second order serial correlation test shows whether or not the original untransformed disturbances of the first-differenced equation are serially correlated.

Roodman (2009) argued that the system GMM might handle fixed effects, endogeneity of regressors and dynamic panel bias. However, the instrument counts grow quadratically with respect to T. The estimator of difference GMM (Arellano and Bond) exploits, for each endogenous variable, *(T-2)(T-1)/2* moment condition for Eq.(3.3.3.1.10) in first difference. The estimator of system GMM (Blundell and Bond) exploits, for each endogenous variable, the additional non-redundant *T-2* orthogonality conditions for Eq.(3.3.3.1.10) in level. As the number of instruments becomes too large, there is the trade off between over fitting of endogenous variables (bias) and additional moment conditions (efficiency). This also gives an imprecise estimate of the variance/covariance matrix of the moments, lowers the power of specification test of Sargan (1958) and Hansen (1982) test of over-identifying restriction, and exacerbates the weak instruments problem. Thus, collapsing the instrument set, limiting the lag depth of the instrument set, or combination of both might transform instrument matrix to the optimal set of instruments. By limiting the lag depth, serial correlation will be low after a few periods, even if the autoregressive parameter is high. However, some important information in the instrument set might be lost. On the other hand, collapsing the instrument set retains important information whilst condensing it into a lower number of instruments. Thus, collapsing the instrument set for the system GMM is selected, producing the following instrument matrix for Eq.(3.3.3.1.10) in first difference

$$\begin{pmatrix} 0 & 0 & 0 & \cdots \\ PURE_{i1} & 0 & 0 & \cdots \\ PURE_{i2} & PURE_{i1} & 0 & \cdots \\ PURE_{i3} & PURE_{i2} & PURE_{i1} & \cdots \\ \vdots & \vdots & \vdots & \ddots \end{pmatrix}$$

The collapsed instrument set for Eq.(3.3.3.1.10) in level is summarized in the following matrix

$$\begin{pmatrix} 0 \\ \Delta PURE_{i2} \\ \Delta PURE_{i3} \\ \Delta PURE_{i4} \\ \vdots \end{pmatrix}$$

The estimation of system GMM uses heteroskedasticity-consistent standard errors explained in section 3.3.3.1.

3.4. Data

The empirical model is estimated on quarterly data of 51 of 66 bank respondents in the survey. The 51 commercial banks count for 90% of total loans in Indonesia. Problem banks are excluded from sample since such banks typically have different asset and liquidity management. Besides, such banks often deal with restriction imposed by bank supervisory authorities such as curbing loan growth. Banks with more than 90% of their loan portfolio are mortgage loans are also excluded from sample. Banks focusing on mortgage loans are assumed to be lack of expertise in project finance. All data are retrieved from quarterly financial statement of banks except for contractual interest rates. Quarterly contractual loan rate and deposit rate are retrieved from quarterly regulatory report.

The dependent variable in the model is intermediation margin, composing of net interest margin and net non interest margin. To investigate the plausibility of using contractual interest rates, pure margin (*PURE*) is calculated for contractual net interest margin and accounting interest margin. Contractual *PURE* is the spread between contractual loan price (r_L) and contractual deposit prices (r_i) Accounting *PURE* is the spread between annualized interest revenue per unit of loans and interest expenses per unit of deposits. Table 12 shows descriptive statistics of pure margin for the unbalanced data (*PURE*) as well as sub sample of banks with core competence in the seed capital or investment outlay financing (*PURE_inv*), working-capital loans (*PURE_work*), consumer loans (*PURE_cons*), non-maturity deposit (*PURE_ni*), and non loan earning assets (*PURE_n*).

Table 12 Descriptive statistics of contractual pure margin

variable	mean	median	max	min	st.dev	skewness	kurtosis
pure	0.075832	0.071287	0.325928	0.002879	0.039644	2.034688	10.56832
pure (D_i)	0.07751	0.080492	0.258887	0.002879	0.038659	1.029614	5.329747
pure (L_{inv})	0.038415	0.027395	0.089432	0.015021	0.025987	1.037529	2.434597
pure (L_{work})	0.070673	0.067427	0.200127	0.002879	0.033441	1.088666	5.040352
pure (L_{cons})	0.127129	0.115596	0.325928	0.045346	0.067423	1.681538	5.133822
pure (FI)	0.071381	0.068546	0.325275	0.002879	0.038105	1.899199	11.15896

Banks heavily depending on non-maturity deposits have higher interest margin than banks on the average. Banks with high share of consumer loans have slightly higher pure margin than banks with high share of investment loans or credit lines for working capital. Expectedly, banks holding more non loan earning assets have lower pure margin than average during low interest rate period.

Net interest margin (*NIM*) is composed of pure margin and spread between yield of fixed income securities on the asset side and yield of fixed income securities on the liability side. Accounting *nim* is simply spread between annualized interest revenue and expenses. Gross margin (*GM*) which is composed of *NIM* and net income per unit from other intermediary activities is likely to mimic the interest margin behavior. Contractual and accounting *NIM* and *GM* are summarized in table 13.

Table 13 Descriptive statistics of contractual and accounting net interest margin and gross margin

	mean	median	max	min	std. dev	skewness	kurtosis
nim_c	0.062852	0.067978	0.315725	0.02770	0.073415	-6.89918	97.68808
im_c	0.213706	0.192323	0.952873	0.031583	0.412521	-29.176	947.7851
nim_a	0.032959	0.028017	0.551075	0.075706	0.028173	5.817789	100.9995
im_a	0.064053	0.030971	19.66632	0.037108	0.649628	26.79755	761.3717

Other variables estimated from the theoretical model Eq.(3.1.1.38) are as follow:

a. Market power (*MKTPWR*)

   Following Maudos and Guevara (2004) procedure to estimate bank's market power, Lerner Index is used to estimate α/β in Eq.(3.1.1.38). Lerner Index has been widely used in banking study to estimate degree of competition and calculated as follows

$$MP_{i,t} = \frac{P_{i,t} - MC_{i,t}}{P_{i,t}}$$

where $P_{i,t}$ is price per unit for bank i and MC_t is marginal cost to produce the products for bank i. The index takes value from 0 to 1. Price per unit is proxied by total revenue over total assets whilst marginal cost is similar way as in Eq.(3.3.1.5).

$$\ln TC_{i,t} = \alpha_{0,i} + \alpha_{1,i} \ln assets_{i,t} + \frac{1}{2}\alpha_{2,i}(\ln assets_i)^2 + \sum_{j=1}^{3} \beta_{j,i} \ln w_{j,i} + \frac{1}{2}\sum_{j=1}^{3}\sum_{k=1}^{3} \beta_{jk,i} \ln w_{j,i} \ln w_{k,i} + \frac{1}{2}\sum_{j=1}^{3} \gamma_{j,i} \ln assets_i \ln w_{j,i} + \mu_{1,i}Trend + \mu_{2,i}\frac{1}{2}Trend^2 + \mu_{3,i}Trend \ln assets_{i,t} + \sum_{j=1}^{3} \lambda_j Trend \ln w_{j,i} + \mu_i + e_{i,t}$$

Lerner (1934) showed that elasticity of demand on a product can be written as $\frac{-\mathrm{P}}{\mathrm{MC}-\mathrm{P}}$. Thus, Lerner Index also shows how profit margin depends on elasticity demand on bank's products. The higher elasticity of demand on a product, the more likely consumers find substitutes when a bank increases prices of that product. Hence, bank's profit margin is low when elasticity of demand high, making the index closer to 0. In other word, the intermediation margin is expected to be low when Lerner Index is low.

b. Degree of risk aversion (*RA*)

Maudos and Solis (2009) suggested that excess regulatory capital might be a better proxy for degree of risk aversion than equity to asset (E/A) ratio. Nevertheless, the study did not provide evidence whether the former is a better proxy than the later. The following figure indicates that banks' excess capital might not be a good proxy. Minimum regulatory capital should increase with Risk Weighted Assets (RWA). Given that there is no stock issue, excess capital is likely to decrease as RWA increase. However, during the sample period, excess capital often increases when RWA increases. Therefore, instead of using excess capital as proxy for degree of risk aversion, E/A ratio and ratio of RWA over total assets are considered in the empirical model. RWA takes value of 0% to 100% of asset size. The RWA reflects credit, operational and credit risk exposure in a bank. Details for the calculation of RWA are in the appendix.

c. Size of new transaction (*LOAN, IEA, EA*)

Data of size of new transaction could not be retrieved from banks' financial statement. Thus, following Saunders and Schumacher (2000) and Maudos and Solis (2009) natural logarithm of data is used a proxy of new transaction. Translog of loan (*LOAN*) is used in regression on *PURE* while translog of interest bearing assets (*IEA*) is used in regression on *NIM*. Translog of earning asset (*EA*) is considered in regression on *GM* since gross margin is generated from all types of earning assets, including fee based activities.

d. Credit risk (*CRL, CRI, CRE*)

Since intermediation margin is composed of gross margin on all of bank's business lines, credit risk $\sigma_{ea,i}^2$ in equation (3.1.1.38) is defined as a bank's risk of all earning assets at default. Thus, credit risk comprises loss arising from a bank's borrowers as well as other counterparties who fail to make payment on the promised principal as well as the promised return. Other counterparties are firms issuing financial instruments such as money market funds, stocks and derivatives. *CRL* is the ratio of loan loss provision over total loan while *CRI* is loss provision for interest bearing assets over total interest bearing assets. *CRE* is calculated as loss provision of earning assets over total earning assets. The higher credit riskiness of banks' portfolio, the higher is bank's potential loss exposure. Thus, high intermediation margin is expected to compensate high credit risk exposure.

e. Market risk (*MR*)

Market risk $\sigma_{M,t}^2$ in equation (3.1.1.38) is a bank's loss arising from decreasing value of maturity assets due to variability of interest rates. Market risk is proxied as annual standard deviation of monthly real interest rates on one month – Sertifikat Bank Indonesia (SBI). Interest rates on one month – SBI are considered since this instrument is the most liquid T-bills in Indonesia, and most banks' term deposits are one month – term deposits. Similar to credit risk case, intermediation margin is expected to be high to compensate high market risk exposure.

f. Operating cost (*COST*)

Operating cost is calculated as annualized total operating costs over average total assets as follows

$$C_{i,t} = \frac{4C_{i,t}^{q}}{0.5t(assets_t - assets_{t-1})}, \quad t = 1,2,3,4$$

where $C_{i,t}^{q}$ is operating cost of bank *i* at quarter *t*. The operating cost puts pressure on intermediation margin. Thus, intermediation margin is expected to be low when operating cost is high.

In addition to variables specified in the theoretical model, the survey revealed other variables as follows:

a. Opportunity cost of holding minimum reserve requirement and deposit insurance premium (*IMPLICIT*)

   Banks are required to hold minimum liquidity reserves in the form of demand deposit in Central Bank as well as T-bills and T-bonds which could not be either sold or lent. By holding the required liquidity reserves, banks loss opportunity to gain from investing the fund. The opportunity cost of holding the reserves is often treated as implicit cost of fund. Thus, the higher opportunity cost, the higher is implicit cost of deposits. In other word, the intermediation margin decreases with the opportunity cost of holding reserve requirement. Jakarta Interbank Offered Rate (JIBOR) 1 month is proxy for the opportunity cost since 1 month interbank call money is the most liquid money market fund. Thus, *implicit_rates* is summation of deposit insurance premium and the product between JIBOR 1 month and reserve requirement over earning assets, divided by deposit size.

b. Opportunity cost of holding cash (*CASH*)

   Banks convert some of their earning assets into cash in vault to anticipate customer's cash withdrawal. Failure to satisfy customer's need of cash might divert customers to other banks for a more satisfying service. In an extreme scenario such as financial crisis, problem in cash withdrawal might lead to "rush". Thus, holding sufficient cash in vault is one of way to retain customer's loyalty but costs banks. Banks lose opportunity to gain return from investing assets in other instruments instead of converting the assets in cash. The opportunity cost of holding cash is proxied as the product between cash and weighted average of interest rate on deposits.

c. Opportunity cost of holding minimum capital (*CAPITAL*)

The minimum capital is the product between minimum Capital Adequacy Ratio (CAR) and Risk Weighted Assets (RWA). Central Bank Indonesia had required banks to hold 8% of a bank's RWA. The RWA is the estimates of credit, market and operational risk exposure in a bank's asset portfolio. The RWA calculation is illustrated in the appendix. The higher investment on risky assets, the higher is RWA. Thus, increasing investment on risky assets might boost bank's profit but increases minimum regulatory capital. The sample also shows that banks having higher RWA tend to have lower Returns On Equity (ROE). Therefore, opportunity cost of holding minimum capital *CAPITAL* is the product between ROE and ratio of minimum regulatory capital over equity. The opportunity cost of holding minimum capital is typically passed on borrowers as implicit cost of loanable fund. Thus, intermediation margin is expected to increase with opportunity cost of holding minimum capital.

d. Interest rates published by deposit insurance agency (*LPS*)

Lembaga Penjamin Simpanan (LPS) is an Indonesian deposit insurance agency which publishes interest rate on insured deposits. Any deposit paying higher than this published rate will not be covered in the deposit insurance scheme. Therefore, customers who are unwilling to risk their deposits will choose to invest in deposit paying interest rate not higher than the published rate. To fit target on deposit size, banks take into account *LPS* in pricing their deposits, and intermediation margin should increase with *lps*.

e. Expected profit margin (*PM*)

The expected profit margin comprises expected return on banks' net investment and any externalities that can not be accounted for directly but can impact wealth of bank such as price risk of emission credits in lending activities, reputational risk, and legal risk. *PM* is passed on banks' customers; hence, *PM* is expected to positively related to intermediation margin..The empirical application of the extended dealership model will use the same proxy for PM as all bank respondents i.e. ROA.

Table 14 Summary statistics for all explanatory

	mean	median	max	min	std.dev	skewness	kurtosis
cost	0.046633	0.032346	0.980485	5.08E-05	0.056721	7.21798	101.4956
implicit_rates	0.005637	0.00522	0.077249	0.001065	0.003617	10.41367	181.6905
lps	0.88887	0.083333	0.12775	0.07000	0.018592	0.91879	2.64004
cost_cash	0.007533	0.00664	0.035364	0.00032	0.004434	1.542614	7.119256
cost_capital	8.259842	0.228561	429.6093	0.111162	327.3874	-33.5527	1138.542
cr	0.015857	0.006588	6.125523	0.68521	0.181116	32.89	1111.722
mr	0.015303	0.015364	0.03627	0.000732	0.010444	0.355452	2.00119
epm	0.055408	0.0489	2.930509	0.067019	0.088334	29.62052	963.4132
R	1.367378	0.760332	282.1849	0.041426	11.4958	22.48856	525.2123
mkt_pwr	0.033031	0.02756	0.533055	0.000134	0.031038	6.722101	88.04013

To compare results from the proposed theoretical model Eq.(3.1.1.38), variables proposed in Saunders and Schumacher (2000) is estimated on Eq.(3.3.1.1) and (3.3.1.2). Empirical model in Maudos and Solis (2009) is also estimated in Eq.(3.3.1.6) to (3.3.1.9).

a. Saunders and Schumacher (2000)

- Pure margin (*PS*)

  PS is spread between annualized interest income and annualized interest expense, over earning assets

- Implicit interest rate (*IMPLICIT*)

  IMPLICT is spread between annualized non financial income and annualized non financial expense, over total assets

- Cost of reserve requirement (*RR*)

  RR is calculated as non-maturity earning assets over earning assets

- Capital (*CAPITAL*)

  CAPITAL is regulatory capital over total assets

- Market structure (*MP*)

  Recalling equation (3.3.3.) to estimate market structure,

  $PS_i = \alpha + \beta_1 IMPLICIT_i + \beta_2 RR_i + \beta_3 CAPITAL_i + e_i$

  where *i* is individual bank *i*. Thus, from 1224 observation, 24 *MP* for 24 quarters will be derived. The value of *MP* is the same across banks.

- Interest rate risk (*IR*)

  IR is proxy as quarterly standard deviation of 90days SBI

- Degree of risk aversion (*R*)

  R is calculated as non per forming loan over loan

- Transaction size (*Q*)

  Q is the translog of loan size.

b. Maudos and Solis (2009)

Intermediation margin (*IM*) is calculated as spread between annualized interest income as well as annualized income from earning assets, and annualized interest expense as well annualized loss on earning asset, divided by asset.

- Market power (*MP*)

  Lerner index is used as proxy for *MP*

- Operating cost (*C*)

  C is operating expenses over assets

- Degree of risk aversion (*R*)

  Equity to asset ratio is a proxy for *R*

- Market risk (*MR*)

  MR is proxied as quarterly standard deviation of 90days SBI

- Credit risk (*CR*)

  CR is calculated as non performing loan over loan size in the previous quarter.

- Product between *CR* and *MR* (*COV*)

- Transaction size (*Q*)

  Q is the translog of loan size

- Net non interest income (*NII*)

  NII is calculated as spread between non interest income and non interest expense, divided by assets.

- Fee based income (*FEE*)

  FEE is proxied as spread between fee based income over total income and fee based income over assets

- Cost of reserve requirement (*RR*)

  Cash to asset ratio is used as proxy for *RR*

- Management efficiency (*MGT*)

  MGT is proxied as operating costs over gross margin

- Loan to asset ratio (*L/A*)

- Debt to asset ratio (*D/A*)
- Gross domestic product (*GDP*)
- Quarterly inflation rates (*INF*)

  INF is the quarterly growth of consumer price index

3.5. Results

This section compares the estimates from by using model specified previous work and the proposed extension of dealership model. Section 3.5.1 explains the results when model specification borrows from Saunders and Schumacher (2000). The model specification does not change model structure in Ho and Saunders (1981). Results using model specified in Maudos and Solis (2009) are also presented. This model adds variables to model in Maudos and Guevara (2004). Section 3.5.2 summarizes results from extended dealership model that is proposed in this study. Model performance when accounting margin is used is compared to that of contractual margin.

3.5.1 The Ho-Saunders and Maudos-Guevara model: The seminal model

This section describes results using variables introduced in Saunders and Schumacher (2000) which is defined from model of Ho and Saunders (1981). Following Saunders and Schumacher (2000), market power is estimated using cross section data, by regressing implicit interest rates, opportunity cost of reserve requirement and capital on net interest margin or pure spread (*PS*). The second step is regressing market power (*MP*), market risk (*MR*), degree of risk aversion (*R*) and loan size (*Q*) on pure spread (*PS*). The results of the second step are summarized in table 15.

Table 15 Determinant of net interest margin (Saunders and Schumacher, 2000)

Dependent variable : NIM			
	Coefficient	**s.e.**	**t-stat**
MP	0.0975	0.0421	2.3133
MR	-0.0211	0.0633	-0.3327
R	-0.0027	0.0029	-0.9481
Q	0.0030	0.0013	2.2610
Constant	0.0506	0.0031	16.2146
N.obs		1224	
Breusch Pagan Test		2119.79	
p-value		0	
Hausman test		8.3566	
p-value		0.0794	
Normality of residual		1229.98	
Chi-sq		0	
Null hypothesis			
Breush Pagan test	: zero variance of unit specific error		
Hausman test	: GLS estimates are consistent		
Test for normality of residual	: error is normally distributed		

Net interest margin or pure spread is positively related to market power and loan size. On the other hand, market risk and risk aversion negatively influence net interest margin. Although coefficient of market risk is not statistically significant, negative relationship between market risk and net interest margin does not support the theoretical model. The higher market risk and degree of risk aversion, the higher risk premium to bear the risk. Thus, net interest margin should increase with market risk and degree of risk aversion.

Variables proposed in Maudos and Solis (2009) are used since they attempted to integrate variables in some studies about bank margin. 15 variables were used to explain the dynamics of intermediation margin. They also took into account the impact of margin in the previous period on today’s margin. Table 16 and 17 show results of static model with fixed effects, using variables introduced in Maudos and Solis (2009).

Table 16 Determinants of intermediation margin – Static model 1 (Maudos and Solis, 2009)

Dependent variable : IM	**(1)**			**(2)**		
	Coeff.	**s.e.**	**t-stat**	**Coeff.**	**s.e.**	**t-stat**
MP	0.0001	0.0001	0.9651	0.0001	0.0001	0.9651
C	-1.1913	0.0639	-18.6400	-1.1913	0.0639	-18.6400
R	-0.0297	0.0049	-6.0310	-0.0297	0.0049	-6.0310
MR	0.1203	0.1760	0.6835	0.1203	0.1760	0.6835
CR	0.0097	0.0123	0.7915	0.0097	0.0123	0.7915
Q	0.0011	0.0082	0.1330	0.0011	0.0082	0.1330
IMPLICIT	-0.0094	0.2588	-0.0362			
RR	1.3642	0.4319	3.1580	1.3642	0.4319	3.1580
MGT	-0.0297	0.0226	-1.3130	-0.0297	0.0226	-1.3130
NII				0.0094	0.2588	0.0362
const	-0.0423	0.1285	-0.3292	-0.0423	0.1285	-0.3292
N.obs		1224			1224	
Diff. group intercept		18.0348			18.0348	
p-value		0.0000			0.0000	
Dist. Wald test		386545			386545	
p-value		0.0000			0.0000	
Normality of residual		3441.54			3441.54	
p-value		0.0000			0.0000	

Null hypothesis

Test for differing group intercepts	: the groups have a common intercept
Distribution free Wald test	: the units have a common error variance
Test for normality of residual	: error is normally distributed

Column 1 shows results when net income from fee based activities (*NII*) are considered in the model, but implicit interest rate (*IMPLICIT*) are not taken into account. Column 2 summarizes results by taking into account cost implicit interest rate but not net income from fee based activities. In all cases, only operating cost (*C*), degree of risk aversion (*R*) and cost of reserve requirement (*RR*) are significant in explaining variability in the intermediation margin. Other variables in the theoretical model (i.e. market power, risk exposure, loan size) are not statically significant. The margin increases with market power (*MP*), market risk exposure (*MR*), credit risk exposure (*CR*) and loan size (*Q*). Cost reserve requirement (*RR*) increases cost of fund which intuitively puts pressure on the margin. Thus, the sign of *RR* is expected to be negative. The results however show that the sign is positive but statistically insignificant. As expected, the margin decreases with operating cost, degree of risk aversion, implicit interest rate, and management inefficiency.

Table 17 summarizes results when empirical model is extended to solvency and macroeconomic measures. Column 1 shows results incorporating solvency measures i.e. loan to asset ratio (*L/A*) and deposit to asset ratio (*D/A*). Column 2 shows results taking into account macroeconomic measures i.e. gross domestic product (*GDP*) and changes of consumer price index (*INF*) as well as solvency measures. The interaction between variables changes when the empirical model is extended to solvency and macroeconomic measures. Market power, degree of risk aversion, cost of reserve requirement and solvency (*D/A*) are significant in explaining variability in the margin. Operating cost, risk exposure and loan size, which are variables specified in the theoretical model, do not count much in explaining the dynamics of the margin.

Table 17. Determinants of intermediation margin – Static model 2
(Maudos and Solis, 2009)

Dependent variable : IM	(1)			(2)		
	Coeff.	**s.e.**	**t-stat**	**Coeff.**	**s.e.**	**t-stat**
MP	0.0002	0.0001	2.1610	0.0003	0.0001	3.7000
C	-0.2235	0.2216	-1.0080	-0.3119	0.2446	-1.2750
R	-0.0707	0.0103	-6.8770	-0.0684	0.0107	-6.4130
MR	0.0616	0.1293	0.4764	0.1566	0.1159	1.3510
CR	0.0099	0.0067	1.4860	0.0115	0.0060	1.9270
Q	0.0052	0.0049	1.0580	0.0030	0.0064	0.4696
IMPLICIT	-0.0659	0.4142	-0.1591			
RR	2.4553	0.6544	3.7520	2.4849	0.6567	3.7840
MGT	-0.0187	0.0126	-1.4840	-0.0178	0.0122	-1.4570
NII				0.1399	0.4236	0.3303
L/A	0.0001	0.0134	0.0064	0.0029	0.0140	0.2068
D/A	0.0543	0.0148	3.6650	0.0486	0.0164	2.9720
GDP				-0.0002	0.0001	-2.3000
INF				0.0001	0.0001	1.6680
const	0.0491	0.0768	0.6388	-0.0540	0.0943	-0.5732
N.obs		1224			1224	
Diff. group intercept		21.9152			22.4581	
p-value		0.0000			0.0000	
Dist. Wald test		42700.9			54260.1	
p-value		0.0000			0.0000	
Normality of residual		7508.22			8265.24	
p-value		0.0000			0.0000	

Null hypothesis
Test for differing group : the groups have a common intercept
Distribution free Wald te : the units have a common error variance
Test for normality of re : error is normally distributed

Similar to the simple model, cost of reserve requirement is positively related to the margin. The margin expectedly increases with market power, credit and market risk exposure, loan size and solvency (*L/A*). The margin decreases with operating cost, implicit interest rate and management inefficiency. What has been puzzling is the negative sign of degree of risk aversion and positive sign of *D/A*. Theoretically, the more risk averse a bank, the higher risk premium it charges to bear the risk. The higher risk premium is translated into higher margin. High deposit to asset ratio (*D/A*) represents high leverage. Banks with high leverage have high cost of financial distress, increasing cost to raise fund. Thus, *D/A* theoretically dampens the margin.

Extending the empirical model to macroeconomic model changes the interaction between margin and credit risk exposure. Credit risk exposure along with market power, degree of risk aversion, cost of reserve requirement, solvency (*D/A*), gross domestic product and inflation (*INF*) are significant in explaining the margin. The margin increases with inflation as nominal interest rates increases with inflation. Interestingly, the margin decreases with gross domestic product. An increase in domestic product is supposed to be transmitted into an increase in loan size to support the expanding economic activity. Thus, the margin is expected to increases with loan size as well gross domestic product.

Apparently, margin in the previous quarter is not statistically significant in explaining the variability of the margin. The results for dynamic model for Eq.(3.3.3.1.6) and Eq.(3.3.3.1.7) are summarized in table 18.

Table 18 Determinants of intermediation margin – Dynamic model 1 (Maudos and Solis, 2009)

Dependent variable : IM			
	Coeff.	**s.e.**	**t-stat**
IM(-1)	-0.0216	0.0202	-1.0680
MP	0.0105	0.0003	6.2400
C	-1.5596	0.2662	-5.8580
R	0.0258	0.0144	1.7870
MR	-2.1060	2.3069	-0.9129
CR	-0.1926	0.2611	-0.7376
Q	0.0027	0.0038	0.7113
RR	-0.0713	1.0750	-0.0663
MGT	-0.0060	0.0456	-0.1324
NII	1.0370	0.7672	1.3520
const	0.0430	0.0498	0.8629
N.obs		1224	
Test for AR(1) errors		-0.9570	
p-value		0.3386	
Test for AR(2) errors		-1.04557	
p-value		0.2958	
Sargan over-identification		49.8309	
p-value		1.0000	
Wald (joint) test		188337	
p-value		0.0000	

Sign of some variables are difficult to be interpreted. For instance, the signs for risk exposure and loan size are negative when the margin theoretically increases with risk premium to bear risk and economies of scale. The margin also unexpectedly increases with management inefficiency. The more inefficient management operates, the higher is the cost to run a bank; hence the margin is expectedly lower. The longer equation Eq.(3.3.3.1.8) and (3.3.3.1.9) do not improve the results as shown in table 19.

Table 19 Determinants of intermediation margin – Dynamic model 2 (Maudos and Solis, 2009)

Dependent variable : IM	(1)			(2)		
	Coeff.	s.e.	t-stat	Coeff.	s.e.	t-stat
IM(-1)	-0.0216	0.0205	-1.0550	-0.0245	0.0220	-1.1140
MP	0.0102	0.0003	1.9000	0.0103	0.0002	5.2400
C	-1.3571	1.0567	-1.2840	-0.5514	0.3682	-1.4980
R	-0.0419	0.0140	-2.9890	-0.0510	0.0081	-6.3220
MR	-2.0184	2.2425	-0.9001	0.4483	0.4853	0.9237
CR	-0.1969	0.2220	-0.8871	-0.0012	0.0677	-0.0180
Q	0.0041	0.0044	0.9149	0.0063	0.0057	1.1030
IMPLICIT	-1.1888	0.7693	-1.5450			
RR	0.8186	1.7991	0.4550	-0.6072	0.8494	-0.7148
MGT	-0.0171	0.0220	-0.7757	-0.0008	0.0139	-0.0540
NII				0.3443	0.2704	1.2730
L/A	0.0119	0.0442	0.2698	-0.0263	0.0262	-1.0050
D/A	0.0041	0.0786	0.0525	0.0649	0.0334	1.9440
GDP				0.0009	0.0009	0.9552
INF				-0.0005	0.0004	-1.3920
const	0.0472	0.0902	0.5229	-0.0824	0.1255	-0.6561
N.obs		1224			1224	
Test for AR(1) errors		-1.2936			-1.4131	
p-value		0.1958			0.1576	
Test for AR(2) errors		-1.002			-1.0339	
p-value		0.3164			0.3012	
Sargan over-identification		171.391			152.122	
p-value		0.0000			0.0005	
Wald (joint) test		229704			181131	
p-value		0.0000			0.0000	

Similar to the results from simple model Eq.(3.3.3.1.6) and (3.3.3.1.7), margin in the previous quarter is not statistically significant in explaining the margin. Only market power, degree of risk aversion and solvency (*D/A*) significantly influence the margin. The negative signs of risk exposure, degree of risk aversion and loan size are also difficult to explain. The sign of variable management inefficiency (*MGT*) and deposit to asset (*D/A*) implies that both variables theoretically hamper the margin.

3.5.1. The Extended Models

3.5.1.1.Contractual margin

The equation of contractual intermediation margin from Eq.(3.3.3.1.10) to Eq.(3.3.3.1.12) is estimated with random effects. Breusch-Pagan test shows that null hypothesis of zero variance of the unit specific error is rejected in all cases.

Simultaneously, Hausman test rejects null hypothesis of consistent GLS estimates. Thus, fixed effect model estimators are consistent and efficient. Table 21 summarizes the determinants of contractual intermediation margin. Column (1) corresponds to the results of regression on pure margin (*PURE*) whilst column (2) and (3) correspond to regression on net interest margin (*NIM*) and gross margin (*GM*). Variable *size* in the first column represents size of new loans. In the second and third column however, *size* is volume of new maturity assets and volume of new earning assets respectively.

Table 20 Determinants of contractual intermediation margin
(regression with fixed effects and heteroskedasticity robust variance matrix)

	Explanatory variables								
	PURE			NIM			GM		
IMPLICIT	-0.1091	[0.1332]		-0.1657	[0.1596]		-4.7357	[0.5650]	***
CASH	-0.2119	[0.2021]		-0.2737	[0.2211]		-2.6260	[0.7443]	***
CAPITAL	0.0000	[0.0000]		0.0000	[0.0000]		0.0000	[0.0000]	
COST	-0.0311	[0.0133]	**	-0.0067	[0.0039]	**	-1.0122	[0.1336]	***
LPS	-0.0864	[0.0507]	*	-0.2198	[0.0743]	***	-0.0001	[0.1662]	
PM	0.0160	[0.0086]	*	0.0006	[0.0017]		0.0093	[0.0237]	
MR	0.1778	[0.0366]	***	0.3124	[0.1124]	***	0.1054	[0.2539]	
CRL,CRI,CRE	0.0890	[0.0262]	***	0.0569	[0.0337]	*	0.1760	[0.0555]	***
LOAN,IEA,EA	-0.0057	[0.0012]	***	0.0007	[0.0017]		0.0119	[0.0032]	***
RA	0.0000382	[0.0001]		0.0000456	[0.0000]	*	0.0001	[0.0041]	
MKTPWR	0.0605	[0.0329]		0.0329	[0.0242]		0.0568	[0.0761]	
No. obs		1165			1165			1165	
MSE		0.0004			0.0212			0.0044	
R2		0.7651			0.5311			0.6712	
Hausman test		(0.9876)			(0.9599)			(0.7292)	
Breusch Pagan test		(0.0000)			(0.0000)			(0.0000)	

[ ] : standard error

( ) : p-value

*, **, *** shows level of significance of 10%, 5% and 1%

The results of regression with cluster variance estimation are summarized in table 21.

Table 21 Determinants of contractual intermediation margin
(regression with fixed effects and clustered robust variance matrix)

	Explanatory variables								
	PURE			NIM			GM		
IMPLICIT	-0.1091	[0.1332]		-0.1745	[0.2345]		-4.6605	[0.6240]	***
CASH	-0.3120	[0.1661]		-0.2697	[0.3095]		-2.6278	[0.7395]	***
CAPITAL	0.0000	[0.0000]		0.0000	[0.0000]		0.0000	[0.0000]	
COST	-0.0525	[0.1496]	**	-0.0174	[0.0046]	**	-1.0237	[0.1222]	***
LPS	-0.0513	[0.0516]	*	-0.2664	[0.0817]	***	-0.0002	[0.1869]	
PM	0.0932	[0.0153]	*	0.0008	[0.0054]		0.0095	[0.0507]	
MR	0.0211	[0.0658]	***	0.4710	[0.3752]	***	0.1049	[0.2658]	
CRL,CRI,CRE	0.0598	[0.0126]	***	0.0327	[0.0310]	*	0.1734	[0.0973]	***
LOAN,IEA,EA	-0.0057	[0.0012]	***	0.0003	[0.0015]		0.0117	[0.0273]	***
RA	0.0088000	[0.0062]		0.0015	[0.0028]	*	0.0037	[0.0013]	
MKTPWR	0.0521	[0.0518]		.019241	[0.0836]		0.0523	[0.0963]	
No. obs		1165			1165			1165	
MSE		0.0132			0.0330			0.0341	
R2		0.7651			0.5311			0.6712	
Hausman test		(0.9876)			(0.9599)			(0.7292)	
Breusch Pagan test		(0.0000)			(0.0000)			(0.0000)	

[ ] : standard error
( ) : p-value
*, **, *** shows level of significance of 10%, 5% and 1%

Table 22 and 23 show that results summarized in table 20 and 21 are robust to the inclusion of time dummies.

Table 22 Determinants of contractual intermediation margin with time dummies (regression with fixed effects and heteroskedasticity robust variance matrix)

	Explanatory variables								
	PURE			NIM			GM		
IMPLICIT	-0.1087	[0.1478]		-0.1685	[0.1561]		-4.6604	[0.6453]	***
CASH	-0.2750	[0.1578]		-0.2279	[0.3589]		-2.6510	[0.6800]	***
CAPITAL	0.0000	[0.0000]		0.0000	[0.0000]		0.0000	[0.0000]	
COST	-0.0595	[0.0179]	**	-0.0175	[0.0043]	**	-1.0279	[0.1230]	***
LPS	-0.0519	[0.0253]	*	-0.2306	[0.0849]	***	-0.0002	[0.1624]	
PM	0.0882	[0.0784]	*	0.0008	[0.0054]		0.0092	[0.0481]	
MR	0.0213	[0.0448]	***	0.4710	[0.3752]	***	0.1045	[0.2881]	
CRL,CRI,CRE	0.0595	[0.0128]	***	0.0328	[0.0446]	*	0.1521	[0.0881]	***
LOAN,IEA,EA	-0.0067	[0.0047]	***	0.0006	[0.0031]		0.0139	[0.0278]	***
RA	0.0112	[0.0037]		0.0010	[0.0038]	*	0.0032	[0.0027]	
MKTPWR	0.0513	[0.0449]		0.0167	[0.0822]		0.0521	[0.0624]	
Q1	-0.0014	[0.0025]		-0.0128	[0.0094]		-0.013	[0.0096]	
Q2	-0.0013	[0.0019]		(dropped)			-0.013	[0.0096]	
Q3	0.0001	[0.0013]		-0.0109	[0.0122]		0.003	[0.0148]	
Q4	(dropped)			(dropped)			(dropped)		
const	0.0121	[0.0023]		0.0522	[0.0256]		0.0026	[0.0066]	
No. obs		1165			1165			1165	
MSE		0.0133			0.0330			0.0342	
R2		0.7491			0.5252			0.6611	
Hausman test		(0.9836)			(0.5279)			(0.7292)	
Breusch Pagan test		(0.0000)			(0.0000)			(0.0000)	

[ ] : standard error

( ) : p-value

*, **, *** shows level of significance of 10%, 5% and 1%

Table 23 Determinants of contractual intermediation margin time dummies (regression with fixed effects and clustered robust variance matrix)

	Explanatory variables								
	PURE			NIM			GM		
IMPLICIT	-0.1064	[0.1502]		-0.1649	[0.1586]		-4.5614	[0.6556]	***
CASH	-0.2692	[0.1603]		-0.2231	[0.3646]		-2.5947	[0.6908]	***
CAPITAL	0.0000	[0.0000]		0.0000	[0.0000]		0.0000	[0.0000]	
COST	-0.0582	[0.0182]	**	-0.0171	[0.0044]	**	-1.0060	[0.1250]	***
LPS	-0.0508	[0.0257]	*	-0.2257	[0.0863]	***	-0.0002	[0.1650]	
PM	0.0863	[0.0797]	*	0.0008	[0.0055]		0.0090	[0.0489]	
MR	0.0208	[0.0455]	***	0.4610	[0.3812]	***	0.1023	[0.2927]	
CRL,CRI,CRE	0.0582	[0.0130]	***	0.0321	[0.0453]	*	0.1489	[0.0895]	***
LOAN,IEA,EA	-0.0066	[0.0048]	***	0.0006	[0.0031]		0.0136	[0.0282]	***
RA	0.0110	[0.0038]		0.0010	[0.0039]	*	0.0031	[0.0027]	
MKTPWR	0.0502	[0.0456]		0.0163	[0.0835]		0.0510	[0.0634]	
Q1	-0.0014	[0.0025]		-0.0126	[0.0096]		-0.0129	[0.0097]	
Q2	-0.0013	[0.0019]		(dropped)			-0.0129	[0.0097]	
Q3	0.0001	[0.0014]		-0.0107	[0.0124]		0.0030	[0.0150]	
Q4	(dropped)			(dropped)			(dropped)		
const	0.0118	[0.0023]		0.0511	[0.0260]		0.0025	[0.0067]	
No. obs		1165			1165			1165	
MSE		0.0133			0.0335			0.0347	
R2		0.7491			0.5252			0.6611	
Hausman test		(0.9836)			(0.5279)			(0.7292)	
Breusch Pagan test		(0.0000)			(0.0000)			(0.0000)	

[ ] : standard error

( ) : p-value

*, **, *** shows level of significance of 10%, 5% and 1%

In all cases, all variables have the same sign as predicted in the theoretical model Eq.(3.3.1.1.38). Intermediation margin decreases with opportunity cost of reserve requirement and deposit insurance premium (*IMPLICIT*), opportunity cost of cash reserves (*COST*), and lower bound of deposit price under deposit insurance scheme (*LPS*). Recalling that *COST* is operating cost over total assets, the variable also implies operating efficiency of a bank. Thus, the higher *COST* the less efficient the operation, squeezing bank's intermediation margin. Expectedly, market power is not statistically significant in explaining dynamics of net interest margin and gross margin since banks could not individually influence yield of fixed income securities and money market fund as well as value of financial derivatives. In pure margin case, large size of new loan push down transaction costs per unit and loan prices, which is translated into low pure margin. Banks having higher credit exposure (*CRL, CRE, CRI*) and interest rate risk exposure (*MR*) appear to have higher intermediation margin, to compensate them bearing the risks. Higher degree of risk aversion (*RA*) also corresponds to higher intermediation margin. The more risk averse are banks, the higher risk premium they call by increasing intermediation margin.

Since some banks uses margin in previous quarter as proxy of expected profit margin, table 24 summarizes estimation of dynamic model for Eq.(3.3.3.2.1) to Eq.(3.3.3.2.3).

Table 24 Determinants of contractual intermediation margin
(system model with collapsed instrument set)

No. of instruments: 27 (PURE), 26 (NIM), 27 (GM)

	Explanatory variables								
	PURE			NIM			GM		
MARGIN(-1)	0.6229	[0.0127]	***	-0.0421	[0.0022]	***	-4.7357	[0.5650]	***
IMPLICIT	-0.2435	[0.0833]	**	-0.2767	[0.0928]	***	-2.6260	[0.7443]	***
CASH	-0.3071	[0.1226]	**	-2.3274	[0.2511]	***	0.0000	[0.0000]	
CAPITAL	0.0000	[0.0000]		0.0000	[0.0000]	***	1.0122	[0.1336]	***
COST	-0.0057	[0.0023]	**	-0.0293	[0.0051]	***	-0.0001	[0.1662]	
LPS	-0.0258	[0.0185]		-0.2457	[0.0195]	***	-0.0093	[0.0237]	
MR	0.1488	[0.0074]	***	0.1485	[0.0106]	***	0.1054	[0.2539]	
CRL,CRI,CRE	0.0607	[0.0126]	***	0.3649	[0.0253]	***	0.1760	[0.0555]	***
size(LOAN,IEA,EA)	-0.0028	[0.0006]	***	0.0133	[0.0015]	***	0.0119	[0.0032]	***
RA	0.0002	[0.0000]	***	0.0011	[0.0002]	***	0.0001	[0.0003]	
MKTPWR	0.0319	[0.0228]		0.1981	[0.0267]	***	0.0568	[0.0761]	
No. obs		1165			1165			1165	
MSE		0.0003			0.0064			0.4532	
Sargan test		(0.6988)			(0.7062)			(0.6446)	
AR(-1) test		(0.0094)			(0.0237)			(0.1876)	
AR(-2) test		(0.7894)			(0.1366)			(0.7780)	

[ ] : standard error
( ) : p-value
*, **, *** show level of significance of 10%, 5% and 1%
MSE: mean squared of error

The sign of explanatory variables do not change except for opportunity cost of cash reserve. Margin is negatively related to opportunity cost of capital when margin in the previous quarter is taken into account. Negative sign of autoregressive term of *nim* and *im* as well as positive sign of *size* could be explained as follows. As low net interest margin and gross margin in the previous quarter will drive banks to charge more on their products in order to meet their earnings target. Thus, the larger size of new transaction, the higher revenues are (which is translated into higher margin).

The results summarized in table 25 are robust when time variables are taken into account as depicted in table 25.

Table 25 Determinants of contractual intermediation margin with time dummies (system model with collapsed instrument set)

No. of instruments: 27 (PURE), 26 (NIM), 27 (GM)

	Explanatory variables								
	PURE			NIM			GM		
MARGIN(-1)	0.6152	[0.0125]	***	-0.0415	[0.0022]	***	-4.6769	[0.5580]	***
IMPLICIT	-0.2405	[0.0823]	**	-0.2733	[0.0917]	***	-2.5935	[0.7351]	***
CASH	-0.3033	[0.1210]	**	-2.2986	[0.2480]	***	0.0000	[0.0000]	
CAPITAL	0.0000	[0.0000]		0.0000	[0.0000]	***	0.9997	[0.1320]	***
COST	-0.0056	[0.0022]	**	-0.0289	[0.0051]	***	-0.0001	[0.1641]	
LPS	-0.0255	[0.0183]		-0.2427	[0.0192]	***	-0.0091	[0.0234]	
MR	0.1469	[0.0073]	***	0.1466	[0.0105]	***	0.1041	[0.2507]	
CRL,CRI,CRE	0.0600	[0.0124]	***	0.3603	[0.0250]	***	0.1738	[0.0548]	***
LOAN,IEA,EA	-0.0028	[0.0006]	***	0.0132	[0.0015]	***	0.0117	[0.0031]	***
RA	0.0002	[0.0000]	***	0.0011	[0.0002]	***	0.0001	[0.0003]	
MKTPWR	0.0315	[0.0225]		0.1956	[0.0263]	***	0.0561	[0.0751]	
Q2	0.0031	[0.0033]		0.0906	[0.0021]		0.0017	[0.0014]	
Q3	0.0060	[0.0080]		dropped			0.0033	[0.0028]	
Q4	0.0107	[0.0117]		0.0041	[0.0630]		0.0041	[0.0034]	
No. of obs.	1165			1165			1165		
S.E. of regression	0.0003			0.0064			0.0548		
Test of AR(1) errors	(0.0050)			(0.5250)			(0.6350)		
Test for AR(2) errors	(0.0970)			(0.4820)			(0.4710)		
Sargan test of overidentification	(0.0890)			(0.3030)			(0.3480)		
Hansen test of overidentification	(0.2185)			(0.1970)			(0.1862)		
Normality of residual	(0.0000)			(0.0000)			(0.0000)		

3.5.1.2.Accounting margin

The determinants of accounting margin are estimated with fixed effect since Breusch-Pagan test and Hausman tests show that estimators are preferred to GLS estimators. The results of regression for *pure, nim* and *im* are summarized in table 26.

Table 26 Determinants of accounting intermediation margin
(static model)

	Explanatory variables		
	Pure	NIM	GM
implicit_rates	3.9444 [0.0141] ***	-0.4760 [0.3539]	2.7751 [0.0000] ***
mr	-0.5958 [0.0060]	0.1844 [0.1364]	0.3692 [0.0043]
cr	0.2415 [0.0034] ***	-0.1762 [0.0466] ***	0.0113 [0.0020] *
cost	-0.3978 [0.0289] ***	0.2531 [0.0533] ***	0.4913 [0.0024] ***
cost_capital	0.0001 [0.0003]	0.0000 [0.0000]	0.0000 [0.0050]
cost_cash	-1.1702 [0.5404]	-0.2376 [0.4110]	0.0924 [0.0000] ***
lps	0.2321 [0.3834]	0.0284 [0.0938]	0.0794 [0.0058]
epm	0.0607 [0.0576]	0.0572 [0.0254] **	-0.3788 [0.0010] ***
size	-0.1043 [0.0140] ***	-0.0186 [0.0028] ***	0.0032 [0.0010] *
R	-0.0005 [0.0009]	0.0000 [0.0001] ***	0.0655 [0.0000] ***
mkt_pwr	0.0125 [0.1320]	0.1611 [0.0543]	0.1728 [0.0039]
No. obs	1165	1165	1165
MSE	0.0114	0.0115	1.2167
Hausman test	(0.0000)	(0.0000)	(0.0000)
Breusch Pagan test	(0.0000)	(0.0000)	(0.0000)

[ ] : standard error
( ): p-value
*, **, *** shows 10%, 5% and 1% level of significance
MSE: mean squared of error

The results show that accounting intermediation margin is significantly determined by credit risk premium, operating cost and size of new transaction. Implicit interest rates are statistically significant in explaining dynamics of pure margin and gross margin but statistically insignificant in explain net interest margin. Implicit interest rates are positively related to pure margin and gross margin. It implies that implicit interest rates are passed on prices of all bank products. If this is true, implicit interest rates should also be positive related to net interest margin. The negative sign of *cr* in net margin case is also puzzling. Intuitively, banks ask for high risk premium to invest in risky assets. Thus, the higher credit riskiness of assets, the higher yields should be demanded on the assets, which is translated into high interest margin. This indicates that loss provision does not correspond to interest income and expenses in the same quarter. Interest income recognition might occur long after loss provision recognition due to grace period in loan disbursement and so on. The dynamic model also performs as summarized in table 27.

Table 27 Determinants of accounting intermediation margin (dynamic model)

	Explanatory variables								
	Pure			NIM			GM		
margin(-1)	-0.1563	[0.0000]	***	-0.0959	[0.0089]	***	0.0020	[0.0035]	***
implicit_rates	2.5720	[0.0585]		0.2423	[0.3496]		0.3612	[0.5077]	***
mr	-24.7479	[0.0212]	***	-0.1855	[0.0774]		0.4268	[0.0728]	***
cr	-78.0666	[0.0141]	***	0.0612	[0.2099]	**	-0.0081	[0.2817]	***
cost	13.6311	[0.0172]	***	2.8812	[0.0692]	***	1.9723	[0.0570]	***
cost_capital	0.0001	[0.0000]	***	0.0000	[0.0000]	**	0.0000	[0.0000]	***
cost_cash	-3.9813	[0.0686]	***	-2.7957	[0.5530]	***	-3.0707	[0.4750]	***
lps	-8.5209	[0.0326]	**	0.3897	[0.0560]	***	0.5332	[0.0511]	***
size	-5.8936	[0.0123]	***	-0.0236	[0.0059]	***	0.0073	[0.0051]	***
R	-0.0770	[0.0231]	***	-0.0004	[0.0001]	***	0.0683	[0.0002]	***
mkt_pwr	-18.8278	[0.2330]	***	0.2617	[0.1176]	**	-0.0259	[0.1566]	***
No. obs		1165			1165			1165	
MSE		0.7685			1.5057			1.8550	
AR(1) error		(0.1361)			(0.0609)			(0.0000)	
AR(2) error		(0.0331)			(0.3084)			(0.1654)	
Sargan test		(1.0000)			(1.000)			(1.0000)	
Wald (joint) test		(0.0000)			(0.0000)			(0.0000)	

[ ] : standard error

( ): p-value

*, **, *** show 10%, 5

MSE: mean squared of error

Briefly, the static and dynamic models perform better when contractual margin is used as proxy of intermediation margin. When accounting margin is used as proxy of intermediation margin, standard error of some coefficients is higher than in the contractual margin. Similarly, mean squared error is higher in the accounting margin case than contractual margin case. In term of explanatory power, adjusted R square is higher in the contractual margin case than in accounting margin case. Moreover, the sign and significance of variables in the empirical model confirms the model assumption. On the other hand, using accounting intermediation margin gives implausible results. Thus, using contractual intermediation margin is less likely to raise biased estimation problem.

3.6. Conclusion

A number of studies discuss bank margin in term of interest margin as well as gross margin. The intermediation margin comprises incomes and expenses from all business lines of a bank. Thus, the definition of intermediation margin is closer to that of gross margin than interest margin. In this study, theoretical model in Ho and Saunders (1981) is extended by adopting multi-product framework introduced in Allen (1998). The extended model takes into account the impact of non-maturity deposit, marginal rate of substitution between different types of loans as well as non loan products, on intermediation margin. Non-maturity deposit increases intermediation margin when return on invested non-maturity deposit surpasses operating cost and risk premium associated with this deposit. At the same time, diversifying loan as well as earning asset increases the margin when immediacy fee and risk premium is higher than operating cost occurring for each product.

The static and dynamic models are used to examine factors influencing intermediation margin in the extended theoretical model. The static model is estimated with fixed effect and robust error (HAC) as well as clustered robust variance estimation. Contractual intermediation margin over the period of 2005 to 2010 for 51 commercial banks in Indonesia is analyzed. The analysis shows that operating cost of holding cash and degree of risk aversion are statistically significant. Nonetheless, the greatest impact on intermediation margin comes from market power, transaction size, risk exposure, operating cost, opportunity cost of reserve requirement, LPS's rate in the previous quarter, and expected profit margin. The margin increases with market power and transaction size. This implies that banks gain from economies of scale and elasticity of demanded products. The margin is also positively related to credit risk exposure, market risk exposure and degree of risk aversion. Thus, increasing either risk exposure or degree of risk aversion increases risk premium which is translated into higher margin. The margin also increases with opportunity cost of regulatory capital since the cost calls for higher margin to allow banks to meet their expected profit margin. The margin decreases with variables composing cost of fund i.e. operating cost, opportunity cost of reserve requirement as well as cash, and LPS's rate in the previous quarter.

The findings indicate that using accounting intermediation margin changes the interaction between variables. Implicit interest rates are statistically significant in explaining dynamics of pure margin and gross margin but statistically insignificant in explain net interest margin. Moreover, sign of some variables are difficult to explain. For instance, net interest margin decreases with credit risk exposure. Higher risk exposure calls for higher risk premium which should be translated into higher margin.

Examining the impacts of variables introduced in the model of Ho-Saunders (1981), sign of coefficients are different from what had been found in the paper. The margin decreases with market risk exposure and degree of risk aversion, and market power is statistically significant. The results from theoretical model in Valverde and Fernández (2007) also show that margin decreases with degree of risk exposure. However, the margin is positively related to market risk exposure. The sign of variable opportunity cost of reserve requirement changes when more macroeconomic and solvency indicators are taken into account. In contrast to what had been argued in Valverde and Fernández (2007) and Maudos and Solis (2009), margin in the previous quarter is not statistically significant in explaining changes in the margin.

Dynamic model of the extended model shows that margin in the previous quarter is not statistically significant. Using variables introduced in Maudos and Solis (2009) also suggests the insignificant effect of margin in the previous quarter on this quarter's margin. The expected profit margin might be influenced by margin gained in the previous quarter. However, omitting expected profit margin also shows that margin in the previous quarter is not statistically significant. The result from dynamic model is also inconsistent with what has been assumed in the extended model. Only operating cost, opportunity cost of cash and expected margin are statistically significant in determining contractual margin. On the other hand, accounting margin is significantly determined by transaction size, operating cost, opportunity cost of reserve requirement. The results are robust to time variables.

Briefly, the results suggest that using accounting margin as proxy for intermediation margin has potential bias of estimators which was also indicated in Demirgüç-Kunt and Huizinga (1999). Secondly, using marketing instruments to raise non-maturity deposit might cost banks less than raising maturity deposit. Contrary to the hypothesis about the importance of upper bound of deposit prices, fluctuation in SBI yields is statically more important than upper bound of deposit prices in most cases. In other word, policy interest rate, which is transmitted into yields on SBI, is statistically important in determining loan prices. In contrast to findings in Valverde and Fernández (2007) and Maudos and Solis (2009), margin in the previous quarter is not statistically significant in explaining changes in net interest margin but significantly explain pure margin and gross margin.

CHAPTER 4 INTERNALIZATION OF ENVIRONMENTAL EXTERNALITIES AND SOCIAL IMPACT UNDER DEALERSHIP FRAMEWORK

4.1. Introduction

Environmental legislation and regulation on corporate social responsibility enforces firms to take measures to mitigate their environmental and social impact. If firms fail to take preventive measures, they are liable to clean up the environmental and social impact. At the same time, market for environmental externalities[15] such as the EU Emission Trading System (ETS), allows firms to generate additional revenue by trading externalities. Thus, financiers should take into account these aspects in pricing and allocating fund to productive and consumptive investment.

In Indonesia where more than 60% of productive and consumptive investment financed through bank loans, banks have been required to measure and price environmental and social risk of borrowing firms. Ministry of Environment provides environment and social risk rating as main reference. The risk rating tracks how important community development in firms' corporate social responsibility initiatives, and how well firms in reducing, reusing, recycling, and recovering wastes or pollutants. Therefore, risk rating is the basis to set provision that absorbs expected cost to clean up social and environmental damage. The loss provision is transmitted to loan prices of the associated borrowers (Bank Indonesia, 2005). This statutory approach helps banks lacking expertise in or knowledge of assessing environmental and social risk to price both risks. Such references to assess and price risk has been looked-for by banks in Europe, the USA, and Pacific region (Rhee and Lee, 2003; Thomson and Crowton, 2004; Köllner et al, 2004; McKenzie and Wolfe, 2004; Weber et al 2008; Chave, 2010).

[15] Environmental externalities are benefits or costs of production and consumption goods, which are not transmitted into price of goods and services, but externalized to natures or parties uninvolved in production and consumption process (Mishan, 2007).

What has been explained previously indicates that regulation in Indonesia does not comprise risk-return on loans generating tradable externalities. The tradable externalities generate additional revenue to make up environmental and social benefits missing from prices of goods and services. In Indonesia context, the only market available to trade externalities is international Emission Trading System (ETS). ETS such as the EU ETS allows firms in developing and developed countries to sell reduced emission of greenhouse gases (GHG)[16] to firms emitting GHG excessively in developed countries. Many types of emission credits are traded at international and regional ETS. However, Certified Emission Reduction (CER) is the only emission credits tradable by developing countries such as Indonesia.

The internalization of CER is as important as internalization of adverse impact of lending activities to environmental and society. Expected revenue from selling CER is often incorporated in the estimation of borrower's financial capacity to repay loans. However, variation in CER prices and uncertainty about the issuance of CER by Clean Development Mechanism (CDM) registry administrators are risks inherent in the expected revenue from selling CERR. Without taking into account this risk, banks are likely to overestimate financial capacity of borrowing firms. In Indonesia, some banks have taken into account risk-return on selling CER and transmitted it into loan prices through one component in cost of loanable fund i.e. expected profit margin. These banks net expected revenue from selling CER of potential loss from unfavourable CER prices, and mix it with other factors composing expected profit margin. The rest of banks in Indonesia tend to ignore the impact of trading CER due to lack of expertise and knowledge of assessing risk-return on trading CER.

In light of the abovementioned issues, this study aims to two objectives. First, it identifies how risk-return on loans generating CER influences loan prices and wealth maximizing intermediation margin. If CER is significantly important in pricing loans and maximizing banks' wealth, variation in CER prices drives up loan prices and hurts demand on loans. The second objective is to investigate

[16] Intergovernmental Panel on Climate Change (IPCC) classified six GHG emitted from production and consumption process as triggers of climate changes such as overlong draught and extreme winter. GHG emission abatement is argued to be the most important measure to mitigate climate change (IPCC, 2001).

whether mandatory environmental and social risk management enforces banks to internalize both risks. If so, loss provision associated with environmental and social risk of lending activities significantly influence loan prices and banks' wealth maximization. Additionally, the study also provides empirical application of extended partial liability that is introduced in Dionne and Spaeter (2003). The extended partial liability has been has been discussed in many papers but empirical studies supporting the theoretical framework is almost nonexistent (Hiriart and Martimort, 2004; Kambia-Chopin, 2010; Jacob and Spaeter, 2010).

A theoretical construct is proposed to demonstrate the internalization of environmental and social risk of lending activities as well as risk-return on loans generating emission credits. Dealership model modified in chapter 3 is extended to the impact of CER, and environmental and social risk of lending activities. The inclusion of three factors borrows Dionne and Spaeter's (2003) idea about extended partial liability. They demonstrated that banks might lose but not more than loan size by lending to firms damaging environment. Thus, borrowers' liability of their environmental impact is essentially extended to banks. Model in this study differs from Dionne and Spaeter's by assuming loan prices and supply are dependent of risk return on fund supplied to banks, and cost of regulation such as opportunity cost of regulatory capital.

Obviously, the contribution of the study takes two folds. First, it provides empirical evidence about extended partial liability that has been almost nonexistent in the economic literatures. Second, it extends dealership model from 'traditional' risk management to environmental and social risk of lending activities, and impact of emission credits. The inclusion of the three factors becomes important since banks globally have been urged to manage and mitigate the factors.

The modified dealership model is tested on 1,165 quarterly unbalanced observations of 51 banks in Indonesia from March 2005 to December 2010. Techniques to correct clustering, heteroskedasticity and autocorrelation in standard error are employed. The results confirm theoretical construct representing the internalization, and robust to time variables and measures of interest rate risks and implicit interest rates. Intermediation margin, spread between loan price and deposit price, increases with transaction size, interest rate and credit riskiness, environmental and social risk of lending activities, price volatility of CER, degree of risk aversion, opportunity cost of capital charge, and expected profit margin.

Intermediation margin decreases during the first three quarter, and negatively influenced by The results show that demand on loans generating CER decreases with spread between loan price and borrowing cost from money market, but increases with expected revenue from selling CER and prices of other products. Spread between loan price and deposit price, which is known as intermediation margin, increases with environmental and social risk of lending activities, transaction size, market and credit riskiness of bank's products, degree of risk aversion, opportunity cost of regulatory capital, and expected profit margin. Intermediation margin decreases with operating cost and implicit interest rates. Implicit interest rates are composed of opportunity cost of cash reserves and liquidity reserves requirement, and upper bound of deposit prices under mandatory deposit insurance scheme. Price volatility of CER and market power of banks is positively related to intermediation but statistically insignificant. Small number of banks factoring CER might be the cause.

4.2. Environmental and Social Impact Assessment in Bank's Risk Management

4.2.1. Government policies on extending liability to environmental management and social responsibility to banks

As previously explained, government policies on extending liability to environmental management and social development to banks vary across countries. However, the underlying idea considerably converges to the important role of banks in allocating capital in the economy. Banks' deposit taking activities mobilize fund and allocate it through lending activities across sectors. Thus, banks present an opportunity for government intervention to achieve sustainable development[17]. Government intervention to promote sustainable development creates investment opportunities and attempts to shift business as usual activities to environmentally and socially conscious activities. When such intervention takes form of fines, revoking business license, or even criminal charges, it creates risks to lending activities. Therefore, government intervention typically aims to change firm and household attitude by influencing banks' lending activities to be in favor of environmentally and socially conscious projects or firms.

Extending liability to social development to banks is a more recent government policy than extending liability to environmental management. The US has adopted the policy known as Under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) since 1980, which was amended by the Superfund Amendments and Reauthorization Act (SARA) in 1986. Under the CERCLA and SARA Superfund, a potential polluter and any party influencing polluter decision making process might be liable to clean up the contaminated sites. If the responsible party fails to clean the site up, he will be fined. In the case polluter filling for bankruptcy, cleaning-up and compensation cost should be recovered before other financial obligation. Such responsible party is likely to fail to repay bank loans when clean-up and compensate costs exhaust the firm’s cash flow and saleable assets. Banks might be also liable to clean-up and compensation costs if the significantly influence polluters' decision-making process (Pitchford, 1995 and 2001; Boyer and Laffont, 1997; Heyes, 1996; Balkenborg, 2001; Kroszner and Strahan, 2001; Patersen and Raya, 1995). The trust fund is set up to raise and manage fund to clean up a contaminated site when the responsible party could not be found. Most of the fund came from tax on petroleum and chemical industries. The fund exhausted in 2003 suggesting too many contaminated sites were cleaned up by the government (GOA, 2003).

Aside from the US, at least four countries in Europe adopt similar regulatory

[17] Sustainable development is an economic development ensuring at least the same amount of natural and man-made resources as well as capital available for current generation are left fro future generation. The concept is highlighted in the EU 5th Environmental Programme and has become global commitment in COP 15 Copenhagen (the European Community, 1997; The UNFCCC, 1995)

intervention. Those are France, German, Italy, and UK. In developing countries, Asia and Latin America in particular, regulation or laws typically do not extend liability to environmental management to a polluter's partners such as banks. To the author knowledge, Indonesia is the only country in Asia has introduced bank regulation to extend liability to environmental and social risk management to banks for more than ten years (Menlh, 2010). Since July 2007, China has followed the act but focused on environmental risk management (Jin and Mengqi, 2010). Bangladesh will launch bank regulation concerning environmental and social risk management by December 2013 (Bangladesh Bank, 2012). Aside from the three countries, Singapore, Thailand, and Philippines are among Asian countries introducing legislation to encourage either limited liability firms or listed firms to be socially responsible. The legislation is however lack in enforcement due to risk of unleveled playing field in the international markets (SGX, 2012; BoT, 2012, BoP, 2012). The rest of developing countries bend to voluntary participation of banks in social and environmental management since there has been insufficient evidence that lending activities in environmentally high-risk sectors increases potential of bank failures.

The voluntary participation has been initially popular in Europe and the US. In Europe, the voluntary participation is highlighted in the fifth EU Environmental Programme. The program encourages financial institutions to influence and to some extent control management and investment decision of their counterparties to benefit environment. Since then more than 22 European banks attain ISO 14001 for corrective and preventive action against adverse impacts of their operation on environment. The Finance Initiative of United Nation Environment Program (UNEP-FI) draws 54 banks in the EU region to commit on sustainable development. The Equator Principles also get 34 banks together to voluntarily deny loans to projects violating the principles. While the first initiative focuses on environmental risk management, the last two have incorporated social risk management. In Asia and Latin America, ISO 14001 is less popular than UNEP-FI and the Equator Principles. About 52 banks in Asia and Latin America participate in the UNEP-FI while 13 banks in the regions sign the Equator Principles. So far, the ISO 14001 has been awarded to more than 14 banks in Asia and Latin America. Later Eco-Management and Audit Scheme (EMAS) was amended in 2009 to encourage voluntarily audit on the indirect impact of banks' products and services on sustainable development (UNEP, 2012; European Community, 2009).

Rhee and Lee (2003) found evidence that voluntary initiatives make participating banks in Europe more active than others in environmental issues, but do not necessarily change operation or business strategy of participating banks. The same evidence is also found in North America and UK (McKenzie and Karfe, 2009; Koolner et al, 2009; Balkenberg, 2001). Moreover, accessibility and costs to gain reliable and consistent environmental information might vary across banks raising problem of unleveled playing field. Thus, regulatory intervention might be necessary to provide reference for banks to voluntarily change their operation or business strategy (Gouldson and Murphy, 1998). Nonetheless, regulatory intervention needs to be well defined or structured. Otherwise, the intervention is not effectual to curb environment and social problem as in the US CERCLA and SARA. The US CERCLA and SARA do not define whether liability extended fully or partly to banks. Under full information, regulation extending full liability to banks drives borrowing firms to invest sufficiently in prevention measures. In practice, banks often do not have access to full information about prevention level of borrowing firms. Thus, the second best policy is extending partial liability to banks (Boyer and Laffont, 2007). However, when bank loans are spent on productive investment but not on preventive investment, extending partial liability might yield lower level of prevention than not extending liability to banks (Pitchford, 1995). On the other hand, extending partial liability to banks might increase private optimal level of environmental protection if banks do not know how borrowers allocate bank loans to production activities and environmental protection. The liability increases face value of bank loans, implying increasing premium associated with environmental risk, which in turn increases level of environmental protection (Dionne and Spaeter, 2001).

In light of regulatory intervention to extent partial liability to banks, Indonesia might provide good empirical evidence. Since 1998, the country has enforced environmental impact assessment, known as AMDAL, on lending activities in environmentally risky activities. AMDAL (Analisa Mengenai Dampak Lingkungan) is carried out by Ministry of Environment before a project or business activity started up. The bank regulation also requires banks to take into account environmental and social performance of borrowing firms in estimating loss provision. The assessment on environmental and social performance of borrowers should at least refer to PROPER rating (Bank Indonesia, 2005). PROPER (Program Penilaian Kinerja Perusahaan dalam Pengelolaan Lingkungan Hidup) is annual assessment on environmental and social performance of selected firms which is carried out by Ministry of Environment. Aside from the firms selected by Ministry of Environment, other firms might voluntarily apply for PROPER assessment. The methodology used in PROPER has been reference for developing countries such as China, India, Mexico and Philippines. The result of the assessment is freely accessible and comes in five ratings i.e. gold, green, blue, red, and black. Firms are qualified for gold rating when they demonstrate excellent environmental and social performance. Green is attained by firms having excellent environmental performance but their social performance just meets the minimum requirement. Blue are obtained by firms demonstrating minimum required environmental management. Red is for firms performing below environmental standard but in the process to meet minimum requirement for environmental management. Black is given to firms poorly perform in environmental management. PROPER rating should minimize potentially unleveled playing field across banks which comes from varying cost and accessibility to information about environmental and social performance of borrowing firms.

4.2.2. Environmental and social risk management in practice: Indonesia case and international practice

Indonesian banking regulation No.7/2/PBI/2005 clearly requires all banks to integrate assessment on environmental and social risk of borrowers into all phases of credit risk management process. The regulation enforces banks to identify, screen, and investigate environmental and social risk by using AMDAL and PROPER at the least. Controlling and monitoring changes in environmental and social risk are carried along the life of the loans by referring to annual PROPER grade. The PROPER grade should be reflected in the loss severity, which calls for capital buffer to absorb risk. The opportunity cost of capital to absorb the risk is transferred to borrowers in the forms of loan prices and costs. Therefore, the regulation provides reference for banks to price environmental and social risk. This quantitative integration is what has not been found in many banks adopting voluntary initiatives. For instance, Weber et al (2008) found evidence that many European banks tend to integrate environmental risks into some parts of process in credit risk management. The most common practice is rating the environmental risk of borrowers. The rating often does not influence the cost and price of loans (Thomson and Cowton, 2004; Köllner et al, 2004). Consequently, banks often do not anticipate that they might be liable to borrower's environmental and social obligation (Pitchford, 1995, 2001; McKenzie and Wolfe, 2004). Chave (2010) suggests that such risk could be transferred to borrowers by means cost and price of loans. The cost and price of loans could also be structured to mimic changes of borrower's risk profile during the life of the loans. Therefore, a systematic and quantitative integration of environmental and social risk into risk management is an instrument to allow such risk influences all phases of risk management process.

It appears that Indonesian regulation gives a good reference to quantify and integrate environmental and social risk into credit risk management process. Moreover, the country adopts "one obligor" concept that single credit rating is applied to all firms owned by the same ultimate shareholders. If some subsidiaries or branches have different credit ratings, the lowest credit rating will be the single credit ratings for all sister companies as well as parent company. If a bank perceives credit rating of a borrower is lower his rating in other banks, other banks should downgrade that borrower's credit rating. Thus, how much a borrower should pay to a bank is expected to be not much different from what he might pay to other banks. This does not happen in practice. The banking regulation leaves banks to decide themselves on how significant environmental and social performance to be factored into loan prices and costs. Therefore, some borrowing firms with red rating still enjoy market prices of loans. Those firms also pay different loan prices to different banks. In 2012, at least one state owned bank disburses loans to two state owned rated black in 2011. Another drawback is that firms rated gold, green and blue will not be liable to clean up or compensate victim of environmental and social problem. It implies that zero liability will be extended to banks disbursing loans to firms having either minimum required environmental management or superior environmental and social management. This does not give incentives for banks and borrowing firms to be more socially conscious. The scheme also does not encourage banks and borrowing firms to invest in projects or activities producing positive environmental externalities such as energy saving and emission abatement. Above all, some firms are not consistently on the list of PROPER auditees and more than 70% of limited liabilities companies have not been audited under PROPER scheme during period 2005 – 2011 (BPS, 2011). Banks sometime fail to access free information about current state of environmental and social performance of their borrowers. The banks are also reluctant to bear cost to obtain such information. Consequently, many banks understate environmental and social risk factored in loan prices and costs. Nevertheless, assuming there is no collusion between audited firms and auditors, and the audited firms dominate environmentally and socially risky firms operating in the economy, linking PROPER and quality of loan portfolio might show the same result as in Dionne and Spaeter (2003) paper.

4.3. The Theoretical Model: A Dealership Approach

This section discusses methodology, with respect to dealership-model framework. The focus is on three major pieces. They are, demand interrelationships within different types of earning assets and two types of deposits, the impact of environmental and social risk as well as price risk of emission credit on bank's wealth, and dynamics of arrival of new transaction with respect to prices of positive externalities i.e. emission credits. The modified dealership model in Allen (1988) has been extended in chapter 3 to capture the impact of demand elasticity between two types of deposits and among four types of earning assets. The extended model however has not detangled environmental risk and social risk premium from standard credit risk premium concerning credit quality of borrowers; hence, it does not consider that uncertainty about profit or revenue of borrowers might be independent of uncertainty about prices of emission credits as well as cost of environmental and social degradation. The following discussion on the model construction is borrowed heavily from Allen (1988), Valverde and Fernández (2007), and Dionne and Spaeter (2003).

4.3.1. Interrelationships in earning assets and deposits

Using the same setting as dealership model modified by Valverde and Fernández (2007) and Allen (1988), banks are assumed risk averse. Banks are also assumed to maximize their utility of wealth by acting as "dealers" in money market. Specifically, banks borrow from or invest in money market when the arrival of demand on earning assets does not match the arrival of deposits. As such, initial wealth of banks (W_0) is composed of their net position in money market (M_0) and net credit inventory (I_0) defined as earning assets net of deposits. Thus, banks expose to uncertainty about interest rate in money market and return of earning assets. To compensate interest rate risk $(\tilde{Z}_M)$, banks ask for immediacy fees i.e. spread between interest rates paid or earned in money market and prices of bank products. Immediacy fees might also allow banks to influence arrival of new transaction. For instance, increasing immediacy fees could dampen demand on earning assets and supply of deposit. Immediacy fees for earning assets and maturity deposits are defined in Valverde and Fernández (2007) and Allen (1988) as follows

$$b_{cons} = r_{cons} - r \quad (4.3.1.1)$$

$$b_{fi} = r_{fi} - r \quad (4.3.1.2.)$$

$$b_{work} = r_{work} - r \quad (4.3.1.3.)$$

$$b_{inv} = r_{inv} - r \quad (4.3.1.4.)$$

$$a_i = r - r_d \quad (4.3.1.5.)$$

b_{cons}, b_{inv}, b_{work}, b_{fi} and a_i denotes immediacy fees of consumer loans, investment loans, working-capital loans, non-loan earning assets and maturity deposit respectively. r, r_d, r_{fi}, r_{cons}, r_{inv}, and r_{work} denotes interest rate in money market, maturity deposit, non-loan earning assets, consumer loans, investment loans, and working-capital loans. The immediacy fee of non-maturity deposit has not been elaborate so far in many variations of dealership models. Non-maturity deposits typically pay zero interest; hence, banks do not bear risk that interest rate paid to depositors is higher than interest rate earned in money market. In other world, immediacy fee of non-maturity deposits $a_n = 0$.

4.3.2. The implication of extended partial liability to social and environmental risk management on wealth of banks

The notion about uncertainty of return of earning assets (i.e. credit risk) arises from the assumption that operating cash flow or revenue of borrowers and other bank's counterparties determines their financial capacity to payback. Regulatory extension of partial liability to environmental and social impact in Indonesia makes funds available to repay loans spent first and up most on cleaning up environmental and social degradation. In other word, environmental and social risk influences bank's wealth but could be mitigated by investing in prevention measures. Resorting to model framework of extended partial liability in Dionne and Spaeter (2003), credit risk $(\tilde{Z}_A)$ as well as environmental and social risk $(\tilde{Z}_e)$ are assumed normally distributed and are two independent events. Thus, $\tilde{Z}_e \sim (0, \sigma_e^2)$, $\tilde{Z}_A \sim (0, \sigma_A^2)$ and $\tilde{Z}_M \sim (0, \sigma_M^2)$ with zero covariance between credit risk, and environmental and social risk. On the other hand $Cov(\tilde{z}_I, \tilde{z}_M)$ and $Cov(\tilde{z}_A, \tilde{z}_M)$ are non zero with $A_0 = FI_0 + L_{cons,0} + L_{work,0} + L_{inv,0}$. FI, L_{cons}, L_{work}, L_{inv} respectively denote non-loan earning assets, consumer loans, working-capital loans and investment loans. The non-zero covariance comes from empirical evidence about the relation between interest rate and credit quality of the firms (Jarrow, 1998; Bomfim, 2002; Drehmann et al, 2006).

Aside from the abovementioned risks, banks also bear other types of risks when disbursing investment and working capital loans associated with emission credits. The borrowing firms might generate revenue from trading emission credits, which is rerouted to banks. The expected revenues typically influences loan prices (Labatt and White, 2002; Jeucken, 2002). Nonetheless, some firms fail to generate emission credits or produce fewer credits than expected (UNFCCC, 2012). Thus, uncertainty associated with emission credits $(\tilde{Z}_s)$ also influences terminal wealth with $\tilde{Z}_s \sim (0, \sigma_s^2)$.

When there is no new transaction, terminal wealth of bank in Eq.(4.3.1.16) is influenced by environmental and social risk and uncertainty about prices of externalities in the following way

$$W_T = I_0(1 + r_I + \tilde{Z}_I) + M_0(1 + r + \tilde{Z}_M) + L_0\tilde{Z}_e + S_0\tilde{Z}_s - C(I_0)$$

If $r_W = \frac{r_I I_0 + rM_0}{W_0}$, then terminal wealth (W_T) can be written as follows

$$W_T = W_0(1 + r_W) + I_0\tilde{Z}_I + M_0\tilde{Z}_M + L_0\tilde{Z}_e + S_0\tilde{Z}_s - C(I_0)$$

When new non-maturity deposit (D_n) comes, terminal wealth becomes

$$W_T = W_0(1 + r_W) + rD_n + I_0\tilde{Z}_I + (M_0 + D_n)\tilde{Z}_M + L_0\tilde{Z}_e + S_0\tilde{Z}_s - C(I_0) - C(D_n)$$

Similarly, terminal wealth when new maturity deposit (D_i) comes is expressed as follows

$$W_T = W_0(1 + r_W) + a_iD_i + I_0\tilde{Z}_I + (M_0 + D_i)\tilde{Z}_M + L_0\tilde{Z}_e + S_0\tilde{Z}_s - C(I_0) - C(D_i)$$

It follows terminal wealth associated with new non-loan earning assets (FI) is written as follows

$$W_T = W_0(1 + r_W) + b_{fi}FI + (I_0 + FI)\tilde{Z}_A + (M_0 - FI)\tilde{Z}_M + L_0\tilde{Z}_e + S_0\tilde{Z}_s - C(I_0) - C(FI)$$

Since environmental and social risk of lending activities is extended to banks, environmental and social risk exposure depends on prevention level of new lending. Thus, terminal wealth when new consumer loans (L_{cons}) comes is expressed as follows

$$W_T = W_0(1 + r_W) + b_{cons}L_{cons} + (I_0 + L_{cons})\tilde{Z}_A + (M_0 - L_{cons})\tilde{Z}_M + (L_0 + L_{cons})\tilde{Z}_e + S_0\tilde{Z}_s - C(I_0) - C(L_{cons})$$

This implies that the new consumer loans presumably do not expose banks to the uncertainty about prices of positive externalities. The underlying notion of this assumption is that monetary values of positive environmental externalities might take two forms. First, it might be revenues from emission reduction trading that are generated from CDM project only. Second, the value could be proxy as government subsidy on “green” technology, which is financed by either investment loans or working-capital loans. Therefore, terminal wealth associated with new working-capital loans (L_{work}) and investment loans (L_{inv}) is influenced by uncertainty about value of positive externalities in the following way

$$W_T = W_0(1 + r_W) + b_{work}L_{work} + (I_0 + L_{work})\tilde{Z}_A + (M_0 - L_{work})\tilde{Z}_M + (L_0 + L)\tilde{Z}_e + (S_0 + S_{work})\tilde{Z}_s - C(I_0) - C(L_{work})$$

$$W_T = W_0(1 + r_W) + b_{inv}L_{inv} + (I_0 + L_{inv})\tilde{Z}_A + (M_0 - L_{inv})\tilde{Z}_M + (L_0 + L_{inv})\tilde{Z}_e + (S_0 + S_{inv})\tilde{Z}_s - C(I_0) - C(L_{inv})$$

4.3.3. Dynamics of arrival of new transaction and the impact of emission credits

Revenues generated from selling emission credits reduces immediacy fee of investment and working-capital loans as follows

$$b_{work} = r_{work} - r + s \qquad (4.3.3.1.)$$

$$b_{inv} = r_{inv} - r + s \qquad (4.3.3.2.)$$

where s are sales of emission credits per unit of loans.

In chapter 3, the assumption about the rate arrival of new transaction in the modified dealership model in Allen (1988) and Valverde and Fernández (2007) is explained. Both papers assume that probability of new transaction follows Poisson distribution conditional to immediacy fees. Then Poisson regression

for each types of bank products is expressed in the following way

$$Pr(D_i = d_i) = \frac{e^{-\lambda}\lambda^{d_i}}{d_i!}, \qquad d_i = 0,1,2,\cdots$$

$$\lambda_j(D_i) = e^{\alpha_i - \beta a_i}, \quad j = 1,\cdots,n \qquad (4.3.3.3.)$$

$$\lambda_j(D_n) = e^{\alpha_n + \delta_i r}, \quad j = 1,\cdots,n \qquad (4.3.3.4.)$$

$$\lambda_j(FI) = e^{\alpha_{fi} - \beta b_{fi} + \delta_{inv}(b_{inv} - s) + \delta_{work}(b_{workv} - s) + \delta_{cons} b_{cons}}, \quad j = 1,\cdots,n \qquad (4.3.3.5.)$$

$$\lambda_j(L_{cons}) = e^{\alpha_{fi} - \beta b_{cons} + \delta_{inv}(b_{inv} - s) + \delta_{work}(b_{workv} - s) + \delta_{fi} b_{fi}}, \quad j = 1,\cdots,n \qquad (4.3.3.6.)$$

$$\lambda_j(L_{inv}) = e^{\alpha_{fi} - \beta(b_{inv} - s) + \delta_{work}(b_{workv} - s) + \delta_{cons} b_{cons} + \delta_{fi} b_{fi}}, \quad j = 1,\cdots,n \qquad (4.3.3.7.)$$

$$\lambda_j(L_{work}) = e^{\alpha_{fi} - \beta(b_{workv} - s) + \delta_{inv}(b_{inv} - s) + \delta_{cons} b_{cons} + \delta_{fi} b_{fi}}, \quad j = 1,\cdots,n \qquad (4.3.3.8.)$$

4.3.4. Maximizing expected utility of wealth in the presence of environmental and social externalities

Using Taylor series expansion around $\overline{W} = E[W]$, the expected utility of wealth is written as follows

$EU(W) = U(\overline{W}) + U'(\overline{W})E[W - \overline{W}] + \frac{1}{2}U"(\overline{W})E[W - \overline{W}]^2$

where $E[W] = W_0(1 + r_W) + I_0\tilde{Z}_I + M_0\tilde{Z}_M + L_0\tilde{Z}_e + S_0\tilde{Z}_s - C(I_0)$

with $U' > 0$

$U" < 0$

$W - \overline{W} = I_0\tilde{Z}_I + M_0\tilde{Z}_M + L_0\tilde{Z}_e + S_0\tilde{Z}_s$

The 2nd order of immediacy and operating costs is assumed negligible.

Thus, the expected utility of terminal wealth with zero new transaction can be written as follows

$EU(W) = U(\overline{W}) + \frac{1}{2}\ U"(\overline{W})(I_0^2\sigma_I^2 + M_0^2\sigma_M^2 + L_0^2\sigma_e^2 + S_0^2\sigma_s^2 + 2I_0M_0\sigma_{IM})$ (4.3.4.1.)

where $I_0\tilde{z}_I = L_{inv,0}\tilde{z}_{inv} + L_{work,0}\tilde{z}_{work} + L_{cons,0}\tilde{z}_{cons} + FI_0\tilde{z}_{fi}$

New non-maturity deposit (D_n) changes the expected utility of wealth changes into

$EU(W|D_n) = U(\overline{W}) + U'(\overline{W})[rD_n - C(D_n)] + \frac{1}{2}U"(\overline{W})\{[rD_n - C(D_n)]^2 + I_0^2\sigma_I^2 + (M_0 + D_n)^2\sigma_M^2 + 2I_0(M_0 + D_n)\sigma_{IM} + L_0^2\sigma_e^2 + S_0^2\sigma_s^2\}$ (4.3.4.2.)

New non-maturity deposit (D_n) changes expected utility of wealth by the following terms.

$\Delta EU(W|D_n) = EU(W) - EU(W|D_n) =$Eq. (3.3.4.2) – Eq. (3.3.4.1)

$= U'(\overline{W})[rD_n - C(D_n)] + \frac{1}{2}U"(\overline{W})\{D_n(D_n + 2M_0)\sigma_M^2 + 2I_0D_n\sigma_{IM}\}$ (4.3.4.3.)

Similarly, new maturity deposit (D_i) changes the expected utility of wealth into

$EU(W|D_i) = U(\overline{W}) + U'(\overline{W})[a_iD_i - C(D_i)] + \frac{1}{2}U"(\overline{W})\{[a_iD_i - C(D_i)]^2 + I_0^2\sigma_I^2 + (M_0 + D_i)^2\sigma_M^2 + 2I_0(M_0 + D_i)\sigma_{IM} + L_0^2\sigma_e^2 + S_0^2\sigma_s^2\}$ (4.3.4.4.)

Thus, new maturity deposit (D_i) changes expected utility of wealth by the following terms.

$$\Delta EU(W|D_i) = EU(W) - EU(W|D_i) = \text{Eq. (4.3.4.4)} - \text{Eq. (4.3.4.1)}$$
$$= U'(\bar{W})[a_i D_i - C(D_i)] + \tfrac{1}{2}U''(\bar{W})\{D_i(D_i + 2M_0)\sigma_M^2 + 2I_0 D_i \sigma_{IM}\} \quad (4.3.4.5.)$$

The expected utility of terminal wealth when non-loan earning arrives is

$$EU(W|FI) = U(\bar{W}) + U'(\bar{W})\big[b_{fi}FI - C(FI)\big] + \tfrac{1}{2}U''(\bar{W})\Big\{\big[b_{fi}FI - C(FI)\big]^2 + (I_0 + FI)^2\sigma_I^2 + (M_0 - FI)^2\sigma_M^2 + 2(I_0 + FI)(M_0 - FI)\sigma_{IM} + L_0^2\sigma_e^2 + S_0^2\sigma_s^2\Big\} \quad (4.3.4.6.)$$

Thus, FI changes expected utility of terminal wealth by

$$\Delta EU(W_T|FI) = Eq.(4.3.4.6) - Eq.(4.3.4.1) = U'(\bar{W})\big[b_{fi}FI - C(FI)\big] + \tfrac{1}{2}U''(\bar{W})\{FI(FI + 2I_0)\sigma_A^2 + FI(FI - 2M_0)\sigma_M^2 + 2FI(M_0 - I_0 - FI)\sigma_{IM}\} \quad (4.3.4.7)$$

Similarly, new consumer loans (L_{cons}) changes expected utility of terminal wealth as follows. (Below expresses changes of expected utility of terminal wealth when either new consumer loans (L_{cons}), working-capital loans (L_{work}), or investment loans (L_{inv}) arrives.

$$\Delta EU(W_T|L_{cons}) = U'(\bar{W})[b_{cons}L_{cons} - C(L_{cons})] + \tfrac{1}{2}U''(\bar{W})[L_{cons}(L_{cons} + 2I_0)\sigma_I^2 + L_{cons}(L_{cons} - 2M_0)\sigma_M^2 + 2L_{cons}(M_0 - I_0 - L_{cons})\sigma_{IM} + L_{cons}(L_{cons} + 2L_0)\sigma_e^2\ ] \quad (4.3.4.8)$$

This implies that consumer loan, which is disbursed for purchasing consumption goods is not the source of environmental and social risk as well as and price risk of emission credits. In contrast, the arrival of working capital loans (L_{work}) transforms the expected utility of terminal wealth into

$$EU(W|L_{work}) = U(\bar{W}) + U'(\bar{W})[b_{work}L_{work} - C(L_{work})] + \tfrac{1}{2}U''(\bar{W})\{[b_{work}L_{work} - C(L_{work})]^2 + (I_0 + L_{work})^2\sigma_I^2 + (M_0 - L_{work})^2\sigma_M^2 + 2(I_0 + L_{work})(M_0 - L_{work})\sigma_{IM} + (L_0 + L_{work})^2\sigma_e^2 + (S_0 + S_{work})^2\sigma_s^2\} \quad (4.3.4.9)$$

Thus, changes of expected utility of terminal wealth associated with L_{work} can be expressed as follows

$\Delta EU(W_T|L_{work}) = Eq.(4.3.4.9) - Eq.(4.3.4.1) =$

$U'(\bar{W})[L_{work}(b_{work} - s) - C(L_{work})] + \frac{1}{2}U"(\bar{W})[L_{work}(L_{work} + 2I_0)\sigma_I^2 + L_{work}(L_{work} - 2M_0)\sigma_M^2 + 2L_{work}(M_0 - I_0 - L_{work})\sigma_{IM} + L_{work}(L_{work} + 2L_0)\sigma_e^2 + S_{work}(S_{work} - 2S_0)\sigma_s^2$ (4.3.4.10)

Similarly, environmental, social and price risks are inherent risk of investment loans (L_{inv}). Thus, the impact of L_{inv} on expected utility of terminal wealth mimics that of new working-capital loans. The arrival of L_{inv} changes expected utility of termanl wealth by

$\Delta EU(W_T|L_{inv}) = U'(\bar{W})[L_{inv}(b_{inv} - s) - C(L_{inv})] + \frac{1}{2}U"(\bar{W})\{L_{inv}(L_{inv} + 2I_0)\sigma_I^2 + L_{inv}(L_{inv} - 2M_0)\sigma_M^2 + 2L_{inv}(M_0 - I_0 - L_{inv}v)\sigma_{IM} + L_{inv}(L_{inv} - 2L_0)\sigma_e^2 + S_{inv}(S_{inv} - 2S_0)\sigma_s^2\}$ (4.3.4.11)

The rate of arrival of new transaction is assumed to follow Poisson distribution depending on immediacy fees as expressed in Eq.(4.3.3.3) to Eq.(4.3.3.8). Wealth maximization problem is expressed as follows

$$Max_{a_i, b_{fi}, b_{cons}, b_{work}, b_{inv},} \Delta EU(W_T)$$
$$= \Pr D_i\, \Delta EU(\Delta W_T|D_i) + \Pr D_n\, \Delta EU(W_T|D_n) + \Pr FI\, \Delta EU(W_T|FI) + \Pr L_{cons}\, \Delta EU(W_T|L_{cons}) + \Pr L_{work}\, \Delta EU(W_T|L_{work}) + \Pr L_{inv}\, \Delta EU(W_T|L_{inv})$$
$$= Eq.(4.3.3.3) \times Eq.(4.3.4.3) + Eq.(4.3.3.4) \times Eq.(4.3.4.5) + Eq.(4.3.3.5) \times Eq.(4.3.4.7) + Eq.(4.3.3.6) \times Eq.(4.3.4.8) + Eq.(4.3.3.7) \times Eq.(4.3.4.10) + Eq.(4.3.3.8) \times Eq.(4.3.4.11)$$

$$\frac{\partial \Delta EU(W_T)}{\partial a_i} = (\alpha_i - \beta a_i)\Delta EU(W_T|D_i) + (\alpha_n + \delta_i a_i)\Delta EU(W_T|D_n) = 0$$

If $-\frac{U"(\bar{W})}{U\prime(\bar{W})} = R$ is absolute risk aversion, then

$a_i = \frac{1}{2}\frac{\alpha_i}{\beta} + \frac{1}{2}\frac{C(D_i)}{D_i} + \frac{R}{4}\{(D_i + 2M_0)\sigma_M^2 + 2I_0\sigma_{IM}\} + \frac{1}{2}\frac{\delta_i}{\beta}\Big(\frac{D_n}{D_i}\Big\{r - \frac{C(D_n)}{D_n} -$

$$\frac{R}{2}\Big(\big((D_n + 2M_0)\sigma_M^2 + 2I_0\sigma_{IM}\big)\Big\}\Big) \tag{4.3.4.12}$$

$$\frac{\partial \Delta EU(W_T)}{\partial b_{fi}} = U'(\bar{W})FI \times Eq.\,(3.3.5) - \beta\Delta EU(W_T|FI) + \delta_{fi}\{\Delta EU(W_T|L_{cons}) + \Delta EU(W_T|L_{work}) + \Delta EU(W_T|L_{inv})\} = 0$$

$$b_{fi} = \frac{1}{2}\frac{\alpha_{fi}}{\beta} + \frac{1}{2}\frac{C(FI)}{FI} + \frac{R}{4}\{(FI + 2I_0)\sigma_I^2 + (FI - 2M_0)\sigma_M^2 + 2(M_0 - I_0 - FI)\sigma_{IM}\} + \frac{1}{2}\frac{\delta_{fi}}{\beta}\Big\{(b_{inv} - s)\left(\frac{\delta_{inv}}{\delta_{fi}} + \frac{L_{inv}}{FI}\right) + (b_{work} - s)\left(\frac{\delta_{work}}{\delta_{fi}} + \frac{L_{work}}{FI}\right) + b_{cons}\left(\frac{\delta_{cons}}{\delta_{fi}} + \frac{L_{cons}}{FI}\right) - \frac{C(L_{inv})+C(L_{work})+C(L_{cons})}{FI} - \frac{R}{2FI}\Big(\big(L_{inv}(2L_0 + L_{inv}) + L_{work}(2L_0 + L_{work}) + L_{cons}(2L_0 + L_{cons})\big)\sigma_e^2 + \big(S_{inv}(S_{inv} + 2S_0) + S_{work}(S_{work} + 2S_0)\big)\sigma_S^2 + \big(L_{inv}(L_{inv} + 2I_0) + L_{work}(L_{work} + 2I_0) + L_{cons}(L_{cons} + 2I_0)\big)\sigma_I^2 + \big(L_{inv}(L_{inv} - 2M_0) + L_{work}(L_{work} - 2M_0) + L_{cons}(L_{cons} - 2M_0)\big)\sigma_M^2 + \big(2L_{inv}(M_0 - I_0 - L_{inv}) + 2L_{work}(M_0 - I_0 - L_{work}) + 2L_{cons}(M_0 - I_0 - L_{cons})\big)\sigma_{IM}\Big)\Big\} \tag{4.3.4.13}$$

$$\frac{\partial \Delta EU(W_T)}{\partial b_{cons}} = U'(\bar{W})L_{cons} \times Eq.\,(3.3.6) - \beta\Delta EU(W_T|L_{cons}) + \delta_{cons}\big\{\Delta EU(W_T|L_{inv}) + \Delta EU(W_T|L_{work}) + \Delta EU\big(W_T|L_{fi}\big)\big\} = 0$$

$$b_{cons} = \frac{1}{2}\frac{\alpha_{cons}}{\beta} + \frac{1}{2}\frac{C(L_{cons})}{L_{cons}} + \frac{R}{4}\Big\{(L_{cons} + 2I_0)\sigma_I^2 + (L_{cons} - 2M_0)\sigma_M^2 + 2(M_0 - I_0 - L_{cons})\sigma_{IM} + \frac{L_{cons}(L_{cons}+L_0)}{L_{cons}}\sigma_I^2\Big\} + \frac{1}{2}\frac{\delta_{cons}}{\beta}\Big\{(b_{inv} - s)\left(\frac{\delta_{inv}}{\delta_{cons}} + \frac{L_{inv}}{L_{cons}}\right) + (b_{work} - s)\left(\frac{\delta_{work}}{\delta_{cons}} + \frac{L_{work}}{L_{cons}}\right) + b_{fi}\left(\frac{\delta_{fi}}{\delta_{cons}} + \frac{FI}{L_{cons}}\right) - \frac{C(L_{inv})+C(L_{work})+C(FI)}{L_{cons}} - \frac{R}{2L_{cons}}\Big(\big(L_{inv}(2L_0 + L_{inv}) + L_{work}(2L_0 + L_{work})\big)\sigma_e^2 + \big(S_{inv}(S_{inv} + 2S_0) + S_{work}(S_{work} + 2S_0)\big)\sigma_S^2 + \big(L_{inv}(L_{inv} + 2I_0) + L_{work}(L_{work} + 2I_0) + FI(FI + 2I_0)\big)\sigma_I^2 + \big(L_{inv}(L_{inv} - 2M_0) + L_{work}(L_{work} - 2M_0) + FI(FI - 2M_0)\big)\sigma_M^2 + \big(2L_{inv}(M_0 - I_0 - L_{inv}) + 2L_{work}(M_0 - I_0 - L_{work}) + 2FI(M_0 - I_0 - FI)\big)\sigma_{IM}\Big)\Big\} \tag{4.3.4.14}$$

$$\frac{\partial \Delta EU(W_T)}{\partial b_{work}} = U'(\overline{W})L_{inv} \times Eq.(3.3.6) - \beta \Delta EU(W_T|L_{work}) + \delta_{work}\{\Delta EU(W_T|L_{inv}) + \Delta EU(W_T|L_{cons}) + \Delta EU(W_T|FI)\} = 0$$

$$b_{work} = \frac{1}{2}\frac{\alpha_{work}}{\beta} + \frac{1}{2}\frac{C(L_{work})}{L_{work}} + s + \frac{R}{4}\left\{(L_{work} + 2I_0)\sigma_I^2 + (L_{work} - 2M_0)\sigma_M^2 + 2(M_0 - I_0 - L_{work})\sigma_{IM} + L_{work}(L_{work} + L_0)\sigma_I^2 + \frac{S_{inv}(S_{inv}+2S_0)}{L_{work}}\sigma_S^2\right\} + \frac{1}{2}\frac{\delta_{work}}{\beta}\left\{b_{cons}\left(\frac{\delta_{cons}}{\delta_{work}} + \frac{L_{cons}}{L_{work}}\right) + (b_{inv} - s)\left(\frac{\delta_{inv}}{\delta_{work}} + \frac{L_{inv}}{L_{work}}\right) + b_{fi}\left(\frac{\delta_{fi}}{\delta_{work}} + \frac{FI}{L_{work}}\right) - \frac{C(L_{cons})+C(L_{inv})+C(FI)}{L_{work}} - \frac{R}{2L_{work}}\Big(\big(L_{cons}(2L_0 + L_{cons}) + L_{inv}(2L_0 + L_{inv})\big)\sigma_e^2 + S_{work}(S_{work} + 2S_0)\sigma_s^2 + \big(L_{cons}(L_{cons} + 2I_0) + L_{inv}(L_{inv} + 2I_0) + FI(FI + 2I_0)\big)\sigma_I^2 + \big(L_{cons}(L_{cons} - 2M_0) + L_{inv}(L_{inv} - 2M_0) + FI(FI - 2M_0)\big)\sigma_M^2 + \big(2L_{cons}(M_0 - I_0 - L_{cons}) + 2L_{inv}(M_0 - I_0 - L_{inv}) + 2FI(M_0 - I_0 - FI)\big)\sigma_{IM}\Big)\right\} \tag{4.3.4.15}$$

$$\frac{\partial \Delta EU(W_T)}{\partial b_{inv}} = U'(\overline{W})L_{inv} \times Eq.(3.3.7) - \beta \Delta EU(W_T|L_{inv}) + \delta_{inv}\{\Delta EU(W_T|L_{cons}) + \Delta EU(W_T|L_{work}) + \Delta EU(W_T|FI)\} = 0$$

$$b_{inv} = \frac{1}{2}\frac{\alpha_{inv}}{\beta} + \frac{1}{2}\frac{C(L_{inv})}{L_{inv}} + s + \frac{R}{4}\left\{(L_{inv} + 2I_0)\sigma_I^2 + (L_{inv} - 2M_0)\sigma_M^2 + 2(M_0 - I_0 - L_{inv})\sigma_{IM} + L_{inv}(L_{inv} + L_0)\sigma_I^2 + \frac{S_{inv}(S_{inv}+2S_0)}{L_{inv}}\sigma_S^2\right\} + \frac{1}{2}\frac{\delta_{inv}}{\beta}\left\{b_{cons}\left(\frac{\delta_{cons}}{\delta_{inv}} + \frac{L_{cons}}{L_{inv}}\right) + (b_{work} - s)\left(\frac{\delta_{work}}{\delta_{inv}} + \frac{L_{work}}{L_{inv}}\right) + b_{fi}\left(\frac{\delta_{fi}}{\delta_{inv}} + \frac{FI}{L_{inv}}\right) - \frac{C(L_{cons})+C(L_{work})+C(FI)}{L_{inv}} - \frac{R}{2L_{inv}}\Big(\big(L_{cons}(2L_0 + L_{cons}) + L_{work}(2L_0 + L_{work})\big)\sigma_e^2 + S_{work}(S_{work} + 2S_0)\sigma_s^2 + \big(L_{cons}(L_{cons} + 2I_0) + L_{work}(L_{work} + 2I_0) + FI(FI + 2I_0)\big)\sigma_I^2 + \big(L_{cons}(L_{cons} - 2M_0) + L_{work}(L_{work} - 2M_0) + FI(FI - 2M_0)\big)\sigma_M^2 + \big(2L_{cons}(M_0 - I_0 - L_{cons}) + 2L_{work}(M_0 - I_0 - L_{work}) + 2FI(M_0 - I_0 - FI)\big)\sigma_{IM}\Big)\right\} \tag{4.3.4.16}$$

Intermediation margin = Eq.(4.3.4.12) + Eq.(4.3.4.13) + Eq.(4.3.4.14) + Eq.(4.3.4.15) + Eq.(4.3.4.16)

Assuming that $L_{inv}, L_{work}, L_{cons}$ and FI has the same size A, the same elasticity of demand for L_{inv} and L_{work} (δ_{IW}), investment and working-capital loans in projects generating emission credits will reduce intermediation margin when

$$b_{inv} + b_{work} - 2s > b_{cons}\left(1 + \frac{\delta_{cons}}{\delta_{IW}}\right) + b_{fi}\left(1 + \frac{\delta_{fi}}{\delta_{IW}}\right) + 4\frac{C(L_{cons}) + C(FI)}{A} + \frac{3}{2}\frac{C(L_{inv}) + C(L_{work})}{A} + 2R(\cdot)$$

$R(\cdot)$ is the first term of risk premium in Eq.(4.3.4.13) and Eq.(4.3.4.14), representing risk premium for L_{cons} and FI. Competitive advantage of investment loans lies on whether average operating cost and risk premium of competing assets exceeds immediacy fees on competing earning assets net of per unit profit from selling emission credits.

The inclusion of these indirect risks does not change condition for competitive advantage of non-maturity deposits, which is illustrated in chapter 3 section 3.3.1.

Non-maturity deposits are more lucrative when

$$r > \frac{R}{2}\left((2M_0 + D_n)\sigma_M^2 + 2I_0\sigma_{IM}\right) + \frac{C(D_n)}{D_n}$$

In other word, non-maturity deposits should weight more in deposit portfolio when return in money market exceeds average operating cost, and credit and interest rate risk premium of non-maturity deposits.

4.4. Empirical Model and Data

4.4.1.Empirical model

4.4.1.1. Estimation of intermediation margin

In practice, price risk premium of emission credit is embedded in the expected profit margin while premium for bearing environmental and social risk as well as governance of lending activities embedded in loan loss provision. The methodology to disentangle risk premium from the two variables is explained in section 4.4.2. This section focuses on the methodology to examine the impact of price risk, environmental risk, social risk, and governance of lending activities on intermediation margin. The intermediation margin is premium required by banks to supply loans, invest in other earning assets and receive deposits, which is the summation of Eq.(4.3.4.12) to Eq.(4.3.4.16) in the extension of dealership model in section 4.3.4.

Unbalanced quarterly data of 14 variables on 51 banks in Indonesia from March 2005 to December 2010 are regressed on intermediation margin. The 14 variables are explained in section 4.2. Those variables are market power of banks, operating cost, transaction size, degree of risk aversion, implicit cost of fund, lower bound prices of insured deposits, opportunity cost of cash reserves and regulatory capital, expected profit, banks' degree of risk aversion, and premium for bearing risks (i.e. interest rate risk, credit risk, price risk of emission credits, environmental and social risk as well as governance of lending activities). Linear regression is employed to estimate the impacts of 14 variables on intermediation margin. Instead of assuming whether or not some explanatory variables arising from random causes, the inclusion of fixed effects and random effects is based on specification test of Breusch and Pagan (1978) and Hausman (1978). The specification tests are explained in details in chapter 3.

The general form of regression is written as follows.

$$PURE_{it} = \beta_1 MP_{it} + \beta_2 COST_{it} + \beta_3 RA_{it} + \beta_4 MR_{it} + \beta_5 CRL_{it} + \beta_6 LOAN_{it} + \beta_7 IMPLICIT_{it} + \beta_8 CASH_{it} + \beta_9 CAPITAL_{it} + \beta_{10} PM_{it} + \beta_{11} ESR_{it} + \beta_{12} CER_{it} + \beta_{13} LPS_t + e_{it} \tag{4.4.1.1}$$

$$GM_{it} = \beta_1 MP_{it} + \beta_2 COST_{it} + \beta_3 RA_{it} + \beta_4 MR_{it} + \beta_5 CRE_{it} + \beta_6 EA_{it} + \beta_7 IMPLICIT_{it} \beta_8 CASH_{it} + \beta_9 CAPITAL_{it} + \beta_{10} PM_{it} + \beta_{11} ESR_{it} + \beta_{12} CER_{it} + \beta_{13} LPS_t + e_{it} \tag{4.4.1.2}$$

where e_{it} is i.i.d. Market power (*MP*) is an estimated variable while the rest of variables are observed variables. Details for each variable are discussed in section 4.4.2.

To ensure valid statistical inference when i.i.d. assumption of e_{it} is violated, robust standard error is employed. If error terms e_i are independent but having variance σ_i^2, White's (1980) heteroskedasticity consistent estimator (HC) is employed to correct heteroskedastic in error terms. The White's estimator transforms the following OLS variance-covariance matrix estimator (VCE).

$$\widehat{\Sigma}^{OLS} = (X'X)^{-1}(X'\Sigma X)(X'X)^{-1} ,$$

where $\Sigma = \frac{s^2}{(X'X)}$

$s^2 = \frac{\sum_i \hat{e}_i^2}{n-k}$

k is no. of parameters to be estimated

n is no. of observations

X is matrix of explanatory variables

The White's VCE (HC) is derived as follows.

$$\hat{\Sigma}^{HC} = (X'X)^{-1}X'diag(\hat{e}_1^2, \cdots, \hat{e}_n^2)X(X'X)^{-1}$$

Nonetheless, standard errors are usually underestimated if the error terms for banks within group are not independent. The coefficients of regressors look statistically significant when they are actually not. In this case, White's standard errors are adjusted to possible correlation within a cluster by two-way cluster robust standard errors (2CL). Cameron et al (2009) demonstrated that this technique yields errors that are robust to time-series correlation and cross-sectional correlation.

Below is the general form of regression with two-way cluster.

$$Y_{igh} = \alpha + X'_{igh}\beta + \gamma CL1_{ig} + \delta CL2_{ih} + \varepsilon_{igh}$$

with cluster $g = 1, \cdots, G$

cluster $h = 1, \cdots, H$

$$\hat{\Sigma}^{2CL} = \hat{\Sigma}^{G} + \hat{\Sigma}^{H} + \hat{\Sigma}^{G\cap H}$$

$$= \sum_{i=1}^{N}\sum_{j=1}^{N} X_i X_j' \hat{\varepsilon}_i \hat{\varepsilon}_j \, 1[EV_g] + \sum_{i=1}^{N}\sum_{j=1}^{N} X_i X_j' \hat{\varepsilon}_i \hat{\varepsilon}_j \, 1[EV_h] + \sum_{i=1}^{N}\sum_{j=1}^{N} X_i X_j' \hat{\varepsilon}_i \hat{\varepsilon}_j \, 1[EV_{gh}]$$

where the indicator function $1[EV_g]$ takes value 1 when *i,j* in the cluster g

$1[EV_h]$ takes value 1 when *i,j* in the cluster h

$1[EV_{gh}]$ takes value 1 when *i,j* in both cluster g and h

Aside from 2CL procedure, Driscoll and Kraay's (1998) procedure is considered. They modified standard nonparametric VCE by modifying Newy-West's robust estimator to allow general forms of temporal and cross-sectional dependence. The standard error of coefficients is obtained by taking square roots of the diagonal elements of the following asymptotic VCE.

$$\hat{\Sigma}^{DK} = (X'X)^{-1}\hat{S}_T(X'X)^{-1}$$

In addition, $\hat{S}_T$ is borrowed from New-West (1987) as follows.

$$\hat{S}_T = \hat{\Omega}_0 + \sum_{j=1}^{m(T)} w(j,m)\left(\hat{\Omega}_j + \hat{\Omega}'_j\right)$$

where $m(T)$ is the lag length of autocorrelation in error terms, and $w(j,m)$ is the modified Bartlett weights $w(j,m(T)) = 1 - j/(m(T)+1)$. $\hat{\Omega}_j$ is $(k+1)\times(k+1)$ matrix derived in the following way.

$$\hat{\Omega}_j = \sum_{t=j+1}^{T} h_t(\hat{\beta})h_{t-j}(\hat{\beta})'$$

With $h_t(\hat{\beta}) = \sum_{i=1}^{N(t)} h_{it}(\hat{\beta})$

$$h_{it}(\hat{\beta}) = X_{it}\left(Y_{it} - X'_{it}\hat{\beta}\right)$$

Either HC or 2CL modifies standard error of the estimated parameters but does not affect the point of estimates.

Two-step system GMM with autoregressive term (Blundell and Bond, 1997) is also employed for robustness check although only a few of banks in the sample factoring prices of deposits and earning assets in previous quarter into current prices of deposits and earning assets.

$$PURE_{it} = \alpha + \beta_1 PURE_{it-1} + \beta_2 MP_{it} + \beta_3 COST_{it} + \beta_4 RA_{it} + \beta_5 MR_{it} + \beta_6 CRL_{it} + \beta_7 LOAN_{it} + \beta_8 IMPLICIT_{it} + \beta_9 LPS_{it} + \beta_{10} CASH_{it} + \beta_{11} CAPITAL_{it} + \beta_{12} PM_{it} + \beta_{13} ESR_{it} + \beta_{14} CER_{it} + u_{it}$$

$$GM_{it} = \alpha + \beta_1 GM_{it-1} + \beta_2 MP_{it} + \beta_3 COST_{it} + \beta_4 RA_{it} + \beta_5 MR_{it} + \beta_6 CRE_{it} + \beta_7 EA_{it} + \beta_8 IMPLICIT_{it} + \beta_9 LPS_{it} + \beta_{10} CASH_{it} + \beta_{11} CAPITAL_{it} + \beta_{12} PM_{it} + +\beta_{12} ESR_{it} + \beta_{12} CER_{it} + u_{it}$$

The GMM technique should avoid downwards biased in Arellano and Bond's (1991) differenced-GMM when sample period *T* is considerably small. The system consists of two simultaneous equations. The first equation borrows from difference-GMM i.e. equation in levels with lagged first differenced of instrument variables. The second equation is in first difference with lagged level of instrument variables, adding moment conditions to the difference-GMM. Blundell et al (2000) found that the additional moment conditions could reduce finite sample bias.

In the presence of heteroskedasticity and autocorrelation in error terms, Windmeijer's (2005) finite sample correction is employed. The technique corrects the both problems as well as downward bias of two-step VCE sourced from large number of instrumental variables for Eq.(4.4.1.3) and Eq.(4.4.1.4). The equation in first difference has instrument count $253 = (24 - 1)(24 - 2)/2$) while equation in level add 23 instruments. Below is derivation of corrected VCE.

$$\hat{\Sigma}^{windmeijer} = \hat{\Sigma}^{2SGMM} + \hat{D}\hat{\Sigma}^{2SGMM} + \hat{\Sigma}^{2SGMM}\hat{D}' + \hat{D}\hat{\Sigma}^{1SGMMr}\hat{D}'$$

$\hat{D}$ is $k \times k$ matrix with elements of pth column derived as

$$\hat{D} = -\left(X'Z\left(Z'\hat{\Sigma}^{1SGMM}Z\right)^{-1}Z'X\right)^{-1} X'Z\left(Z'\hat{\Sigma}^{1SGMM}Z\right)^{-1} Z'\frac{\partial\hat{\Sigma}^{GMM}}{\partial\hat{\Sigma}^{GMMp}}\Big|_{\hat{\Sigma}^{GMM}=\hat{\Sigma}^{1SGMM}}$$

$$Z\left(Z'\hat{\Sigma}^{1SGMM}Z\right)^{-1} Z'\hat{E}_2$$

VCE of uncorrected two-step GMM $\hat{\Sigma}^{2SGMM} = \left(X'Z\left(Z'\hat{\Sigma}^{1SGMM}Z\right)^{-1}Z'X\right)^{-1}$.

$\hat{\Sigma}^{1SGMMr}$ is robust VCE of one-step GMM calculated as follows.

$$\hat{\Sigma}^{1SGMMr} = (X'Z(Z'HZ)^{-1}Z'X)^{-1}X'ZZ'HZ^{-1}Z\hat{\Sigma}^{1SGMM}Z(Z'HZ)^{-1}Z'X$$
$$(X'Z(Z'HZ)^{-1}Z'X)^{-1}$$

with $\hat{\Sigma}^{1SGMM} = \hat{E}_1\hat{E}_1{}'$

$$\hat{E}_1 = Y - \hat{\beta}^{1SGMM}$$

$$\hat{\beta}^{1SGMM} = (X'Z(Z'HZ)^{-1}Z'X)^{-1}X'Z(Z'HZ)^{-1}Z'Y$$

Z is $n \times L$ matrix of instrument set

Clearly, weight matrix is replaced by $L \times L$ optimal weight matrix $(\widehat{Z'HZ})^{-1}$, and matrix H follows initial weighting matrix in Arellano and Bond (1991) as follows.

$$H = \begin{pmatrix} 2 & -1 & 0 & \cdots & 0 & 0 & 0 & 0 & 0 & 0 \\ -1 & 2 & -1 & 0 & \cdots & 0 & 0 & 0 & 0 & 0 \\ 0 & -1 & 2 & -1 & 0 & \cdots & 0 & 0 & 0 & 0 \\ \vdots & \vdots & \vdots & & & \vdots & & \vdots & & \vdots \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 2 & -1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 2 \end{pmatrix}$$

Roodman (2009) pointed out that robust system-GMM might correct downward bias in the standard error estimates, but increasing number of instrument set costs Hansen's (1982) overidentification test. The p-value tends to close to one when instrument set is not optimal. The error of adjusted Sargan test introduced in Arellano and Bond (1991) also increases with the number of instrumental variables. To condense the instrument set, the instrument matrix is collapsed such that missing information can be minimized.

Recalling that system-GMM consists of equation in first difference and equation in level, equation in first difference for Eq.(4.4.1.3) has the following 253 instrumental variables.

$$\begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 & \cdots & 0 & 0 & 0 \\ PURE_{i1} & 0 & 0 & 0 & 0 & 0 & \cdots & 0 & 0 & 0 \\ 0 & PURE_{i2} & PURE_{i1} & 0 & 0 & 0 & \cdots & 0 & 0 & 0 \\ 0 & 0 & 0 & PURE_{i3} & PURE_{i2} & PURE_{i1} & \cdots & 0 & 0 & 0 \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \ddots & \vdots & \vdots & \vdots \\ 0 & 0 & 0 & & \cdots & & \cdots & PURE_{i22} & \cdots & PURE_{i1} \end{pmatrix}$$

By collapsing technique (Roodman, 2009), the instrument is condensed into

$$\begin{pmatrix} 0 & 0 & 0 & \cdots & 0 \\ PURE_{i1} & 0 & 0 & \cdots & 0 \\ PURE_{i2} & PURE_{i1} & 0 & \cdots & 0 \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ PURE_{i22} & PURE_{i21} & & \cdots & PURE_{i1} \end{pmatrix}$$

Below is instrument matrix of equation in level for Eq.(4.4.1.3).

$$\begin{pmatrix} 0 & 0 & 0 & \cdots & 0 \\ \Delta PURE_{i2} & 0 & 0 & \cdots & 0 \\ 0 & \Delta PURE_{i3} & 0 & \cdots & 0 \\ 0 & 0 & 0 & \cdots & 0 \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & 0 & \cdots & \Delta PURE_{i24} \end{pmatrix}$$

Borrowing from Roodman (2009), the instrument set is condensed in the following way.

$$\begin{pmatrix} 0 \\ \Delta PURE_{i2} \\ \vdots \\ \Delta PURE_{i24} \end{pmatrix}$$

where $\Delta PURE_{i2}$ is first difference of $PURE$ at time $t-2$.

The same technique is employed to condense instrument set for Eq.(4.4.1.4).

To test whether moment conditions fit the date well, Hansen's J test is used on system GMM with collapsed instrument set and robust VCE. The J test checks the following hypothesis with χ^2 with $j-k$ degree of freedom.

$$\left(\frac{1}{n}Z'\hat{E}_2\right)'(Z'Z)^{-1}Z'\hat{E}_2$$

4.4.1.2. The rate of arrival of new transaction

Utility maximizing intermediation margin, the summation from Eq.(4.3.4.12) to Eq.(4.3.4.15), is influenced by rate of arrival of each bank product. Fundamental dealership model assumes that this rate of arrival follows Poisson distribution depending on immediacy fees. Poisson regression allows statistical theories determine hypothesis test and statistical inference, and the fitting procedure is easy. However, the regression has strong assumption that conditional variance is equal to conditional mean. In most cases, conditional variance exceeds the conditional mean, which is known as overdispersion problem. Consequently, standard errors become downward bias. Therefore, the following test is employed to detect overdispersion.

$$Var(y_i|X_i) = \lambda_i + \alpha g(\lambda_i)$$

α is an unknown parameter and $g(\cdot)$ is a known function, most commonly $g(\lambda) = \lambda^2$ or $g(\lambda) = \lambda$. It is assumed that under null and alternative hypothesis the mean is correctly specified as, for example, $e^{\alpha_i - \beta a_i}$. The overdispersion test can be constructed as a simple test statistic for equidispersion $H_0\colon \alpha = 0$ so that $Var(y_i|X_i) = \lambda_i$ versus $H_1\colon \alpha \neq 0$ or $1\colon \alpha > 0$. The test can be computed by estimating the Poisson model, extracting fitted value $\hat{\lambda}_i$, and running the auxiliary OLS regression without constant. The reported t-statistic for α is asymptotically normal under the null hypothesis of no dispersion. The test can also be used to detect underdispersion i.e. conditional variance is less than conditional mean.

Winkelmann (1995) argues that unobserved heterogeneity might cause overdispersion in the count data. In this case, the rate parameter λ of Poisson process might not be correctly specified. Instead, λ is itself a random variable as assumed in the negative binomial model. In particular, let $\lambda = \mu\nu$, where ν is a deterministic function of X, for example $e^{X_i'\beta}$ and $\nu > 0$ is i.i.d. distributed with density $g(\nu|\alpha)$. Thus, different observations may have different heterogeneity λ but part of this difference is due to a random (unobserved) component ν. The marginal density of y, unconditional on the random parameter ν but conditional on the deterministic parameter μ and α is expressed as follows

$$h(y|\mu,\alpha) = \int f(y|\mu,\nu)g(\nu|\alpha)d\nu$$

where $g(\nu|\alpha)$ is a mixing distribution with α as the unknown parameter in the mixing distribution. The negative binomial density is obtained when $f(y|\lambda)$ is the Poisson density, $g(\nu)$ is the gamma density with $E[\nu] = 1$ and $Var(\nu) = \alpha$. The first two moments of the negative binomial distribution are

$$E[y|\mu,\alpha] = \mu$$

$$Var(y|\mu,\alpha) = \mu(1 + \alpha\mu) \tag{4.3.3.1.}$$

Thus, overdispersion always arises if $f(y|\lambda)$ is Poisson and the mixing distribution is of the form $\lambda = \mu\nu$ where $E[\nu] = 1$. Two standard variants of negative binomial are used in regression application. Both variants specify $\lambda_i = e^{X_i'\beta}$. The difference in the two standard variants is that the first standard variant has α as a parameter to be estimated with conditional variance function, $\mu + \alpha\mu^2$ in Eq.(4.3.3.1.), is quadratic in the mean. This variant is called negative binomial 2 (NB2) model. The second standard variant, known as negative binomial 1 (NB1), has a linear function $Var(y|\mu,\alpha) = (1 + \delta)\mu$, obtained by replacing α with δ/μ through out the following negative binomial density

$$h(y|\mu,\alpha) = \frac{\Gamma(\alpha^{-1} + y)}{\Gamma(\alpha^{-1})\Gamma(y + 1)}\left(\frac{\alpha^{-1}}{\alpha^{-1} + \mu}\right)^{\alpha-1}\left(\frac{\mu}{\mu + \alpha^{-1}}\right)^{y}, \quad \alpha > 0$$

Previously mentioned techniques to correct clustering, heteroskedasticty and autocorrelation in error terms are employed.

4.5. Data

The sample used is formed by unbalanced panel data from 24 quarterly observations, corresponding to 51 commercial banks for the period between 2005 and 2010, which represents an average of 90% of total loans in the Indonesia commercial banking system during the period of study. Sample does not include banks subsidized by government to disburse mortgage loans for the poor. Problem banks are also excluded since bank supervisory authority imposes some restrictions such as curbing loan growth on these banks. The data are obtained from quarterly financial statement of banks except for contractual interest rates and new transaction. Quarterly contractual loan rate and deposit rate as well as new transaction are retrieved from quarterly regulatory report. Volatility of prices of emission credits is estimated under VARMAX framework, which is explained in details in chapter 2 section 2.5. Variables specified in the VARMAX model are explained in chapter 3 from section 2.3.1. to section 2.3.5.

Two proxies for intermediation margin are used as dependent variables. The first proxy, pure margin (*PURE*), is the spread between contractual prices of loans and contractual prices of maturity deposits. The second proxy, gross margin (*GM*) is the contractual prices of all bank products on the asset side, net of contractual prices of all bank products on the liability side. The estimation of theoretical model in section 4.3.1 demonstrates nine variables determining banks' intermediation margin: market power, unit operating cost, degree of risk aversion, volatility of market interest rates, credit risk, covariance between interest rate and credit risk, environmental and social risk, price risk of emission credits, and size of new transactions. These variables are explained in chapter 3 section 3.3.4 and can be summarized as follows

- Market power (*MKTPWR*)

  The Lerner index is widely used as to estimate market power in the specific case of banks (Angelina and Cetorelli, 1999; Fernández and Guevara, 2001; Maudos and Solis, 2009). The index could be estimated for individual banks at each point of time. Lerner index is calculated as spread between product price and marginal cost, divided by product price. The marginal cost is estimated by using model structure in the three-abovementioned papers.

$$\ln TC_{i,t} = \alpha + \alpha_j \sum_{j=1}^{3} w_{i,t}^{j} + \frac{1}{2}\sum_{j=1}^{3}\sum_{k=1}^{3} \alpha_{jk} \ln w_{i,t}^{j} w_{i,t}^{k} + \beta_1 \ln \mathrm{Y}_{\mathrm{i,t}} + \frac{1}{2}\beta_2\left(\ln Y_{i,t}\right)^2$$
$$+ \sum_{j=1}^{3} \beta_{3j} \ln Y_{i,t} \ln w_{i,t}^{j} + \gamma_{1t} T + \frac{1}{2}\gamma_{2t} T^2 + \sum_{j=1}^{3} \gamma_{3t} \ln w_{i,t}^{j}$$
$$+ \gamma_{4t} \ln Y_{i,t} + \mu_i + u_i$$

  where w_1 is labor price, w_2 is price of loanable fund, w_3 is other operating cost, Y is total asset, T is time trend capturing technical progress, and μ captures individual fixed effect.

- Unit operating cost (*COST*)

  Unit operating cost is measured by ratio of annualized total operating costs to average total assets.

- Degree of risk aversion (*RA*)

  Degree of risk aversion is proxied as ratio of average risk weighted asset (RWA) to average total assets. RWA takes value of 0% to 100% of asset size. Details for the calculation of RWA are in the appendix.

- Volatility of market interest rates (*MR*)

  The volatility is proxied as annual standard deviation of monthly real interest rates on one-month treasury bills known as Sertifikat Bank Indonesia (SBI).

- Credit risk (*CRL, CRE*)

  CRL is the ratio of loan loss provision over total loan while *CRE* is calculated as loss provision of earning assets over total earning assets.

- Cross products between credit risk and market risk

  The variable illustrates interdependency between interest rate risk and credit risk.

- Size of new transaction (*LOAN*, *EA*)

  Size of new loans (*LOAN*) is used as proxy for estimating dynamics of pure margin. In the case of gross margin, *EA* represents size of new earning assets.

- Environmental and social risk (*ESR*)

  The risk is calculated as potential extended liability to environmental and social degradation over size of loans. Indonesian bank regulation does not prescribe methodology to quantify the extended liability. Surely, all firms with “black” grade settle costs to clean up environmental and social damage on courts. Some of those firms also end up with closure of their business operation or revoked business license (Menlh, 2010). Model based probability is difficult to estimate since factors determining PROPER grades vary across industry and change over time. Thus, empirical probability, which is the number of firms in each grade over total number of firms, estimates potential extended liability to clean up social and environmental damage.

- Dynamic of prices of emission credits (*CER*)

  The dynamic of prices is estimated using VARMAX (4,0,3) – ARCH(4). The empirical application of this model is explained in chapter 2 section 2.5. All variables specified in the model are explained in chapter 2 from sub section 2.4.1. to sub section 2.4.5.

Aside from variables in the theoretical model, five other variables are included in the empirical model. They are implicit interest rates (*IMPLICIT*), opportunity cost of capital charge (*CAPITAL*), opportunity cost of holding cash (*CASH*), Interest rates published by deposit insurance agency (*LPS*) and expected profit margin (*PM*). The five variables are factored in product prices in some bank respondent in the banking survey. The banking survey has been carried out in April 2011 and explained in details in chapter 3.

- Implicit interest rates (*IMPLICIT*)

  Implicit interest rates are calculated as the summation of insurance premium paid for deposit protection and opportunity cost of minimum reserve requirement, over total deposits. Jakarta Interbank Offered Rate (JIBOR) 1 month is used as proxy for the opportunity cost of minimum requirement.
- Opportunity cost of capital charge (*CAPITAL*)

  Proxy for opportunity cost of capital is the product return on equity (ROE) and ratio of minimum regulatory capital over total equity.
- Opportunity cost of holding cash (*CASH*)

  The opportunity cost of holding cash is the product of cash and return on earning assets
- Interest rates published by deposit insurance agency (*LPS*)

  The interest rate is set as the lower bound of deposit prices under LPS's deposit insurance scheme. Deposits pay interest rate higher than *LPS* are not covered by deposit insurance.
- Expected profit margin (*PM*)

  The expected profit margin is passed on banks' customers. The proxy for *EPM* is Return On total Assets (ROA).

Table 28 summarizes descriptive statistics of pure margin, gross margin, immediacy fees, and return in money market. Table 29 summarize all explanatory variables used in the empirical models

Table 28 Summary statistics on intermediation margin, immediacy fees and market interest rates

	mean	median	max	min	std. dev	skewness	Ex. kurtosis
pure	0.075832	0.071287	0.325928	0.002879	0.039644	2.034688	7.56832
im	0.213706	0.192323	0.952873	0.031583	0.412521	-29.176	944.7851
r	0.088107	0.083433	0.127500	0.062533	0.020063	0.58359	-0.77393
a_i	0.014899	0.022847	0.091998	-0.049302	0.020767	0.54567	0.77268
b_{inv}	0.030575	0.034047	0.272910	-0.084722	0.036165	0.37638	2.3788
b_{work}	0.028586	0.032258	0.151290	-0.065329	0.070800	-0.01278	-0.18856
b_{cons}	0.066793	0.056187	0.371910	-0.088917	0.078751	1.4883	2.9636
b_{fi}	-0.041115	-0.056757	0.730550	-0.125550	0.078751	4.6352	29.239

Table 29 Summary statistics on explanatory variables

	mean	median	max	min	std.dev	skewness	kurtosis
cost	0.046633	0.032346	0.980485	5.08E-05	0.056721	7.21798	101.4956
implicit	0.005637	0.00522	0.077249	0.001065	0.003617	10.41367	181.6905
lps	0.888870	0.083333	0.12775	0.07000	0.018592	0.91879	2.64004
cash	0.007533	0.00664	0.035364	0.00032	0.004434	1.542614	7.119256
capital	8.259842	0.228561	429.6093	0.111162	327.3874	-33.5527	1138.542
cr	0.015857	0.006588	6.125523	0.68521	0.181116	32.89	1111.722
mr	0.015303	0.015364	0.03627	0.000732	0.010444	0.355452	2.00119
env	0.01105	0.00564	0.05956	0.00000	0.01253	0.75252	2.19668
s	0.002591	0.001323	0.013967	0.000000	0.002938	0.176466	0.515121
epm	0.055408	0.0489	2.930509	0.067019	0.088334	29.62052	963.4132
R	1.367378	0.760332	282.1849	0.041426	11.4958	22.48856	525.2123
lerner	0.033031	0.02756	0.533055	0.000134	0.031038	6.722101	88.04013

4.6. Empirical results

4.6.1. Rate arrival of new transaction

The banking survey in April 2011 indicates that banks closely tied by ownership tend to have the same price structure on their products, loans in particular. Thus, the estimation of arrival rate of each product considers correlation within cluster. There are 7 clusters i.e. state owned banks, local banks having international operation, local banks without to international money markets, branches of foreign banks heavily depending on non-loan business activities, branches of foreign banks heavily depending on lending activities, subsidiaries of international banks heavily depending on non-loan business activities, subsidiaries of international banks heavily depending on lending activities, and subsidiaries of non-bank international financial institutions.

In all cases, Poisson regression yields theoretical variance lower than the observed variance. Thus, the rate of arrival of each product is estimated by using negative binomial regression with fixed effect and Cameron and Triverdi's (1985) Pseudo Poisson, with VCE is used to correct clustering and heteroskedasticity in error terms.. Overdispersion test on both models employs Cameron and Triverdi's procedures. Model selection is based on Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC). AIC and BIC indicates that negative binomial with fixed effect is better fit to data than Pseudo Poisson. Table 30 summarizes results of negative binomial and pseudo Poisson regression for arrival rate of maturity deposits.

Table 30 Arrival rate of maturity deposits

Variable	White's robust s.e.			2 way cluster robust s.e.	
	Coeff.	s.e.	z-stat	s.e.	z-stat
a_i	-10.4865	0.2865	-7.7335	0.3724	-5.9500
intercept	16.4554	0.0727	3.9658	0.1343	2.1463
No. Of obs.			1165		1165
Adj. R^2			0.8725		0.8725
AIC of the model			3815.249		419.367
BIC of the model			381.6271		419.5203
AIC of Pseudo Poisson			28900		28900
BIC of Pseudo Poisson			28900		28900
Overdispersion test (p-value) - Ho: mean equals the variance			0.5300		0.5300
Normality of error terms (p-value)			0		0

The sign of estimators is as expected in theoretical model. Immediacy fees of maturity deposits (a_i) are negatively related to arrival rate of maturity deposits. The results are robust to time variables as depicted in table 31. Size of new deposits picks up in the first two quarters but depleting in the third quarter, indicating money demand for transaction around long public holidays in the third quarter.

Table 31 Arrival rate of maturity deposits with time variables

Dependent variable: maturity deposits (D_i)

Variable	White's robust s.e.			2 way cluster robust s.e.	
	Coeff.	s.e.	z-stat	s.e.	z-stat
a_i	-10.3670	0.2576	-6.9523	0.3885	-6.2081
Q1	-0.0189	0.0499	-1.3478	0.0588	-0.9400
Q2	-0.0125	0.0269	-0.7271	0.0411	-0.6569
Q3	-0.0201	0.0274	-0.7401	0.0380	-0.6067
intercept	16.4056	0.0727	1.9624	0.1515	-2.4207
No. Of obs.			1165		1165
Adj. R^2			0.8725		0.8713
AIC of the model			381.5249		419.367
BIC of the model			381.6271		419.5203
AIC of Pseudo Poisson			28900		28900
BIC of Pseudo Poisson			28900		28900
Overdispersion test (p-value) - Ho: mean equals the variance			0.5300		0.5300
Normality of error terms (p-value)			0		0

Table 32 shows that arrival rate of non-maturity deposit increases with immediacy fee of maturity deposits (a_i). This confirms the notion that reducing price of one type deposit increases the arrival of other type deposits.

Table 32 Arrival rate of non-maturity deposits

Dependent variable: maturity deposits (Dn)

Variable	White's robust s.e.			2 way cluster robust s.e.	
	Coeff.	s.e.	z-stat	s.e.	z-stat
a_i	17.3830	0.2992	58.1000	0.3889	6.2138
intercept	3.3943	0.0614	3.35100	0.0135	0.2158
No. Of obs.			1165		1165
Adj. R^2			0.8164		0.8164
AIC of the model			381.4269		419.698
BIC of the model			381.5291		419.8513
AIC of Pseudo Poisson			24600		28900
BIC of Pseudo Poisson			24600		28900
Overdispersion test (p-value) - Ho: mean equals the variance			0.4310		0.4310
Normality of error terms (p-value)			0		0

Supply of non-maturity deposits increases when maturity deposits become cheaper. Cheaper price of maturity deposit is reflected in increasing spread between return on invested maturity deposit in money market and price of maturity deposit. Table 33 shows that he results are robust to time variables.

Table 33 Arrival rate of non-maturity deposits with time variables

Dependent variable: maturity deposits (*Dn*)

Variable	White's robust s.e.			2 way cluster robust s.e.	
	Coeff.	s.e.	z-stat	s.e.	z-stat
a_i	17.3621	0.3016	58.5719	0.4336	6.9285
Q1	-0.0189	0.0499	-9.6958	0.0178	0.2845
Q2	-0.0125	0.0269	5.2303	0.0176	0.2816
Q3	-0.0201	0.0274	-5.3241	0.0180	0.2881
intercept	3.3902	0.0110	0.59857	0.0731	1.1682
No. Of obs.			1165		1165
Adj. R^2			0.8164		0.8164
AIC of the model			381.4269		419.716
BIC of the model			381.5291		420.018
AIC of Pseudo Poisson			24600		24200
BIC of Pseudo Poisson			24600		24200
Overdispersion test (p-value) - Ho: mean equals the variance			0.4310		0.4310
Normality of error terms (p-value)			0		0

The arrival rate of investment loans decreases with its intermediacy fee (b_{inv}) but increases with immediacy fees of working-capital loans (b_{work}), consumer loans (b_{cons}), and non-loan earning assets (b_{fi}).

Table 34. Arrival rate of investment loans

Dependent variable: investment loans (L_{inv})

Variable	White's robust s.e.			2 way cluster robust s.e.	
	Coeff.	s.e.	z-stat	s.e.	z-stat
b_{inv}	-16.7375	0.2051	-8.1600	0.2783	-1.3230
b_{work}	29.7854	0.2780	10.6500	0.3772	7.6079
b_{cons}	0.3786	0.0887	163.5000	0.1203	127.3861
b_{fi}	1.2411	0.0739	1.6780	0.1003	1.0922
intercept	14.7580	0.0774	0.4266	0.1050	0.7043
No. Of obs.			1165		1165
Adj. R^2			0.8765		0.8765
AIC of the model			371.366		380.034
BIC of the model			370.890		379.547
AIC of Pseudo Poisson			8765.0		8765.0
BIC of Pseudo Poisson			8765.0		8765.0
Overdispersion test (p-value) - Ho: mean equals the variance			0.5647		0.5647
Normality of error terms (p-value)			0		0

The time variables indicate that demand on investment loans pick up in the first three quarters. The inclusion of time variables does not change sign of explanatory variables as shown in table 35.

Table 35 Arrival rate of investment loans with time variables

Dependent variable: investment loans (L_{inv})

Variable	**White's robust s.e.**			**2 way cluster robust s.e.**	
	Coeff.	s.e.	z-stat	s.e.	z-stat
b_{inv}	-16.7339	0.2051	-8.1583	0.2782	-1.3228
b_{work}	29.7791	0.2779	10.6477	0.3771	7.6062
b_{cons}	0.3785	0.0887	163.4652	0.1203	127.3589
b_{fi}	1.2408	0.0739	1.6776	0.1002	1.0920
Q1	-0.0345	0.0988	-0.9470	0.1085	-0.9470
Q2	-0.2451	0.0859	-1.0884	0.0944	-1.0884
Q3	-0.9730	0.0988	-0.9467	0.1085	-0.9467
intercept	14.7549	0.0774	0.4265	0.1050	0.7041
No. Of obs.			1165		1165
Adj. R^2			0.8765		0.8765
AIC of the model			379.833		388.698
BIC of the model			379.346		388.200
AIC of Pseudo Poisson			8964.842		8964.842
BIC of Pseudo Poisson			8964.842		8964.842
Overdispersion test (p-value) - Ho: mean equals the variance			0.5647		0.5647
Normality of error terms (p-value)			0		0

Table 36 shows that arrival rate of working capital loans is positively related to immediacy fees of investment loans, consumer loans, and non-loan earning assets, but negatively related to immediacy fees of working-capital loans.

Table 36 Arrival rate of working-capital loans

Dependent variable: investment loans (L_{work})

Variable	White's robust s.e.			2 way cluster robust s.e.	
	Coeff.	s.e.	z-stat	s.e.	z-stat
b_{work}	-16.7375	0.2051	-8.1600	0.2253	-1.3230
b_{inv}	29.7854	0.2780	10.6500	0.3054	7.6079
b_{cons}	0.3786	0.0887	163.5000	0.0975	127.3861
b_{fi}	1.2411	0.0739	1.6780	0.0812	1.0922
intercept	14.7580	0.0774	0.4266	0.0850	0.7043
No. Of obs.			1165		1165
Adj. R^2			0.8765		0.8765
AIC of the model			371.366		380.034
BIC of the model			370.890		379.547
AIC of Pseudo Poisson			8765.0		8765.0
BIC of Pseudo Poisson			8765.0		8765.0
Overdispersion test (p-value) - Ho: mean equals the variance			0.5647		0.5647
Normality of error terms (p-value)			0		0

Standard error increases sharply, reducing level of significance of regressors when cluster robust standard error is used. The results are robust to the inclusion of time variables. New working-capital loans appear to build up in the first three quarters.

Table 37 Arrival rate of working-capital loans with time variables

Dependent variable: investment loans (L_{work})

Variable	White's robust s.e.			2 way cluster robust s.e.	
	Coeff.	s.e.	z-stat	s.e.	z-stat
b_{work}	-9.0947	0.2378	-8.1583	0.2253	-1.3228
b_{inv}	15.8545	0.1912	10.6477	0.3054	7.6062
b_{cons}	0.3677	0.0511	163.4652	0.0974	127.3589
b_{fi}	2.6033	0.0610	1.6776	0.0812	1.0920
Q1	-0.0347	0.0880	1.1636	0.0966	-0.9470
Q2	-0.2470	0.0789	1.2965	0.0867	-1.0552
Q3	-0.9825	0.0986	1.0379	0.1083	-0.8447
intercept	15.9146	0.0653	0.4265	0.0850	0.7041
No. Of obs.			1165		1165
Adj. R^2			0.8765		0.8765
AIC of the model			379.833		388.698
BIC of the model			379.346		388.200
AIC of Pseudo Poisson			8964.842		8964.842
BIC of Pseudo Poisson			8964.842		8964.842
Overdispersion test (p-value) - Ho: mean equals the variance			0.5647		0.5647
Normality of error terms (p-value)			0		0

Table 38 summarizes estimates of negative binomial of arrival rate of consumer loans.

Table 38 Arrival rate of consumer loans

Dependent variable: consumer loans (L_{cons})

Variable	White's robust s.e.			2 way cluster robust s.e.	
	Coeff.	s.e.	z-stat	s.e.	z-stat
b_{cons}	-9.0644	0.1629	-83.8400	0.2210	-13.5937
b_{inv}	35.3892	0.0625	7.3010	0.0848	5.2155
b_{work}	7.9651	0.1900	4.7690	0.2578	3.7156
b_{fi}	7.9651	0.3355	4.7690	0.4552	3.1042
intercept	13.6562	0.1091	3.9650	0.1480	6.5460
No. Of obs.			1165		1165
Adj. R^2			0.9958		0.9958
AIC of the model			313.365		348.187
BIC of the model			313.627		348.239
AIC of Pseudo Poisson			8132.9		8132.9
BIC of Pseudo Poisson			8132.9		8132.9
Overdispersion test (p-value) - Ho: mean equals the variance			0.8337		0.8337
Normality of error terms (p-value)			0		0

Arrival rate of consumer loans decreases with immediacy fees of consumer loans but increases with immediacy fees of other earning assets. Table 39 indicates that new consumer loans also build up in the first three quarters.

Table 39 Arrival rate of consumer loans with time variables

Dependent variable: consumer loans (L_{cons})

Variable	White's robust s.e.			2 way cluster robust s.e.	
	Coeff.	s.e.	z-stat	s.e.	z-stat
b_{cons}	-9.0625	0.1629	-83.8221	0.2210	-13.5908
b_{inv}	35.3817	0.0625	7.2994	0.0848	5.2144
b_{work}	7.9634	0.1900	4.7680	0.2577	3.7148
b_{fi}	7.9634	0.3354	4.7680	0.4551	3.1036
Q1	-0.0276	0.0737	-0.9470	0.0737	-0.9470
Q2	-0.0246	0.0724	-0.9642	0.0724	-0.9642
Q3	-0.0140	0.0655	-1.0662	0.0655	-1.0662
intercept	13.6533	0.1091	3.9642	0.1480	6.5446
No. Of obs.			1165		1165
Adj. R^2			0.9958		0.9958
AIC of the model			342.446		380.498
BIC of the model			342.731		380.556
AIC of Pseudo Poisson			8887.6		8887.6
BIC of Pseudo Poisson			8887.6		8887.6
Overdispersion test (p-value) - Ho: mean equals the variance			0.8337		0.8337
Normality of error terms (p-value)			0		0

Estimation of arrival rate of non-loan earning assets such as fixed income securities and equity investment is summarized in table 40.

Table 40 Arrival rate of non-loan earning assets

Dependent variable: non-loan earning assets (*FI*)

Variable	White's robust s.e.			2 way cluster robust s.e.	
	Coeff.	s.e.	z-stat	s.e.	z-stat
b_{inv}	-18.6368	0.0563	-26.2000	0.6433	-4.6700
b_{work}	2.4735	0.1904	4.8720	0.7606	3.9500
b_{cons}	0.7317	0.2369	7.8680	0.5834	3.0300
b_{fi}	9.2778	0.0653	3.7850	0.6759	3.5100
intercept	16.8751	0.0746	1.29900	0.2836	1.4730
No. Of obs.			1165		1165
Adj. R^2			0.9734		0.9734
AIC of the model			306.32		340.3584
BIC of the model			306.576		340.410
AIC of Pseudo Poisson			7950		7950
BIC of Pseudo Poisson			7950		7950
Overdispersion test (p-value) - Ho: mean equals the variance			0.8150		0.8150
Normality of error terms (p-value)			0		0

Arrival rate of non-loan earning assets confirms theoretical model. Arrival rate of non-loan earning assets decreases with immediacy of non-loan earning assets but increases with immediacy fees of loans. Size of new non-loan earning assets increases in the first three quarters. The following table implies that the same conclusion as found in loans. Asset building occurs across banks during the first three quarter.

Table 41 Arrival rate of non-loan earning assets with time variables

Dependent variable: non-loan earning assets (*FI*)

Variable	White's robust s.e.			2 way cluster robust s.e.	
	Coeff.	s.e.	z-stat	s.e.	z-stat
b_{fi}	-18.4131	0.0556	-25.8856	0.2354	-12.7600
b_{inv}	2.4686	0.1900	4.8623	0.7543	3.9830
b_{work}	0.7302	0.2364	7.8523	0.4797	6.2627
b_{cons}	9.2593	0.0652	3.7774	0.8007	3.7523
Q1	-0.0276	0.0737	-0.9470	5.2614	-0.5710
Q2	-0.0246	0.0724	-0.9642	3.8916	-0.7720
Q3	-0.0140	0.0655	-1.0662	3.3344	-0.9010
intercept	16.8542	0.0745	1.2974	2.0396	1.4730
No. Of obs.			1165		1165
Adj. R^2			0.9734		0.9734
AIC of the model			306.2121		340.4966
BIC of the model			306.621		340.957
AIC of Pseudo Poisson			7690		7690
BIC of Pseudo Poisson			7690		7690
Overdispersion test (p-value) - Ho: mean equals the variance			0.8150		0.8150
Normality of error terms (p-value)			0		0

4.6.2. Intermediation margin

Pure margin is estimated by using regression with fixed effects and robust error (HAC). Table 42 show the test results that GLS estimates are not consistent in pure margin case.

Table 42 Static model with fixed effect – pure margin (*PURE*)

Dependent variable: quarterly *PURE*

Variable	Coeff.	s.e.	t-stat
MKTPWR	0.0194	0.0552	0.3507
COST	-0.01145	0.02582	-3.6000
CASH	-4.3723	0.3564	-0.0898
IMPLICIT	-0.0119	0.1322	-1.2270
LPS	-0.3044	0.0524	-5.8090
CAPITAL	8.56311e-07	9.68291e-07	0.8844
LOAN	-0.0047	0.0025	-1.9650
MR	0.1504	0.0712	2.1120
CRL	0.1485	0.0923	2.3670
PM	0.2582	0.1091	1.6090
RA	0.0033	0.0055	0.6038
ESR	0.3310	0.05134	1.9721
CER	0.1103	0.0171	0.1612
Intercept	0.1356	0.0377	0.4434
No. of obs			1166
S.E. of regression			0.0290
Adjusted R-squared			0.8009
Breusch-Pagan test- Null hypothesis: Variance of the unit-specific error = 0 (p-value)			0
Normality of residual (p-value)			7.2963e-034
Hausman test – Null hypothesis: GLS estimates are consistent (p-value)			3.59798e-019

The results support the theoretical model about interplay between margin and its determinants. Pure margin increases with market power of banks, riskiness of lending activities, and degree or risk aversion of banks. The margin is negatively influenced by unit operating cost and implicit interest rates. The opportunity cost of holding cash reserves might put pressure on the margin while opportunity cost of capital charge could be translated into prices of earning assets. The margin decreases with loan size, indicating that economic scale might allow banks to reduce loan prices. Negative sign of LPS's published rates indicates that increasing threshold for fully insured deposits might increase deposit prices and put pressure on pure margin. Notably, uncertainty about emission credits, bank's market power, implicit interest rates, opportunity cost of regulatory capital and cash reserve, degree of risk aversion, and expected profit margin are not statically significant in explaining pure margin. Table 43 shows that decreasing pure margin is observed due to low loan prices during low interest rate periods.

Table 43 Static model with fixed effect and time variables – pure margin (*PURE*)

Dependent variable: quarterly *PURE*

Variable	Coeff.	s.e.	t-stat
MKTPWR	0.0192	0.0557	0.3504
COST	-0.01127	0.0261	-3.5965
CASH	-4.2833	0.3599	-0.0897
IMPLICIT	-0.0121	0.1335	-1.2258
LPS	-0.2940	0.0529	-5.8033
CAPITAL	8.563e-07	0.0000	0.8835
LOAN	-0.0065	0.0025	-1.9632
MR	0.1558	0.0719	2.1099
CRL	0.1469	0.0932	2.3647
PM	0.2589	0.1102	1.6074
RA	0.0033	0.0056	0.6032
ESR	0.2651	0.0518	0.4830
CER	0.1096	0.0173	0.9623
MKTPWR	0.0194	0.0557	0.3504
Q1	-0.0009	0.0014	0.8881
Q2	-0.0004	0.0008	0.1612
Q3	-0.0008	0.0011	0.1739
Intercept	0.1356	0.0381	0.4430
No. of obs			1166
S.E. of regression			0.0293
Adjusted R-squared			0.8000
Breusch-Pagan test- Null hypothesis: Variance of the unit-specific error = 0 (p-value)			0
Normality of residual (p-value)			7.2812e-034
Hausman test – Null hypothesis: GLS estimates are consistent (p-value)			3.2567e-019

Regressing explanatory variables in on gross margin in the static model uses regression with random effect and robust error (HAC). The random effects are considered since Breusch-Pagan test and Hausman test indicate that GLS estimators are consistent and efficient. The results of regression as well as Breusch-Pagan test and Hausman test are summarized in table 44.

Table 44 Static model with random effect – gross margin (*GM*)

Dependent variable: quarterly *GM*

Variable	Coeff.	s.e.	t-stat
MKTPWR	0.0988	0.0548	0.2381
COST	-2.1317	0.0804	-26.50
CASH	-8.0809	0.3264	-2.476
IMPLICIT	-1.9188	0.4201	-4.568
LPS	-0.4771	0.1138	-4.191
CAPITAL	1.02719e-06	4.31458e-06	1.801
EA	0.0049	0.0025	1.930
MR	0.3817	0.1871	2.040
CRE	0.4481	0.2454	5.683
PM	0.4489	0.0790	2.626
RA	0.0182	0.0087	2.088
ESR	0.3050	0.1161	1.826
CER	0.1016	0.0388	0.1267
Intercept	-0.01683	0.0443	-0.2535
No. of obs			1166
S.E. of regression			0.0543
Adjusted R-squared			0.8009
Breusch-Pagan test- Null hypothesis: Variance of the unit-specific error = 0 (p-value)			6.86241e-106
Normality of residual (p-value)			0
Hausman test – Null hypothesis: GLS estimates are consistent (p-value)			0.05145

Similar to the results using pure margin as proxy for intermediation margin, gross margin increases with market power of banks, opportunity cost of capital charge, degree of risk aversion, and expected profit margin. Gross margin decreases with unit operating cost, implicit interest rate, opportunity cost of holding cash reserves, and LPS's published rates. However, sign for coefficient of transaction changes. Gross margin is positively influenced by size of earning assets. This could possibly be explained by the high weight of non-loan earning assets in the earning asset portfolio. Prices of non-loan earnings assets such as bonds and financial derivatives are often not in the control of individual banks. Thus, high return on non-loan earning assets is likely to increase the weight of such assets in earning asset portfolio, which in turn increases gross margin. Similar to pure margin case, gross margin is decreasing during low interest rate period. It is interesting to note that opportunity cost of cash reserve and regulatory capital, expected profit margin, implicit interest rate, and degree of risk aversion are statistically significant in explaining variation in gross margin. Thus, these factors are likely to be passed on buyer of non-loan earning assets, implying cross subsidy in prices of bank's products.

Table 45 Static model with random effect and time variables – gross margin (*GM*)

Dependent variable: quarterly *GM*

Variable	Coeff.	s.e.	t-stat
MKTPWR	0.0998	0.0553	0.2379
COST	-2.1314	0.0812	-26.4739
CASH	-8.0798	0.3296	-2.4736
IMPLICIT	-1.9377	0.4242	-4.5635
LPS	-0.4770	0.1149	-4.1869
CAPITAL	0.0000	0.0000	1.7992
EA	0.0049	0.0025	1.9281
MR	0.3817	0.1889	2.0380
CRE	0.4525	0.2478	5.6774
PM	0.4533	0.0798	2.6234
RA	0.0182	0.0088	2.0859
ESR	0.3080	0.1172	1.8242
CER	0.1026	0.0392	0.1266
Q1	-0.0009	0.0014	0.8872
Q2	-0.0004	0.0008	0.1610
Q3	-0.0008	0.0011	0.1737
Intercept	-0.0170	0.0447	-0.2533
No. of obs			1166
S.E. of regression			0.0543
Adjusted R-squared			0.8009
Breusch-Pagan test- Null hypothesis: Variance of the unit-specific error = 0 (p-value)			6.8617e-106
Normality of residual (p-value)			0
Hausman test – Null hypothesis: GLS estimates are consistent (p-value)			0.05151

Using GMM procedure in Blundell and Bond (1997) with collapsed instrument matrix deriving from PCA of the initial instrument set, dynamic panel model gives similar results. The dynamic model should capture survey findings that intermediation margin in the previous quarter determines current value of intermediation margin in some banks.

Table 46 Dynamic model (Blundell and Bond, 1997)

Dependent variable: quarterly *PURE, GM*
No. of instruments: 46

Variable	PURE			GM		
MARGIN(-1)	0.4601	[0.0147]	*	0.4081	[0.0130]	*
MKTPWR	-0.1310	[0.0490]		-0.0073	[0.0027]	*
COST	-0.5071	[0.0182]	**	-0.4567	[0.0164]	***
CASH	-0.0119	[0.1322]	*	-0.0035	[0.0385]	**
IMPLICIT	-1.3600	[0.0524]	**	-0.5205	[0.0201]	***
LPS	-0.0047	[0.0025]	*	-0.0015	[0.0008]	*
CAPITAL	0.0000	[0.0000]		0.0000	[0.0000]	*
LOAN,EA	-0.0328	[0.0236]	**	0.0285	[0.0205]	**
MR	0.0340	[0.0876]	**	0.0198	[0.0511]	***
CRL, CRE	0.0719	[0.0694]	**	0.0149	[0.0144]	**
PM	0.0033	[0.0055]		0.0002	[0.0003]	
RA	0.0081	[0.0254]	*	0.0018	[0.0057]	*
ESR	0.1103	[0.0171]	*	0.0140	[0.0022]	
CER	0.0001	[0.0000]		0.0001	[0.0000]	
Intercept	0.5589	[0.0386]		0.1557	[0.0108]	
No. of obs			1166			1166
S.E. of regression			0.0295			0.0548
Adjusted R-squared			0.7224			0.6580
Test of AR(1) errors			(0.0000)			(0.0000)
Test of AR(2) errors			(0.4640)			(0.5141)
Hansen test of overidentification – Ho: overidentified restriction			(0.1870)			(0.1889)
Normality of residuals			(0.0000)			(0.0000)

In the dynamic model, the sign of all coefficients does not change when explanatory variables are regressed on pure margin. Pure margin increases with market power, opportunity cost of capital charge, and riskiness of lending activities. The margin decreases with unit operating cost, implicit interest rate, opportunity cost of holding cash reserves, LPS's published interest rates, and loan size. Interestingly, high or low pure margin might be persistent since past value of pure margin is positively related to current value of pure margin. The small amount of emission credits (i.e. counting for less than 0.022% of total operating income of 51 banks) might explain that statistically, the uncertainty about emission credits is not significantly influenced pure margin.

Regressing all explanatory variables on gross margin *GM* produces the coefficients with the same sign as all coefficients mimics the results in static model. Gross margin increases with past value of gross margin, market power, opportunity cost of capital charge, riskiness of earning assets, degree of risk aversion, and size of new earning assets. Gross margin is negatively influenced by operating cost, implicit interest rate, opportunity cost of holding cash reserves, and LPS's published rates. Uncertainty about emission credits is not statistically significant in explaining gross margin. The results are robust to the inclusion of time variables as summarized in table 47.

Table 47 Dynamic model with time variables (Blundell and Bond, 1997)

Dependent variable: quarterly *PURE, GM*
No. of instruments: 46

Variable	PURE			GM		
MARGIN(-1)	0.4601	[0.0148]	*	0.4121	[0.0131]	*
MKTPWR	-0.1310	[0.0495]		-0.0073	[0.0027]	*
COST	-0.5071	[0.0184]	**	-0.4566	[0.0166]	***
CASH	-0.0119	[0.1335]	*	-0.0035	[0.0389]	**
IMPLICIT	-1.3600	[0.0529]	**	-0.5204	[0.0203]	***
LPS	-0.0047	[0.0025]	*	-0.0015	[0.0008]	*
CAPITAL	0.0000	[0.0000]		0.0000	[0.0000]	*
LOAN,EA	-0.0328	[0.0238]	**	0.0285	[0.0207]	**
MR	0.0340	[0.0885]	**	0.0200	[0.0516]	***
CRL, CRE	0.0719	[0.0701]	**	0.0150	[0.0145]	**
PM	0.0033	[0.0056]		0.0002	[0.0003]	
RA	0.0081	[0.0257]	*	0.0018	[0.0058]	*
ESR	0.1103	[0.0173]	*	0.0141	[0.0022]	
CER	0.0001	[0.0000]		0.0001	[0.0000]	
Q1	-0.0022	[0.0077]		-0.0031	[0.0010]	
Q2	-0.0048	[0.0095]		-0.0020	[0.0012]	
Q3	-0.0023	[0.0066]		-0.0018	[0.0043]	
Intercept	0.5589	[0.0390]		0.1572	[0.0109]	

	PURE	GM
No. of obs	1166	1166
S.E. of regression	0.0295	0.0548
Adjusted R-squared	0.7208	0.6512
Test of AR(1) errors	(0.0023)	(0.0016)
Test of AR(2) errors	(0.5178)	(0.5212)
Hansen test of overidentification – Ho: overidentified restriction	(0.1870)	(0.1889)
Normality of residuals	(0.0000)	(0.0000)

Briefly, the relation between intermediation margin and explanatory variables are consistent in term of sign of coefficient. The intermediation margin is positively influenced by market power of banks, riskiness of products, degree of risk aversion, opportunity cost of capital charge, and expected profit margin. The intermediation margin decreases with operating cost per unit, implicit interest rate (which is composed of deposit insurance premium and opportunity cost or reserve requirement), opportunity cost of holding cash reserves, and upper bound of deposit price under deposit insurance scheme. When individual banks might influence product price, economies of scale might allow banks to offer cheaper prices. Risks associated emission credits are not statistically significant in determining intermediation margin.

4.7. Conclusions

In this chapter, the case study of Indonesian banks is used to illustrate the financial impact of extending partial liability to environmental and social risk management of lending activities and risk of emission credits on banks. Dionne and Spaeter (2003) provide comprehensive theoretical setting on the impact of extending partial liability to banks. However, the theoretical model is restrictive. Modified dealership model (Allen, 1988; Valverde and Fernández, 2007) is extended to partial liability of bank in Dionne-Spaeter (2003) model.

The dealership model in the context of extended partial liability demonstrates how social and environmental risk, and uncertainty about emission credits influence wealth if banks. Revenue from selling emission credit increases rate of arrival of investment and working capital loans for emission abatement projects if the revenue is rerouted to banks. Working-capital loans and investment loans for emission abatement technology have competitive advantage when immediacy fees and emission credit sales per unit investment and working capital loans supersedes operating cost per unit and risk premium of the loans. Maturity deposits make banks better off if return in money market exceeds average operating cost, and credit and interest rate risk premium of non-maturity deposits.

Empirical model is estimated on unbalance quarterly panel data of 51 Indonesia banks counting for 90% of national credits for sample period 2005 – 2010. Contractual prices and size for each bank products is used to avoid potential bias estimation. Selection of static model is based on results of Breusch-Pagan test and Hausman test. The estimation employs two-way cluster robust standard error to allow correct clustering, autocorrelation, and heteroskedasticity in error terms. GMM procedure of Blundell and Bond (1997) with Windmeijer's (2005) finite sample correction is employed to accommodate some banks in the sample that factor past value of intermediation margin into current value of intermediation margin. To ensure validity of Hansen's overidentification test, the instrument set is condensed by collapsing technique in Roodman (2009). The dynamic of gross margin, defined as spread between prices of earning assets and deposits, is estimated using regression with robust error (HAC). Dynamic model is estimated using GMM procedure of Blundell and Bond (1997).

The empirical model results show that pure and gross margin increases with market power of banks, degree of risk aversion, opportunity cost of capital charge, expected profit margin, and risk premium associated with emission credits, environmental and social risk, credit risk and interest rate risk. Pure and gross margin decreases with operating cost per unit, deposit insurance premium, opportunity cost of reserve requirement, upper bound of deposit price under deposit insurance scheme, and opportunity cost of holding cash reserve. In the case that individual banks might freely change prices of earning assets, economies of scale allows bank to reduce product prices. Thus, intermediation margin might decrease with transaction size. Uncertainty about emission credits is also statically insignificant in explaining intermediation margin. The small amount of emission credits (i.e. counting for less than 0.022% of total operating income of 51 banks) might explain that statistically, the uncertainty about emission credits is not significantly influenced pure margin.

Briefly, environmental and social impact of lending activities might matter in pricing loans when the internalization of such impact into banks' risk management process is mandatory. The insignificance of the impact of emission credits implies that the lack of reference about methodology to assess the impact and mechanism to internalize is likely to boost the amount of unpriced benefits and costs. The implication of this finding is that statutory approach in managing environmental and social impact of lending activities should take into account not only unpriced cost but also unpriced benefit from disbursing loans to firms. Otherwise, risk associated with unpriced benefit is overlooked and banks overestimate debts service of borrowing firms. The second important point is that environmental and social risk rating such as risk rating published by Ministry of Environment focuses on environmentally and socially sensitive sectors. In reality, all economic sectors such as telecommunication might have environmental and social footprints or assume indirect environmental and social risk. If the indirect risk takes form reputational risk or risk of loosing potential buyers and suppliers, then the risks should be factored into loan prices. Thirdly, Labatt and White (2002)'s findings that only a small number of banks lend to GHG abatement project because many banks lack of knowledge about price formation of CER might not be completely true. Maturity profile of deposit portfolio might matter in asset selection. In Indonesia case, the more non-maturity deposit is raised, the less deposit is invested in loans. Additionally, monetary policy to control inflation might be contra productive if deposit insurance in a country imposes upper bound for deposit price that does not mimic the dynamics of policy rates. All banks in the sample factor in LPS's upper bound of deposit price into cost of fund, which is transmitted into prices of bank's products.

CHAPTER 5 CONSLUSIONS AND IMPLICATIONS

This chapter critically discusses findings of thesis for internalization of emission credits, environmental risk, and social impact of lending activities. The chapter is structured as follows: in section 5.1, the main findings of the thesis are summarized; section 5.2 discusses the implications of the findings, the shortcoming of the findings, and further research are discussed.

5.1. Summary of Main Findings

This thesis addresses the growing demand for assessing and mitigating environmental and social impact of lending activities. There has been evidence that the UK, EU, and USA where assessing and mitigating such impact is not mandatory, banks fail to integrate the impact to each stage of their risk management (Rhee and Lee, 2003; Thomson and Crowton, 2004; Köllner et al, 2004; McKenzie and Wolfe, 2004; Weber et al 2008; Chave, 2010). Thus, case study in integrating environmental and social impact of lending activities is barely found. Even literatures in environmental economics concentrate on theoretical setting for internalizing negative impact of production and consumption process to the environment. Doubt therefore exists the explicit considerations of the risk-return on lending to projects generating emission credits together with environmental and social impact of lending.

This thesis provides empirical evidence about the necessity of government intervention to enforce banks to manage environmental and social impact of their lending activities. Reference about assessment and pricing methodology has allowed banks in Indonesia to link environmental and social performance of borrowing firms and loan prices. This thesis also indentifies an urgent need to improve statutory approach in Indonesia to ensure unpriced benefits and costs of production and consumption process are counted in loan prices. Specifically, risk-return on environmental and social impact that is tradable such as emission credits should be taken into account in the guidelines for assessing and pricing environmental and social impact of lending activities. The thesis also gives an sight to bank practitioners about what they should understand before disbursing loan to firms generating emission credits.

5.1.1. Dynamics of CER prices

In Indonesia context, the only market available to trade externalities is international Emission Trading System (ETS) for trading Certified Emission Reduction (CER). CER is sold by firms reducing greenhouse gases (GHG)[18] emission to firms emitting GHG excessively in developed countries. A small number of banks estimates revenue from selling CER and risk associated with CER trading.

Estimation of risk associated with CER trading is carried out by investigation factors influencing CER spot prices at Bluenext from August 12, 2008 to May 31, 2011. The use of spot price eliminates the effect of project risk that has been captured in the credit risk of lending activities. Vector autoregressive moving-average processes with exogenous regressors (VARMAX) procedure is used to allow interdependency of the variables and for exogenous shocks. This has been a critical issue in the empirical investigation prices of emission credits. Previous works concerning macroeconomic effects on EUA future prices indicate bidirectional causality between some variables. The technique is also not theoretic which can be used when theory does not yield a clear prediction, but its estimated parameters have structural interpretation and economic meaning. Exogenous variables considered in VARAMAX (4,0,3) are extreme cold temperature, extreme hot temperature, and changes in climate policy. Endogenous variables in the system are CER and EUA spot prices, 11 variables as proxies of cost of switching technology and business cycle in the EU-27)EU-27 is the biggest CER buyers in the world).

The results somewhat do not support conclusion in Mansanet-Bataller et al (2011) and Chevallier (2011) who used future prices of CER and EAU. Using CER spot prices eliminates the effect of project risk and convenience yield, and shows the same effect of economic expansion in the EU-27 on EUA and CER prices. Economic expansion increase emission production which in turn boosts demand on EUA and CER. On the

[18] Intergovernmental Panel on Climate Change (IPCC) classified six GHG emitted from production and consumption process as triggers of climate changes such as overlong draught and extreme winter. GHG emission abatement is argued to be the most important measure to mitigate climate change (IPCC, 2001).

other hand, CER and EUA respond differently to the shocks to the economy. A jump in sCER prices moves up price adjusted output and prices of goods acquired by household. A jump in EUA prices however put pressure on price adjusted output and prices of goods acquired by household. Interdependent relationship between EUA and CER exists. EUA responds negatively to the shocks to CER and vice versa. This implies that demand on one emission credits influences demand on another emission credit.

Extreme weather and changes in climate policy are not significant in the price dynamics of emission credits. EUA and sCER prices respond positively to technology shocks, suggesting that equilibrium price for emission credit mimic dynamics of fuel switching cost. Another important finding is that clean dark spread and clean spark spread are most important in the fluctuation of electricity prices. Further, technology shocks put pressure on electricity prices shocks while shocks to emission credits are fully passed on electricity buyers. Economic expansion expectedly moves up demand on electricity up and energy prices which is translated into higher fuel switching cost.

5.1.2. The implication of risk-return in fund raising and portfolio effect

In April 2001, a banking survey was carried out on 66 banks, representing 97% of total loans in the country. The survey identified pricing methodology and parameters to price banks' products. The results show that prices of bank products are determined by costs of loanable fund and expected profit. Costs of loanable fund comprise cost of fund, risk premium, and opportunity cost associated with regulatory capital and cash reserves. Cost of fund is composed of deposit prices, operating costs, deposit insurance premium, upper bound of prices for deposits under mandatory deposit insurance.

Another finding is that banks have been required to measure and price environmental and social risk of borrowing firms. Ministry of Environment provides environment and social risk rating as main reference. The risk rating tracks how important community development in firms' corporate social responsibility initiatives, and how well firms in reducing, reusing, recycling, and recovering wastes or pollutants. Therefore, risk rating is the basis to set provision that absorbs expected cost to clean up social and environmental damage. The loss provision is transmitted to loan prices of the associated borrowers (Bank Indonesia, 2005). Clearly, the regulation does not comprise risk-return on loans generating tradable externalities.

5.1.3. The impact of CER risk-return, environmental risk, and social impact of lending activities on loan prices and supply

Theoretical construct that represents the internalization of emission credit as well as environmental and social risk of lending activities is tested on unbalanced quarterly data of 51 banks in Indonesia. Aside from the three factors, other factors found in survey are included in the model. The survey found that prices of bank products are determined by costs of loanable fund and expected profit. Costs of loanable fund comprise cost of fund, risk premium, and opportunity cost associated with regulatory capital and cash reserves. Cost of fund is composed of deposit prices, operating costs, deposit insurance premium, upper bound of prices for deposits under mandatory deposit insurance. The assumption about deposits in Ho-Saunder's (1981) is relaxed by classifying deposits into maturity and non-maturity deposits. Maturity deposits are composed of term deposits and saving with lock-up period while non-maturity deposits consist of demand deposit and savings.

Pure margin and gross margin are proxies for net price of bank's products and the basis to investigate the impact of risk and other factors on prices. Pure margin is the spread between loan and deposit price. Gross margin is defined as spread between price of earning asset and deposit price. Least square with two-way cluster robust standard errors is used to correct heteroskedasticity and autocorrelation in error terms, and correct possible correlation within a cluster by two-way cluster robust standard errors (Cameron et al, 2009). Breusch-Pagan test and Hausman test are employed to identify whether fixed effect or random effect present. Aside from least square, system GMM of Blundell and Bond (1997) is another technique that has been employed to accommodate survey findings. Some banks take into account spread between deposit and loan prices in the previous quarters while others do not. The instrument set of system GMM is condensed by using collapsing technique proposed by Roodman (2009). Thus, J-statistics overidentifying restriction is valid. Following Windmeijer's (2005) finite sample correction, VCE is adjusted to correct heteroskedasticity and autocorrelation in error terms as well as downward bias of two-step VCE sourced from large number of instruments.

The results confirm the theoretical model for internalization. Pure and gross margin increases with market power of banks, degree of risk aversion, opportunity cost of capital charge, expected profit margin, and risk associated with CER, environmental and social risk, credit risk and interest rate risk. The margin decreases with operating cost per unit, deposit insurance premium, opportunity cost of reserve requirement, upper bound of deposit price under deposit insurance scheme, and opportunity cost of holding cash reserve. Pure margin decreases with loan size indicating that economies of scale in lending activities allow banks to offer low loan prices. However, banks are price takers in capital markets. Expectedly, the higher is the size of earning assets such as bonds, the higher gross margin is. Bank's market power and uncertainty about CER is statically insignificant in explaining variation in intermediation margin. The possible explanation is that revenue from selling CER counts for less than 0.022% of total operating income of 51 banks.

The estimation of arrival rate of each product considers correlation within cluster. There are 7 clusters i.e. state owned banks, local banks having international operation, local banks without to international money markets, branches of foreign banks heavily depending on non-loan business activities, branches of foreign banks heavily depending on lending activities, subsidiaries of international banks heavily depending on non-loan business activities, subsidiaries of international banks heavily depending on lending activities, and subsidiaries of non-bank international financial institutions.

In all cases, Poisson regression yields estimates with variance higher than the mean. Thus, the rate of arrival of each product is estimated by using negative binomial regression with fixed effect and Cameron and Triverdi's (1985) Pseudo Poisson. The standard error of Pseudo Poisson is robust to clustering by bank ownerships. Both estimators negate overdispersion problem, but information criterion and negative log likelihood indicate that negative binomial with fixed effect is good fit to data. Nonetheless, the use of pseudo-Poisson might reduce bias estimation since the regression produces high standard errors of coefficients and diminishes significance of some coefficients.

5.2. Implications, Limitation and Further Research

The presence of fungibility EUA and CER are strong. This means that assessing and managing risk of lending to projects generating CER requires good estimation about the state of EUA market. In other word, banks should understand the direction business cycle and the states of installation and power plants operators in the member states of EU ETS in the near future. The fungibility also implies substitution effect of emission credits traded in ETS outside EU such as Australian and Canadian emission credits needs to be taken into account. Such emission credits are perfect substitute for CER, hence, influencing demand and prices of CER. Further research needs to be devoted on the impact of ETS-liking directives that allows CER, and ERU import to each ETS and whether import limit on CER such as the EU ETS policy influences prices of CER and ERU.

It is important to note that this work tests statutory approach in internalizing emission credits as well as environmental and social risk in lending activities in Indonesia. It does not relate investigate the impact of the amount invested by borrowers to prevent from environmental and social impact to debt service and default risk exposure of borrowers. Although the amount invested in preventive investment might not move in accordance with environmental and social performance of borrowers. The more important point is that regulation does not enforce banks to capture tradable externalities such as CER. Internalizing tradable externalities should be considered in the regulation to price correctly all benefits and costs in lending activities. Another important point is that cross price subsidy among bank's product might present. The conclusion is drawn from the results that opportunity cost of cash reserve and regulatory capital, expected profit margin, implicit interest rate, and degree of risk aversion are statistically significant in explaining variation in gross margin but not statistically significant in explaining pure margin. Thus, regulation that tightens loan supply by increasing capital charge and liquidity reserve requirement might not be effectual since the opportunity cost of capital charge might be transmitted into prices of non-loan products.

The implication of the abovementioned findings is that statutory approach in managing environmental and social impact of lending activities should take into account not only unpriced cost but also unpriced benefit from disbursing loans to firms. Otherwise, risk associated with unpriced benefit is overlooked and banks overestimate debts service of borrowing firms. The second important point is that environmental and social risk rating such as risk rating published by Ministry of Environment focuses on environmentally and socially sensitive sectors. In reality, all economic sectors such as telecommunication might have environmental and social footprints or pose indirect environmental and social risk. If the indirect risk takes form reputational risk or risk of loosing potential buyers and suppliers, then the risks should be factored into loan prices. Thirdly, Labatt and White (2002)'s findings that only a small number of banks lend to GHG abatement project because many banks lack of knowledge about price formation of CER might not be completely true. Maturity profile of deposit portfolio might matter in asset selection. In Indonesia case, the more non-maturity deposit is raised, the less deposit is invested in loans. Additionally, monetary policy to control inflation might be contra productive if deposit insurance in a country imposes upper bound for deposit price that does not mimic the dynamics of policy rates. All banks in the sample factor in LPS's upper bound of deposit price into cost of fund, which is transmitted into prices of bank's products.

REFERENCES

Alberola, E., J. Chevallier, and B. Cheze. (2007). European carbon prices fundamentals in 2005-2007: the effects of energy markets, temperatures and sectoral production. Document de Travail working paper 2007 : 33

Alberola, E., J. Chevallier, and B. Cheze. (2008). Price Drivers and Structural Breaks in European Carbon Prices 2005-2007. Energy Policy 36(2): 787–797

Alberola, E., J. Chevallier, and B. Cheze. (2009). Emissions Compliances and Carbon Prices under the EU ETS: A Country Specific Analysis of Industrial Sectors. Journal of Policy Modeling 31: 446–462

Allen, L. (1988). The determinants of bank interest margins: a note. Journal of Financial and Quantitative Analysis 23: 231-235

Altunbas, Y., L. Evans, and P. Molyneux. (2001). Bank ownership and efficiency. Journal of Money, Credit and Banking 33: 925-954

Angbazo, L. (1996). Commercial bank net interest margins, default risk, interest rate risk and off-balance sheet banking. Journal of banking and Finance 21: 55-87

Arellano, M. and S. Bond. (1991). Some tests of specification for panel data: Monte Carlo evidence and an application yo employment equations. Review of Economic Studies 58: 277 – 297

Arellano, M. and O. Bover. (1995). Another look at the instrumental-variable estimation of error components models. Journal of Econometrics 68: 29-52

Bailey, E. (1998). Intertemporal pricing of sulfur dioxide allowances. Working paper, MIT Center for Energy and Environmental Policy Research

Balkenborg, D. (2001). How liable should a lender be? The case of judgment-proof firms and environmental risk: Comment. The American Economic Review 91: 731 - 736

Baltensperger, E. (1980). Alternative approaches to the theory of the banking firm. Journal of Monetary Economics 6: 1-37

Bank Indonesia. (2005). Bank regulation No 7/2/PBI/2005 on Asset Quality Assessment. Retrieved from http://www.bi.go.id on May 20, 2012

Benz, E. and S. Trück. (2009). Modeling the price dynamics of CO2 emission allowances. Energy Economics 31(1): 4–15

Berger, A.N. and G.F. Udell. (1992). Some evidence on the empirical significance of credit rationing, Journal of Political Economy 100: 1047-1077

Berlin, M. and L.J. Mester. (1999). Deposits and relationship lending. The Review of Financial Studies 12: 579-607

Bernanke, B., J. Boivin, and P. Eliasz. (2005). Measuring monetary policy: a factor augmented vector autoregressive (FAVAR) approach. Quarterly Journal of Economics 120: 387–422

Blanchard, O.J. and D. Quah. (1989). The dynamic effects of aggregate demand and supply disturbance. The American Economic Review 79(4): 655-673

Bluenext. (May 29, 2008). BlueNext Futures CER launch on 2 June. http://www.bluenext.eu/PressReleases/7_BLUENEXTPRESSRELEASE_290508_En.pdf

Bluenext. (2010). BlueNext launches Spot ERU Contract. retrieved from: http://www.bluenext.eu/PressReleases/33_BLUENEXTPRESSRELEASE_031210_En.pdf

Blundell, R. and S. Bond . (1998). Initial conditions and moment restrictions in dynamic panel data Models. Journal of Econometrics 87: 115–143

Blundell, R. S. Bond, and F. Windmeijer. (2000). Estimation in dynamic panel data models: Improving on the performance of the standard GMM estimators. The Institute of Fiscal Studies Working Paper 00/12

Blyth, W. D.B., J. Kettunen and T. Wilson. (2009). Policy interactions, risk and price formation in carbon markets . Energy Policy 37: 5192–5207

Borak, S., W. Härdle, S. Trück and R. Weron. (2006). Convenience yields for CO2 emission allowance futures contracts. SFB 649 Discussion Paper 2006-076. Humboldt-University of Berlin

Boyer, M., and J. Laffont. (1997). Environmental risks and bank liability. European Economic Review 41: 427-1459

BPS (Biro Pusat Statistik) database. http://www.bps.go.id

Brown, J.H., W.R. Burnside, A.D. Davidson, J.P. DeLong, W.C. Dunn, M.J. Hamilton, N. Mercado-Silva, J.C. Nekola, J.G. Okie, W.H. Woodruff and W. Zuo. (2011). Energetic limits to economic growth. Bio Science 61(1): 19-26

Breush, T.S. and A.R. Pagan. (1979). Simple test for heteroscedasticity and random coefficient variation. Econometrica 47(5): 1287 – 1294

Cahave, S. (2010). Do environmental concerns affect the cost of bank loans? Working paper: George Institute of Technology - College of Management

Carbon Finance. (2010). *State and trends on carbon market 2010.* Washington: World Bank

Cetorelli, N. and M. Gambera. (2002). Banking market structure, financial dependence and growth: international evidence from industry data. The Journal of Finance 56: 617-648

Chesney, M and L. Taschini. (2008). The endogenous price dynamics of emission allowances and an application to CO2 option pricing. Swiss Finance Institute Research Paper Series No.08-01

Chevallier, J. (2009). Carbon futures and macroeconomic risk factors: a view from the EU ETS. Energy Economics 31 (4): 614-625

Chevalier, J. (2011). Macroeconomics, finance, commodities: Interactions with carbon markets in a data-rich model. Economic Modeling 28(1-2): 557-567

Climex. (April 25, 2008). CER Spot Trading new on Climex. http://newvalues.blutarsky.nl/downloads/080206%20CER%20spot%20trading%20document.pdf

Climex. (2009). First ever Exchange Traded ERU Transaction on Climex. Retrieved from http://newvalues.blutarsky.nl/downloads/090930%20Press%20Release%20First%20ever%20exchange%20traded%20ERU%20transaction.pdf

Convery, F.J. and L. Redmond. (2007). Market and price developments in the European Union emissions trading scheme. Review of Environmental Economic and Policy 1(1): 88 – 111

Daskalakis, G. and R.N. Markellos. (2008). Are the European carbon markets efficient? Review of Future Markets 17: 103-128

Daskalakis, G. and R.N. Markellos. (2009). Are electricity risk premia affected by emission allowance price? Evidence from th EEX, Nord Pool and Powernext. Energy Policy 37: 2594–2604

Daskalakis, G., D. Psychoyios and R.N. Markellos. (2009). Modelling CO_2 emission allowance prices and derivatives: evidence from the European trading scheme. Journal of Banking and Finance 33: 1230-1241

Davidson, R. and J.G. MacKinnon. (2004). *Econometric theory and methods.* Oxford: Oxford University Press

Demirgüç-Kunt, A. And H. Kuizinga. (1999). Determinants of commercial bank interest margins and profitability: some int'l evidence. The World bank Economic Review 13(2): 379-408

Dionne, G. and S. Spaeter. (2003). Environmental risk and extended liability: The case of green technologies. Journal of Public Economics 87: 1025-1060

Eccless et al. (November 2007). Harvard Business Review

EEX. (February, 2008). EEX and Eurex to Launch CER Futures. https://www.eex.com/de/document/31745/e_xpand_2008108.pdf

EEX. Trading data http://www.eex.com/en/Market%20Data/Trading%20Data

Elliott, C., T.J. Rothenberg, and J.H. Stock. (1996). Efficient tests for an autoregressive unit root. *Econometrica*, 64: 813–836

Eurostat database. http://epp.eurostat.ec.europa.eu/portal/page/portal/sector_accounts/data/database

European Commission. (2010). A Roadmap for moving to a competitive low carbon economy in 2050. SEC(2011) 287-289 final. http://ec.europa.eu/clima/documentation/roadmap/docs/com_2011_112_en.pdf

European Community. (1997). The role of financial institutions in achieving sustainable development. Report to the European Commissions by DELPHI International Ltd in association with Ecologic GMBH

European Community. (2009). Regulation (EC) No 1221/2009 of the European parliament and the council on the voluntary participation by organizations in a community eco-management and audit scheme (EMAS) - repealing regulation (EC) No 761/2001 and Commission decisions 2001/681/EC and 2006/193/EC. Official Journal of the European Union L 342

Fehr, M. and J. Hinz. (2007). A quantitative approach to carbon price risk modeling. Working paper, Institute for Operations Research ETH Zentrum

Frenkel, J.A. and R.M. Levich. (1977). Transaction costs and interest Arbitrage: Tranquil versus turbulent periods. Journal of Political Economy 85: 1209–1226

Giavazzi, F. (2008). Why does the spread between LIBOR and expected future policy rates persist, and should central banks do something about it? Vox column June 2, 2008

Glynn, J., N. Perera and R. Verma. (2007). Unit root tests and structural breaks: A survey with applications. Revista de M’etodos Cuantitativos Para la Econom’ia Y la Empresa 3: 63-79

Gollier, C. (1999).The economics of risk and time

Gouldson, A. and J. Murphy. (1997). Ecological modernization: Economic restructuring and the environment. Political Quarterly 68: 74 – 86

Government Accountability Office of the U.S. (GOA). (2003). Superfund Program: Updated Appropriation and Expenditure Data. Retrieved from http://www.gao.gov/new.items/d04475r.pdf on July 11, 2012

Goyenko, R., C.W. Holden, and C.A. Trzcinka, C.A. (2009). Do liquidity measures measure liquidity? Journal of Financial Economics 92: 153–181.

Green Exchange. (March 2008). The Green Exchange™ Reports Robust First Week Trading Volume in Carbon, US Emissions Contracts. http://new.evomarkets.com/pdf_documents/Green%20Exchange%20Reports%20Strong%201st%20Week%20Volume.pdf

Hamilton, J.D. (1995). *Time series analysis*. Princeton University Press

Hansen, L.P. (1982). Large sample properties of generalized method of moments estiamtors. Econometrica 50: 1029 – 1054

Hausman, J.A. (1978). Specification tests in econometrics. Econometrica 46(6): 1251 – 1271

Hausman, J.A. and W.E. Taylor. (1981). Panel data and unobservable individual effects. Econometrica 49: 1377 – 1398

Heys, A.G. (1996). Lenders penalty for environmental damage and the equilibrium cost of capital. Economica 63: 311 - 323

Ho, T. and H. Stoll. (1980). On Dealers' Markets under Competition. Journal of Finance 35.

Ho, T. and A. Saunders. (1981). The determinants of banks interest margins: theory and empirical evidence. Journal of Financial and Quantitative Analysis 16 (4): 581-600

Homburg, M.U. and M. Wagner. (2007). Futures Price Dynamics of CO2 Emission Certificates – An Empirical Analysis. Quantitative Finance 7(2): 73:88

Howell and Buckius. (1987). *Fundamentals of Engineering Thermodynamics*. McGraw-Hill, New York

ICE. Report center data https://www.theice.com/marketdata/reports

ICE. (2010). ICE futures Europe announces first cleared trades of ECX emissions reduction unit contracts. Retrieved from http://ir.theice.com/releasedetail.cfm?ReleaseID=527935

IEA. (2011). Monthly electricity statistics. April 2011. Retrieved from: http://www.iea.org/stats/surveys/mes.pdf

Jacob, J. and S. Spaeter. (2010). Large-scale risks and technological change: What about limited liability? Document de Travail 2010-12. Bureau d'économie Théorique et appliquée (BETA) UMR 7522

Jeucken, M. (2001). *Sustainable finance and banking: The financial sector and the future of the planet.* Eratscan Publication Ltd: London

Johnson, T.C. (2008). Volume, liquidity and liquidity risk. Journal of Financial Economics 87: 388–417

Kambia-Chopin, B. (2010). Environmental risks, the judgment-proof model and financial responsibility. European Journal of Law and Economics 30(2): 77-87

Kiriyama,E. and A. Suzuki. (2004). Use of real options in nuclear power plant valuation in the presence of uncertainty with CO2 emission credit. Journal of Nuclear Science and Technology 41(7):756–764.

Klein, M. (1971). A theory of the banking firm. Journal of Money, Credit and Banking 3: 205-218

Köllner, R.D., O. Weber, M. Fenchel and R.W. Scholz. (2004). Principles of sustainability rating for investment funds. Business Strategy and the Environment 14 (1): 54 – 70

Kotomin, V., Smith, S.D., Winters, D.B. (2008). Preferred habitat for liquidity in international short term interest rates. Journal of Banking and Finance 32: 240–250

Kroszner, R.S. and P.E. Strahan. (2001). Bankers on boards: Monitoring, conflict of interest and lender liability. Journal of Financial Economics 62: 415 – 452

Kury, T.J. and J. Harrington. (2010). The marginal effects of the price of carbon dioxide: Quantifying the effects on the market for electric generation in Florida. The Electricity Journal 23(4): 73-78

Kwiatkowski, D., P.C.B. Phillips, and Y. and Shin, Y. (1992). Testing the null hypothesis of stationarity against the alternative of a unit root: How sure are we that economic time series have a unit root? Journal of Econometrics 54:159–178

Labatt, S. and R.R. White. (2002). *Environmental finance: A guide to environmental risk assessment and financial products*. John Wiley and Sons Inc: New Jersey

Lepetit, L., E. Nys, P. Rous and A. Tarazi. (2006). The expansion of services in European banking: Implications for loan pricing and interest margins. Journal of Banking and Finance 32: 2325-2335

Lewis,M. (2008). It takes CO2 to Contango. Deutsche Bank Report

Lumsdaine, R.L and D.H. Papell. (1997). Multiple Trend Breaks and the Unit Root Hypothesis. Review of Economics and Statistics 79(2): 212-218.

Mansanet-Bataller, M., A. Pardo and E. Valor. (2007). CO2 Prices, Energy and Weather. The Energy Journal 28 (3): 67 – 86

Mansanet-Bataller, Maria et al. (2011). EUA and sCER phase II price drivers: Unveiling the reasons for the existence of the EUA–sCER spread. Energy Policy 39(3):1056-1069

Maudos, J. and J.F. de Guevara. (2004). Factors explaining the interest margin in the banking sectors of the European Union. Journal Banking and Finance: 2259-2281

Maudos, J. And L. Solís. (2009). The determinants of net interest income in the Mexican banking system: An integrated model. Journal of Banking and Finance 33: 1920-1931

McAndrews, J. and A. Sarkar. (2009). Credit risk, liquidity risk and the Federal Reserve's response to the crisis. Working paper, Federal Reserve Bank of New York

McKenzie, G. And S. Wolfe. (2004). The impact of environmental risk on the UK banking sector. Applied Financial Economics 14: 1005 - 1016

McShane, R.W. and I.G. Sharpe. (1985). A time series-cross section analysis of the determinants of Australian trading bank loan-deposit interest margins: 1962-1981. Journal of Banking and Finance 9: 115-136

Menlh (Kementerian Lingkungan Hidup). (2012). Kriteria PROPER 2012. Retrieved from http://www.proper.menlh.go.id on July 10, 2012

Michaelson, J.B., and R.C. Goshay. (1967). Portfolio selection in financial intermediaries: A new approach. Journal of Financial and Quantitative Analysis: 166-200

Milani, F. (2009). Expectations, learning, and the changing relationship between oil prices and the macroeconomy. Energy Economics 31(6): 827-837

Montero, J.P. and A.D. Ellerman. (1998). The Declining Trend in Sulfur Dioxide Emissions: Implications for Allowance Prices. Journal of Environmental Economics and Management 36(1): 26–45

Naccache, T. (2010). Slow oil shocks and the weakening of the oil price-macoeconomy relationship. Energy Policy 28(5): 2340-2345

Naccache, T. (2011). Oil price cycles and wavelets. Energy Economics 33(2): 338-352

Ng, S. and P. Perron (2001) Lag length selection and the construction of unit root tests with good size and power. Econometrica 69: 1519–1554.

Nordseth, M., J. Buen and E. Lokshall. (2007). CER market dynamics in equal exchange: Determining a fair price for carbon. UNEP-CD4CDM Perspective Series 2007

NYSE Euronext. (August 12, 2008**).** First CER Spot transaction traded on BlueNext**.** http://www.nyse.com/press/1218622290055.html

Patersen, M.A. and R. Rajan. (1995). The effect of credit market competition on lending relationships. The Quarterly Journal of Economics 42: 407-444

Paolella, M.S. and L. Taschini. (2008). An econometric analysis of emission trading allowances. Journal of Banking and Finance 32(10): 2022-2032

Pitchford, R. (1995). How liable should a lender be? The case of judgment-proof firms and environmental risks. American Economic Review 815: 1171-1186

Pitchford, R. (2001). How liable should a lender be? The case of judgment-proof firms and environmental risks: Reply. American Economic Review 91: 739 - 745

PointCarbon. (2010). Secondary CERs and sourcing strategies: A delivery to The Danish Energy Agency. http://ens.dk/da-DK/KlimaOgCO2/Klimaprojekter/statens_projekter/Reelle_CO2_reduktioner/Evalueringer/Documents/Secondary%20Carbon credits%20FINAL.pdf

Pyle, D. H. (1971). On the theory of financial intermediation. Journal of Finance 28: 737-747.

Pyle, D. H. (1972). Descriptive theories of financial institutions under uncertainty. Journal of Financial and Quantitative Analysis: 2009-2031

Rapach, D.E. (1998). Macro shocks and fluctuations. Journal of Economics and Business 50: 23-38

Redebusch, G.D. (1993). The uncertain unit root in real GNP. The American Economic Review 83(1): 264-272

Reuters. (February, 2008). European Climate Exchange to launch CER futures. http://uk.reuters.com/article/2008/02/21/climateexchange-lchclearnet-idUKL2184757120080221

Rhee, S.K. and S.Y. Lee. (2003). Dynamic change of corporate environmental strategy: Rhetoric and reality. Business Strategy and the Environment 12: 175 - 190

Roll, R., E. Schwartz, and A. Subrahmanyam. (2007). Liquidity and the Law of One Price: The case of future-cash basis. Journal of Finance 62: 2201–2234.

Roodman, D.M. (2009). A note on the theme of too many instruments. Ocford Bulletin of Economics and Statistics 71: 135 – 158

Sadorsky, P. (2002). Time-varying risk premiums in petroleum futures prices. Energy Economics 24(6): 539-556

Saunders, A. and L. Schumacher. (2000). The determinants of bank interest rate margins: An international study. Journal of International Money and Finance 19: 813-832

Seifert, J., M. Uhrig-Homburg and M. Wagner. (2008). Dynamic behavior of CO2 spot prices, Journal of Environmental Economics and Management 56: 180 – 194

Sims, C.A. (1980). Macroeconomics and reality. Econometrica 48: 1-48

Shapiro, M.D. and W.W. Watson. (1988). Sources of business cycle fluctuations. NBER Macroeconomics Annual 3:111-156

Shleifer, A., Vishny, R.W. (1997). The limits to arbitrage. Journal of Finance 52: 35–55.

Stanhouse, B. And D. Stock. (2004). The impact of loan prepayment risk and deposit withdrawal risk on the optimal intermediation margin. Journal of Banking and Finance 28: 1825 – 1843

Stiglitz, J. (1987). The causes and consequences of the dependence of quality on price. Journal of Economic Literature 25: 1-48

Stoll, H. (1978a). The supply of dealer services in securities markets. Journal of Finance 33: 1133–1151

Stoll, H. R. (1978b). The Pricing of Security Dealer Services: An Empirical Study of NASDQ Stocks. Journal of Finance: 1153-1173

Stoll, H., (2000). Frictions. Journal of Finance 55: 1479–1514

Sullivan, R. (2011). Investment-grade climate change policy: Financing transition to the low carbon economy. Report commissioned by IIGCC, IGCC, INCR and UNEP-FI

Thomson, R. and C.J. Cowton. (2004). Bringing the environment into bank lending: Implications for environmental reporting. The British Accounting Review 36: 197 - 218

Tobin, J. (1980). *Asset accumulation and economic activity*. Chicago: University of Chicago Press

Trück, S., S. Borak, W. Härdle and R. Weron. (2007). Convenience yields for CO2 emission allowance futures contracts. Humboldt-University of Berlin Working Paper

UNFCCC. (2011). Kyoto Protocol database http://unfccc.int/kyoto_protocol/items/2830.php

USEAP (The U.S. Environmental Protection Agency). (1986). The Superfund Amendments and Reauthorization Act

Valverde, S.C and F.R. Fernández. (2007). The determinants of bank margins in European banking. Journal of Banking and Finance 31: 2043-2063

van Ruijen, B. and P. van Vuuren. (2009). Oil and gas prices and greenhouse gas emission mitigation. Energy Policy (37): 4797-480

Weber, O., M. Fenchel and R.W. Scholz. (2008). Empirical analysis of the integration of environmental risk into the credit risk management process of European banks. Business strategy and the Environment 17: 149 – 159

White, H. (1980). A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity. Econometrica 48(8): 817 – 838

Windmeijer, F. (2005). A finite sample correction for the variance of linear two-step GMM estimators. Journal of Econometrics 126: 25 – 51

Yang, M., W. Blyth, R. Bradley, D. Bunn, C. Clarke and T. Wilson, T. (2008). Evaluating the power investment options with uncertainty in climate policy. Energy Economics 30 (4): 1933–1950

Zarruck, E. (1989). Bank margin with uncertain deposit level and risk aversion. Journal of Banking and Finance 13: 797-810

Zivot, E., and Andrews, D. W. K. (1992). Further evidence on the Great Crash, the oil-price shock, and the unit-root hypothesis. Journal of Business and Economic Statistics 10(3): 251–270

Appendix A Estimates of conditional mean equation of cointegrated VARMAX(4,0,3)

Sample (adjusted): 753
Included observations: 748 after adjustment
Standard errors in the 2nd row, t-statistics in [ ]

Cointegrating Eq:	CointEq1	CointEq2	CointEq3
cpi_{t-1}	1	0	0
ipi_{t-1}	0	1	0
eua_{t-1}	0	0	1
cer_{t-1}	-1.378443	-10.76673	-2.014044
	-0.32763	-2.4214	-0.3686
	[-4.20733]	[-4.44649]	[-5.46404]
cas_{t-1}	0.024093	-0.195052	-0.017479
	-0.05834	-0.43118	-0.06564
	[0.41297]	[-0.45236]	[-0.26630]
$cdso_{t-1}$	-3.025465	-25.56311	-1.531217
	-0.98685	-7.29348	-1.11026
	[-3.06578]	[-3.50492]	[-1.37915]
og_{t-1}	-0.090708	-0.108674	0.132648
	-0.0746	-0.55136	-0.08393
	[-1.21590]	[-0.19710]	[1.58044]
css_{t-1}	-0.022551	-0.062719	-0.01745
	-0.02083	-0.15394	-0.02343
	[-1.08266]	[-0.40742]	[-0.74464]
cg_{t-1}	-0.060105	-0.387609	-0.03841
	-0.02822	-0.20856	-0.03175
	[-2.12997]	[-1.85854]	[-1.20985]
epi_{t-1}	-0.165076	-1.082149	-0.184201
	-0.05926	-0.43795	-0.06667
	[-2.78573]	[-2.47092]	[-2.76296]
1	-0.008736	-0.057931	-0.009379
	-0.0025	-0.01851	-0.00282
	[-3.48825]	[-3.12985]	[-3.32870]
C	10.56762	69.51785	12.15969

Appendix B Estimates of error correction of cointegrated VARMAX(4,0,3)

( ): standard error
[ ]: t-statistics

Error Correction:	Δcpi	Δipi	Δeua	Δcer	Δcds	Δcdso	Δog	Δcss	Δcg	Δepi
Coint Eq1	-0.3082	-0.2485	0.0125	0.0201	0.2428	0.0020	-0.1037	0.4717	0.0946	0.2675
	(0.0384)	(0.1886)	(0.0205)	(0.0165)	(0.0426)	(0.0066)	(0.0426)	(0.2241)	(0.0688)	(0.2064)
	[-0.6127]	[-1.3179]	[8.0181]	[1.2205]	[1.1516]	[0.3071]	[-2.4337]	[2.1042]	[1.3756]	[1.2959]
Coint Eq2	-0.0077	-0.4612	0.0153	0.0127	0.1167	-0.0033	0.0098	0.1034	-0.0091	0.1301
	(0.0115)	(0.0566)	(0.0061)	(0.0049)	(0.0633)	(0.0020)	(0.0128)	(0.0673)	(0.0206)	(0.0619)
	[-0.6646]	[-.2.4945]	[-8.1510]	[-2.5760]	[1.8441]	[-1.6467]	[0.7676]	[1.5377]	[-0.4429]	[2.1010]
Coint Eq3	0.2589	3.3364	-0.0884	-0.0608	-0.3242	0.0206	0.0189	-0.5152	-0.1227	-0.3862
	(0.0933)	(0.4571)	(0.0497)	(0.0400)	(0.5118)	(0.0161)	(0.1035)	(0.0544)	(0.1669)	(0.0501)
	[1.5196]	[1.7782]	[-7.2893]	[-2.7747]	[-0.6335]	[1.2760]	[0.1823]	[-0.9470]	[-0.7354]	[-0.7709]
Δcpi_{t-1}	-0.3473	-0.5817	-0.0006	-0.0004	0.0068	0.0000	0.0044	-0.0091	-0.0871	0.0033
	(0.0231)	(0.0961)	(0.0014)	(0.0016)	(0.0084)	(0.0011)	(0.0031)	(0.0186)	(0.0786)	(0.0048)
	[-15.0235]	[-6.0509]	[-0.4359]	[-0.2274]	[0.8052]	[0.0390]	[1.3911]	[-0.4871]	[-1.1082]	[0.6945]
Δipi_{t-1}	0.0077	-0.4588	0.0000	-0.0001	-0.0001	0.0004	-0.0001	-0.0083	-0.0075	-0.0007
	(0.0041)	(0.0265)	(0.0003)	(0.0003)	(0.0013)	(0.0003)	(0.0006)	(0.0043)	(0.0144)	(0.0011)
	[1.8807]	[-17.3018]	[-0.0724]	[-0.2377]	[-0.0484]	[1.2645]	[-0.0938]	[-1.9265]	[-0.5226]	[-0.6372]
Δeua_{t-1}	-11.8739	49.1254	0.2982	0.3162	-5.8297	-0.4733	-1.0316	-19.8331	18.5670	-0.8899
	(0.5759)	(0.3389)	(0.5411)	(0.5118)	(0.2062)	(0.4825)	(0.1107)	(0.0835)	(0.2475)	(0.1769)
	[-2.0615]	[1.4495]	[0.5511]	[0.6178]	[-2.8270]	[-0.9809]	[-0.9315]	[-2.3724]	[0.7501]	[-0.5029]
Δcer_{t-1}	1.6531	2.5525	0.0945	0.0620	-1.3072	0.0315	-0.5175	5.1540	-0.5175	-0.5417
	(0.2177)	(0.1139)	(0.1613)	(0.1663)	(0.0786)	(0.1611)	(0.3511)	(0.2474)	(0.8723)	(0.5525)
	[0.7592]	[0.2241]	[0.5861]	[0.3731]	[-1.6621]	[0.1956]	[-1.4738]	[2.0836]	[-0.0593]	[-0.9804]
Δcds_{t-1}	0.0357	-0.4210	-0.0023	-0.0007	-0.8248	-0.0024	-0.0003	0.0481	0.1357	-0.0068
	(0.0275)	(0.1608)	(0.0021)	(0.0021)	(0.0424)	(0.0019)	(0.0042)	(0.0291)	(0.1197)	(0.0075)
	[1.2983]	[-2.6174]	[-1.1314]	[-0.3564]	[-19.4690]	[-1.2788]	[-0.0683]	[1.6532]	[1.1330]	[-0.9040]
$\Delta cdso_{t-1}$	-14.3188	31.7062	0.3828	0.0007	-4.4211	-0.9653	-0.9218	-27.6680	15.1726	-0.1356
	(0.0590)	(0.3449)	(0.5646)	(0.0020)	(2.0666)	(0.5479)	(0.1177)	(0.0905)	(0.2395)	(0.1822)
	[-2.4249]	[0.9192]	[0.6780]	[0.3564]	[-2.1393]	[-1.7618]	[-0.7829]	[-3.0567]	[0.6332]	[-0.0744]
Δog_{t-1}	1.2544	0.7130	0.1531	0.1615	0.6519	0.2326	0.0783	3.7906	2.0211	-0.1112
	(0.7633)	(0.4343)	(0.0783)	(0.0657)	(0.3205)	(0.0747)	(0.1570)	(0.1372)	(0.3135)	(0.2261)
	[1.6433]	[0.17287]	[1.9546]	[2.4593]	[2.0339]	[3.1109]	[0.4990]	[2.7624]	[0.6446]	[-0.4920]
Δcss_{t-1}	-0.0221	-0.1091	-0.0022	-0.0034	-0.0346	-0.0040	0.0018	-0.3167	0.2032	-0.0048
	(0.0179)	(0.1081)	(0.0015)	(0.0013)	(0.0067)	(0.0016)	(0.0031)	(0.0461)	(0.0703)	(0.0055)
	[-1.2352]	[-1.0087]	[-1.4345]	[-2.5690]	[-5.2024]	[-2.5360]	[0.5717]	[-6.8627]	[2.8920]	[-0.8700]

Error Correction:	Δcpi	Δipi	Δeua	Δcer	Δcds	Δcdso	Δog	Δcss	Δcg	Δepi
Δcg_{t-1}	0.0010	0.2615	-0.0002	-0.0011	0.0317	0.0005	-0.0034	0.0048	-0.0122	0.0161
	(0.0186)	(0.1117)	(0.0016)	(0.0018)	(0.0071)	(0.0015)	(0.0036)	(0.0234)	(0.0692)	(0.0058)
	[0.5126]	[2.3411]	[-0.0954]	[-06530]	[4.4947]	[0.3642]	[-0.9224]	[0.2069]	[-0.1764]	[2.7629]
Δepi_{t-1}	-1.8166	8.7417	-0.0843	-2.5182	-0.2612	-0.1869	-0.1395	-2.5182	3.6938	0.4961
	(0.7035)	(0.5056)	(0.0711)	(0.1021)	(0.4705)	(0.0733)	(0.1493)	(0.1021)	(0.3121)	(0.2371)
	[-2.5820]	[1.7287]	[-1.1868]	[-2.4673]	[-0.5552]	[-2.5502]	[-0.9338]	[-2.4672]	[1.1835]	[2.0924]
Δepi_{t-2}	-1.9903	18.2530	-0.0586	-0.9501	-0.8180	-0.1345	-0.0724	-0.9501	4.9261	0.3566
	(0.6354)	(0.4533)	(0.0621)	(0.8655)	(0.4076)	(0.0664)	(0.1351)	(0.8655)	(0.2662)	(0.2051)
	[-3.1322]	[4.0260]	[-0.9443]	[-1.0977]	[-2.0070]	[-2.0252]	[-0.5356]	[-1.0977]	[1.8501]	[1.7383]
Δcg_{t-2}	0.0403	0.1163	0.0001	0.0082	0.0341	0.0006	-0.0003	0.0082	-0.0028	0.0120
	(0.0173)	(0.0962)	(0.0015)	(0.0201)	(0.0064)	(0.0014)	(0.0033)	(0.0201)	(0.0547)	(0.0049)
	[2.3335]	[1.2085]	[0.0726]	[0.4054]	[5.3195]	[0.4041]	[-0.0851]	[0.4054]	[-0.0516]	[2.4423]
Δcss_{t-2}	0.0094	-0.3698	-0.0049	-0.1286	-0.0221	-0.0055	0.0026	-0.1286	0.0957	0.0074
	(0.0153)	(0.0982)	(0.0013)	(0.0353)	(0.0096)	(0.0015)	(0.0031)	(0.0353)	(0.0659)	(0.0056)
	[0.6140]	[-3.7669]	[-3.6235]	[-3.6479]	[-2.3112]	[-3.7162]	[0.8323]	[-3.6479]	[1.4510]	[1.3174]
Δog_{t-2}	2.3002	-9.5687	0.0960	1.9436	0.8864	0.1667	0.0726	1.9436	1.0333	-0.0926
	(0.7310)	(3.8208)	(0.0689)	(0.1139)	(0.2913)	(0.0702)	(0.1375)	(0.1139)	(0.2874)	(0.2009)
	[3.1467]	[-2.5044]	[1.3926]	[1.7056]	[3.0423]	[2.3761]	[0.5276]	[1.7056]	[0.3595]	[-0.4610]
$\Delta cdso_{t-2}$	-18.8922	91.1574	-0.2772	-11.4518	-6.5327	-0.7480	-0.9997	-11.4518	9.6443	0.3555
	(0.5442)	(0.3109)	(0.0495)	(0.0761)	(0.2028)	(0.5140)	(0.1055)	(0.7610)	(0.2191)	(0.1639)
	[-3.4713]	[2.9323]	[-05600]	[-1.5048]	[-3.2216]	[-1.4551]	[-0.9472]	[-1.5047]	[0.4402]	[0.2169]
Δcds_{t-2}	0.0984	-0.5702	-0.0040	-0.0055	-0.1654	-0.0040	-0.0037	-1.0055	0.2527	-0.0042
	(0.0286)	(0.1499)	(0.0021)	(0.0322)	(0.0376)	(0.0021)	(0.0054)	(0.0322)	(0.1138)	(0.0077)
	[3.4392]	[-3.8026]	[-1.8553]	[-0.1718]	[-4.4011]	[-1.9195]	[-0.6737]	[-0.1718]	[2.2200]	[-0.5420]
Δcer_{t-2}	-0.7946	-7.6627	-0.1204	6.6991	-1.0868	0.0532	-0.6754	6.6991	0.0177	-0.4897
	(0.1934)	(0.1036)	(0.1500)	(0.2114)	(0.6398)	(0.1494)	(0.3082)	(0.2114)	(0.7530)	(0.4902)
	[-0.4108]	[-0.7395]	[-0.8025]	[3.1683]	[-1.6985]	[0.3559]	[-2.1916]	[3.1683]	[0.0024]	[-0.9989]
Δcpi_{t-2}	-0.1879	-0.4532	-0.0007	-0.0622	0.0024	0.0005	-0.0020	-0.0622	0.0423	-0.0026
	(0.0169)	(0.0796)	(0.0014)	(0.0214)	(0.0076)	(0.0011)	(0.0029)	(0.0214)	(0.0615)	(0.0047)
	[-11.1233]	[-5.6921]	[-0.5116]	[-2.9079]	[0.3207]	[0.4562]	[-0.7006]	[-2.9079]	[0.6874]	[-0.5602]
Δipi_{t-2}	-0.0042	-0.2784	-0.0003	-0.0081	-0.0053	-0.0005	-0.0001	-0.0081	0.0347	-0.0003
	(0.0043)	(0.0255)	(0.0003)	(0.0046)	(0.0014)	(0.0003)	(0.0007)	(0.0046)	(0.0146)	(0.0010)
	[-0.9660]	[-10.9035]	[-1.0209]	[-1.7610]	[-0.3676]	[-1.5654]	[-0.0783]	[[-1.7610]	[2.3705]	[-0.3059]

Error Correction:	Δcpi	Δipi	Δeua	Δcer	Δcds	Δcdso	Δog	Δcss	Δcg	Δepi
Δeua_{t-2}	17.9673	-80.2556	0.1888	4.9319	7.2562	0.4733	1.2528	4.9319	-5.5432	0.4041
	(0.5442)	(0.3081)	(0.4652)	(0.6978)	(0.1957)	(0.4825)	(0.1001)	(0.6977)	(0.2250)	(0.1548)
	[-3.4713]	[-2.6051]	[0.4058]	[0.7068]	[3.7079]	[0.9809]	[1.2514]	[0.7068]	[-0.2463]	[0.2610]
Δeau_{t-3}	15.8611	-38.9002	0.0240	-0.6869	4.9912	0.4733	0.9157	-0.6869	2.7506	-0.3848
	(0.4779)	(0.2893)	(0.3862)	(0.6104)	(0.1848)	(0.4825)	(0.8812)	(0.6104)	(0.0958)	(0.1354)
	[3.3187]	[-1.3446]	[0.0621]	[-0.1125]	[2.7006]	[0.9809]	[1.0391]	[-0.1125]	[0.1404]	[-0.2842]
Δcpi_{t-3}	0.0335	-0.2629	0.0001	0.0286	-0.0022	0.0005	-0.0038	0.0286	0.0463	-0.0029
	(0.0218)	(0.0931)	(0.0013)	(0.0199)	(0.0073)	(0.0011)	(0.0030)	(0.0200)	(0.0526)	(0.0046)
	[1.5353]	[-2.8232]	[0.0858]	[1.4320]	[-0.3070]	[0.4562]	[-1.2518]	[1.4320]	[0.8810]	[-0.6348]
Δipi_{t-3}	0.0038	-0.1310	0.0001	-0.0077	-0.0015	0.0001	0.0006	-0.0077	0.0290	-0.0009
	(0.0043)	(0.0241)	(0.0003)	(0.0042)	(0.0014)	(0.0003)	(0.0006)	(0.0042)	(0.0158)	(0.0012)
	[0.8813]	[-5.4440]	[0.3534]	[-1.8345]	[-1.1020]	[0.3018]	[1.0043]	[-18344]	[1.8338]	[-0.7289]
Δcer_{t-3}	-2.9614	-29.2081	-0.0565	5.6912	-1.1434	0.1864	-0.3874	5.6912	2.1898	-0.2564
	(0.1731)	(0.0934)	(0.1367)	(0.1738)	(0.5059)	(0.1302)	(0.2757)	(0.1738)	(0.6444)	(0.4463)
	[-1.7102]	[-3.1253]	[-0.4133]	[3.2741]	[-2.2600]	[1.4316]	[-1.4052]	[3.2741]	[0.3398]	[-0.5745]
Δcds_{t-3}	0.0722	-0.4938	-0.0019	0.0506	-0.2205	-0.0022	-0.0022	0.0506	0.2312	-0.0142
	(0.0275)	(0.1595)	(0.0023)	(0.3361)	(0.0270)	(0.0023)	(0.0052)	(0.0336)	(0.1129)	(0.0083)
	[2.6278]	[-3.0952]	[-0.7896]	[1.5068]	[-9.1527]	[-0.9334]	[-0.4266]	[1.5068]	[2.0478]	[-1.7097]
$\Delta cdso_{t-3}$	-14.9087	76.9970	0.0135	-3.2748	-4.0222	-0.2758	-0.9072	-3.2748	0.1621	1.0119
	(0.4918)	(0.2823)	(0.4137)	(0.6717)	(0.1958)	(0.4248)	(0.0949)	(0.6717)	(0.1991)	(0.1418)
	[-3.0314]	[2.7279]	[0.0326]	[-0.4875]	[-2.0542]	[-0.6493]	[-0.9554]	[-0.4875]	[0.0081]	[0.7138]
Δog_{t-3}	1.8628	-8.8065	0.0112	0.6891	0.4134	0.0651	0.1216	0.6891	0.9502	-0.1203
	(0.6713)	(0.3552)	(0.0588)	(0.1026)	(0.2808)	(0.0599)	(0.1227)	(0.1026)	(0.2693)	(0.1785)
	[2.7749]	[-2.4793]	[0.1911]	[0.6713]	[1.4722]	[1.0867]	[0.9905]	[1.0265]	[0.3529]	[-0.6741]
Δcss_{t-3}	0.0251	-0.6287	-0.0025	-0.1045	-0.0266	-0.0043	-0.0023	-0.1045	0.0180	0.0052
	(0.0178)	(0.1105)	(0.0015)	(0.0287)	(0.0086)	(0.0016)	(0.0033)	(0.0287)	(0.0653)	(0.0058)
	[1.4104]	[-5.6906]	[-1.7187]	[-3.6404]	[-3.0984]	[-2.6901]	[-0.6745]	[-3.6404]	[0.2754]	[0.8918]
Δcg_{t-3}	0.0323	0.1203	0.0004	-0.0070	0.0209	0.0001	0.0013	-0.0070	0.0288	0.0083
	(0.0158)	(0.0868)	(0.0014)	(0.0168)	(0.0058)	(0.0013)	(0.0030)	(0.0168)	(0.0465)	(0.0041)
	[2.0485]	[1.3863]	[0.2908]	[-0.4183]	[3.5993]	[0.0932]	[0.4335]	[-0.4183]	[0.6181]	[2.0179]
Δepi_{t-3}	-1.7001	18.6921	-0.0481	-0.0385	-0.1351	-0.0960	-0.0778	-0.0385	2.6543	0.3921
	(0.5581)	(0.3815)	(0.0468)	(0.0776)	(0.3536)	(0.0522)	(0.1149)	(0.0777)	(0.2301)	(0.1637)
	[-3.0462]	[4.8995]	[-1.0270]	[-0.0495]	[-0.3820]	[-1.8379]	[-0.6768]	[-0.0495]	[1.1531]	[2.3959]

Error Correction:	Δcpi	Δipi	Δeua	Δcer	Δcds	Δcdso	Δog	Δcss	Δcg	Δepi
Δipi_{t-4}	0.0012	-0.1310	0.0001	0.0003	0.0021	0.0001	0.0006	0.0003	-0.0055	0.0009
	(0.0036)	(0.0241)	(0.0003)	(0.0036)	(0.0011)	(0.0003)	(0.0006)	(0.0036)	(0.0153)	(0.0010)
	[0.3361]	[-6.6345]	[0.3251]	[0.0753]	[1.9870]	[0.3018]	[1.0415]	[0.0753]	[-0.3602]	[0.8878]
Δcpi_{t-4}	-0.0612	-0.0867	0.0008	-0.0012	-0.0116	0.0008	-0.0018	-0.0012	-0.0207	-0.0009
	(0.0148)	(0.0857)	(0.0012)	(0.0193)	(0.0092)	(0.0012)	(0.0034)	(0.0193)	(0.0575)	(0.0048)
	[-4.1242]	[-1.0109]	[0.7000]	[-0.0618]	[-1.2639]	[0.6433]	[-0.5212]	[-0.0618]	[-0.3606]	[-0.1944]
Δeua_{t-4}	8.9166	-32.3842	-0.4169	-1.0603	0.9937	-0.6113	0.0581	-1.0603	21.0873	-0.6850
	(0.3816)	(0.2442)	(0.3060)	(0.5117)	(1.0067)	(0.2917)	(0.0741)	(0.5117)	(0.1666)	(0.1118)
	[2.3363]	[-1.3260]	[-1.3624]	[-0.2072]	[0.9871)	[-2.0954]	[0.0784]	[-0.2072]	[1.2660]	[-0.6126]
Δcer_{t-4}	-2.0585	-22.7679	0.0662	3.4972	4.2390	0.1599	-0.3431	3.4972	2.2705	-0.0008
	(0.1435)	(0.0762)	(0.1128)	(0.1417)	(0.1609)	(0.1099)	(0.2161)	(0.1417)	(0.5642)	(0.3916)
	[-1.4348]	[-2.9877]	[0.5870]	[2.4676]	[2.6346]	[1.4540]	[-1.5879]	[2.4675]	[0.4024]	[-0.0020]
Δcds_{t-4}	-0.0086	-0.0235	-0.0020	0.0268	-0.2915	-0.0041	-0.0018	0.0268	0.3274	0.0034
	(0.0241)	(0.1689)	(0.0022)	(0.0278)	(0.0309)	(0.0021)	(0.0059)	(0.0278)	(0.1012)	(0.0057)
	[-0.3589]	[-0.1392]	[0.9196]	[0.9665]	[-9.4384]	[-2.0087]	[-0.3096]	[0.9665]	[3.2343]	[0.5980]
$\Delta cdso_{t-4}$	-8.4548	60.5794	0.3587	-2.2428	-3.5813	0.4708	0.1053	-2.2428	-20.6664	0.7401
	(0.4011)	(0.2450)	(0.3220)	(0.5646)	(0.1672)	(0.3150)	(0.7783)	(0.5646)	(0.1720)	(0.1164)
	[-2.1076]	[2.4725]	[1.1142]	[-0.3973]	[-2.1422]	[1.4943]	[0.1353]	[-0.3972]	[-1.2016]	[0.6358]
Δog_{t-4}	1.2209	-7.8666	-0.0277	0.8138	0.3975	-0.0434	0.0142	0.8138	3.5731	-0.1159
	(0.5567)	(3.2306)	(0.0451)	(0.8459)	(0.2346)	(0.0469)	(0.0987)	(0.8459)	(2.2744)	(0.1504)
	[2.1932]	[-2.4350]	[-06139]	[0.9621]	[1.6941]	[-0.9247]	[0.1440]	[0.9621]	[1.5710]	[-0.7704]
Δcss_{t-4}	0.0276	-0.2183	-0.0008	-0.0625	-0.0064	-0.0039	-0.0073	-0.0625	-0.0345	0.0067
	(0.0187)	(0.1169)	(0.0013)	(0.0269)	(0.0081)	(0.0014)	(0.0033)	(0.0269)	(0.0632)	(0.0050)
	[1.4633]	[-1.8669]	[-0.6294]	[-2.3246]	[-0.7939]	[-2.7798]	[-2.2414]	[-2.3246]	[-0.5454]	[1.3545]
Δcg_{t-4}	0.0065	0.0201	-0.0006	-0.0097	0.0134	-0.0009	0.0004	-0.0097	-0.0198	0.0040
	(0.0135)	(0.0827)	(0.0011)	(0.0125)	(0.0049)	(0.0011)	(0.0022)	(0.0125)	(0.0436)	(0.0034)
	[0.4784]	[0.2424]	[-0.5460]	[-0.7778]	[2.7305]	[-0.8385]	[0.1757]	[-0.7779]	[-0.4540]	[1.1786]
Δepi_{t-4}	-0.7737	12.2888	-0.0102	0.0336	0.1161	-0.0009	0.0027	0.0336	-3.0303	0.2220
	(0.4419)	(0.3159)	(0.0358)	(0.6362)	(0.2648)	(0.0381)	(0.0882)	(0.6362)	(0.2133)	(0.1374)
	[-1.7507]	[3.8895]	[-0.2865]	[0.0529]	[0.4382]	[-0.0248]	[0.0302]	[0.0529]	[-1.4204]	[1.6150]
news	-0.0400	0.1284	0.0017	0.0074	-0.0428	-0.0041	0.0132	-0.0469	-0.0308	0.0071
	(0.0531)	(0.2607)	(0.0283)	(0.0228)	(0.2915)	(0.0092)	(0.0589)	(0.3099)	(0.0951)	(0.2853)
	[-0.7521]	[0.4926]	[0.5847]	[0.3256]	[-0.1470]	[-0.4445]	[0.2240]	[-0.1513]	[-0.3240]	[0.0250]

Error Correction:	Δcpi	Δipi	Δeua	Δcer	Δcds	Δcdso	Δog	Δcss	Δcg	Δepi
cdd	0.0014	-0.0760	0.0258	0.0250	0.1272	-0.0071	0.0817	0.3362	-0.0148	0.2575
	(0.0530)	(0.2600)	(0.0282)	(0.0227)	(0.2907)	(0.0092)	(0.0588)	(0.3091)	(0.0950)	(0.2846)
	[0.0261]	[-0.2922]	[0.9139]	[1.0905]	[0.4376]	[-0.7771]	[1.389]	[1.0876]	[-0.1565]	[0.9046]
hdd	0.0268	2.3140	0.0434	0.0813	1.0207	-0.0057	0.1245	1.1990	0.5458	0.9780
	(0.2837)	(0.1391)	(0.1511)	(0.1215)	(0.1555)	(0.0490)	(0.3145)	(0.1654)	(0.5074)	(0.1523)
	[0.0945]	[1.6631]	[0.2867]	[0.6591]	[0.6561]	[-0.1157]	[0.3957]	[0.7249]	[1.0760]	[0.6422]
const	0.0044	-0.0432	-0.0367	-0.0336	-0.0719	0.0098	-0.0791	-0.2543	0.0268	-0.2392
	(0.0473)	(0.2323)	(0.0252)	(0.0203)	(0.2560)	(0.0082)	(0.0525)	(0.2761)	(0.0847)	(0.2542)
	[0.0920]	[-0.1860]	[-1.4545]	[-1.6542]	[-0.2767]	[1.1938]	[-1.5060]	[-0.9209]	[0.3164]	[-0.9407]
R-sq	0.3742	0.4890	0.8924	0.6999	0.6273	0.0562	0.1289	0.4890	0.2169	0.2668
Adj. R-sq	0.3331	0.4397	0.8822	0.6716	0.5913	-0.0380	0.0718	0.4397	0.1427	0.2187
s.e. Reg.	0.3288	0.7024	0.6748	3.3441	0.6240	0.0258	0.1066	0.7024	0.0658	0.3129
F-stat	1.6106	9.9183	87.4627	24.6122	17.4455	0.5964	2.2559	9.9183	2.9218	5.5460
Log. Lik.	-204.9800	-440.2949	-409.1544	-1669.9420	-166.7955	1768.8130	637.4500	-440.2949	984.0989	-193.0700
Akaike IC	0.6737	1.4067	1.3170	4.8339	0.6438	-4.7498	-1.5787	1.4067	-2.5693	5.2943
Schwarz IC	0.9639	1.8151	1.7190	5.2359	1.0522	-4.3287	-1.2886	1.8151	-2.1673	5.5844

Appendix C Estimates of conditional variance of VARMAX(4,0,3)

	$u(t-1)^2$	$u(t-2)^2$	$u(t-3)^2$	$u(t-4)^2$	c
Δcpi	1.445	0.354	-	-	0.017
	(0.144)	(0.070)	-	-	(0.003)
	[10.011]	[5.079]	-	-	[4.911]
Δipi	1.942	-	-	-	1.207
	(0.175)	-	-	-	(0.151)
	[11.102]	-	-	-	[7.995]
Δeua	0.186	0.115	0.072	0.491	0.027
	(0.053)	(0.043)	(0.029)	(0.085)	(0.004)
	[3.508]	[2.673]	[2.477]	[5.786]	[6.770]
Δcer	0.643	-	-	-	0.035
	(0.096)	-	-	-	(0.003)
	[6.704]	-	-	-	[12.310]
Δcds	0.449	-	-	-	6.912
	(0.078)	-	-	-	(0.515)
	[5.741]	-	-	-	[13.413]
Δcdso	0.142	0.109	0.161	0.283	0.004
	(0.061)	(0.052)	(0.055)	(0.062)	(0.001)
	[2.342]	[2.070]	[2.923]	[4.586]	[6.624]
Δog	0.127	0.242	0.090	0.226	0.151
	(0.043)	(0.057)	(0.051)	(0.061)	(0.023)
	[2.969]	[4.288]	[1.782]	[3.715]	[6.551]
Δcss	0.117	0.192	0.037	0.195	6.086
	(0.057)	(0.066)	(0.038)	(0.050)	(0.695)
	[2.066]	[2.900]	[0.989]	[3.916]	[8.751]
Δcg	0.038	-	-	-	1.085
	(0.041)	-	-	-	(0.042)
	[0.929]	-	-	-	[25.614]
		-	-	-	
Δepi	0.341	-	-	-	7.422
	(0.070)	-	-	-	(0.500)
	[4.863]	-	-	-	[14.844]

Appendix D Risk Weighted Assets

Types of risk weighted assets (RWA)		Model	Size of RWA
(1) Market risk weighted assets	a. Interest rate risk	a.1. standardized approach	Duration x Δyields
		a.2. Internal model	12.5 x VaR
	b. Foreign exchange translation risk	b.1. Standardized approach	12.5 x net open position for each currency
		b.2. Internal model	12.5 x VaR
(2) Operational risk weighted assets		Basic indicator approach	positive annual gross income in the last 3 years
(3) Credit risk weighted assets		a. Without credit insurance	85% of volume
		b. With credit insurance	
		b.1. State owned credit insurance company	20% of volume
		b.2. Other credit insurance companies:	
		b.2.1.) AAA – AA- rated firm	20% of volume
		b.2.2.) A+ - BBB rated firm	50% of volume
		b.2.3.)BB+ - B- firms	75% of volume
		b.2.4.)Others	100% of volume

Sources: Central Bank of Indonesia

Appendix E Questionnaires for banking survey

QUESTIONAIRES

STUDY ON BANK MARGIN AND SUSTAINABLE BANKING

Shanty Noviantie
PhD Program in Economics & Finance
Università degli Studi di Verona, Italy

Q1. Rank financial instruments in which you invest "ST liquidity surplus"[1)] in the last 5 years. Rank the instruments from the most frequently to the less frequently you invest in.

1) "ST liquidity surplus": Cash In Flow > Cash Out Flow, with time to maturity ≤ 1 month

Q2. Rank financial instruments that you use to fund/cover "ST liquidity shortage"[2)] in the last 5 years.
Rank instruments from the most frequently to the less frequently you use.

2) ST liquidity shortage occurs when Cash In Flow < Cash Out Flow at any hour or day, within 1month period

Q3. Write down your pricing model for loans.

Notes:
If your formulation/equation depends on types of loans, write down formulation/equation for each type of loans

Q4. Write down your pricing model for deposits.

Notes:
If you distinguish the formulation/equation for each type of deposits, write down formulation/equation for each type of deposits

Q.5. What is your institutional structure in Indonesia?
(put cross sign (X) in the box next to your answer)

☐ Branch of a foreign bank
Location of the head office (country):

(go to Q8)

☐ Subsidiary of a foreign company
(notes: if your ultimate shareholder is a foreign company, you belong to this class)
(go to Q6)

☐ Local/Indonesian bank
(go to Q16)

Q6. Is your parent company/majority shareholder/ultimate shareholder a foreign bank?
(put cross sign (X) in the box of your answer, and fill up associated yellow box)

☐ Yes
Location of the head office of parent company or majority/ultimate shareholder (country):

(go to Q12)

☐ No
(go to Q7)

Q7. Do you have a sister company which is a foreign bank?
(put cross sign (X) in the box of your answer, and fill up associated yellow box)

☐ Yes
Location of sister company (country):

(go to Q.)

☐ No
(go to Q.)

Q8. Does your head office build pricing model in Q3?
(put cross sign (X) in the box of your answer)

☐ Yes
(go to Q9)

☐ No
(go to Q10)

Q9. Does your head office build pricing model in Q4?
(put cross sign (X) in the box of your answer)

☐ Yes
(go to Q16)

☐ No

(go to Q11)

Q10. Does the regional office build pricing model in Q3?

(put cross sign (X) in the box of your answer, and fill up associated yellow box)

☐ Yes

Location (i.e. Country) of regional office:

(back to Q9)

☐ No

(back to Q9)

Q11. Does the regional office build pricing model in Q4?

(put cross sign (X) in the box of your answer, and fill up associated yellow box)

☐ Yes

Location (i.e. Country) of regional office:

(go to Q16)

☐ No

(go to Q16)

Q12. Does your parent company/majority shareholder/ultimate shareholder build model in Q3?

(put cross sign (X) in the box of your answer)

☐ Yes

(go to 13)

☐ No

(go to Q14)

Q13. Does your parent company/majority shareholder/ultimate shareholder build model in Q4?

(put cross sign (X) in the box of your answer)

☐ Yes

(go to Q16)

☐ No

(go to Q15)

Q14. Does your sister company use pricing model in Q3?
(put cross sign (X) in the box of your answer)

☐ Yes *(back to Q13)*

☐ No *(back to Q13)*

Q15. Does your sister company use pricing model in Q4?
(put cross sign (X) in the box of your answer)

☐ Yes *(go to Q16)*

☐ No *(go to Q16)*

Q16. State variables/factors determining whether or not a project/loan proposal is bankable (max. 20 variables/factors)!

Q17. Do you have volume/size threshold for a bankable loan proposal?
(put cross sign (X) in the box next your answer)

☐ Yes

☐ No
(go to Q19.)

Q18. What kind of volume/monetary limit do you adopt?
(put cross sign (X) in the box of your answer, and fill up associated yellow box)

☐ Lower bound/limit
at least as much as (in IDR) ....

☐ Range (i.e. Lower & upper bound/limit)
....

☐ Upper bound/limit
less than (in IDR) ………………………………

Q19. **Volume of each type of loans as of 31-Dec-2010**

Working capital lines of credit	IDR ………
Seed capital program/start up loans	IDR ………
Trade finance	IDR ………

Q20. **How much have you disbursed annually within period 2005 – 2010, to the following projects?**

Indicate:

A: for "Working capital lines of credit" generating CER

B: for " investment loans" generating CER

C: for "Trade finance" in project generating CER

D: for "Others"

Q.21 Do you estimate revenue generated from selling CER?
If 'YES', gives an example how such revenue is factored in loan price