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Welcome Address from President, UTCC

Welcome to the inaugural issue of the University of the Thai Chamber of Commerce (UTCC) International Journal of Business and Economics (IJBE). I appreciate greatly the support of the UTCC and Thailand Management Association (TMA) in spinning off this first international journal.

In retrospect, the Thai Chamber of Commerce was founded in 1940 and a non-profit education institution called "UTCC" was established with current 9 schools (School of Business, Accountancy, Economics, Humanities, Science, Communication Arts, Engineering, Law, and Graduate School). The UTCC has also consistently issued a domestic journal named as "UTCC Journal" over the past 28 years, written in bilinguals (Thai and English). Its 45 years education experience provides an excellent environment for both of students and faculty in order to enhance to the next academic level.

For its ultimate goal, the UTCC is aimed at becoming 1 out of 500 best universities around the world. To strive to be among the best, this inaugural issue of the UTCC IJBE is therefore instrumental for the most important academic growths to extend a high quality tradition in the education field to the world.

Over the past few years, I have noticed the rapid development of Business, Economics, and Accountancy within the industrial, academic and governmental sectors. More and more people are talking, researching and applying Business, Economics, and Accountancy within a myriad of contexts. There is much excitement in the field; thereby the UTCC IJBE has been established in response to this increased interest in Business, Economics, and Accountancy issues as a forum for interested parties to advance knowledge and science of the aforementioned discipline. The geographical scope of the journal is not solely limited to Thailand and the surrounding regions, but also to the world. It is hoped that this inaugural issue will set a new benchmark in terms of academic publications. Through the support of our Editorial and Advisory Boards, I hope this journal could provide academic articles of the highest quality to all readers.

Chiradet Ousawat, Ph.D.
President,
University of the Thai Chamber of Commerce

Welcome Address from Deans, UTCC

It is appropriate to celebrate the launch of an exciting new journal. The UTCC IJBE will serve and provide a forum for exchange of ideas among business executives and academicians concerned with Business, Economics, and Accountancy issues. With the rapid evolution of corporate business from international to global in recent years, general business has been one of the areas of greatest added complexity and concern for corporate managers. The UTCC IJBE will be an academic journal combining academic inquiry and informed business practices. It will publish empirical, analytical, review, and survey articles, as well as case studies related to all areas of Business, Economics, and Accountancy. A sentiment often expressed by practitioners is that academic research in general may not be addressing the most relevant questions in the real world.

It is fair to say that the UTCC IJBE will publish high-quality applied-research papers. Nevertheless, studies that test important theoretical works and shed additional light on the issue with some business implications will also be solicited. Each submitted paper has been reviewed by several members of the UTCC IJBE international editorial board and external referees. On the basis, we would like to thank all of them for their support with review process of submitted papers.

We cordially invite papers with theoretical research/conceptual work or applied research/applications on topics related to research, practice, and teaching in all subject areas of Business, Economics, Accountancy, or related subjects. We welcome paper submissions on the basis that the material has not been published elsewhere. Our goal is to develop a journal that will appeal to both business and management practitioners. We expect the UTCC IJBE to be an outstanding international forum for the exchange of ideas and results, and provide a baseline of further progress in the aforementioned areas.

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Dr. Frederic Tournemaine is a lecturer at the School of Economics, and a researcher at the University of Chicago-UTCC Research Center at the University of the Thai Chamber of Commerce. He graduated with a Ph.D. in Economics in 2004 from the University of Toulouse (France), with MPhil in Mathematics Economics and Econometrics. Dr. Frederic Tournemaine has published several articles in peer-reviewed journals such as Oxford Economic Papers, Economics Letters, Journal of Population Economics, Economics Bulletin, Ecological Economics, Scottish Journal of Political Economy, Revue d□Economie Politique, Chulalongkorn Journal of Economics, Journal of International Development. His research interests include Growth Theory, Sustainable development, Behavioral Economics and Industrial Organization.

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Foreword

In this inauguration issue of the UTCC International Journal of Business and Economics (UTCC IJBE), the Editors received a number of papers from different countries such as Australia, France, Nigeria, Taiwan, Thailand, and United Kingdom. The received papers encompassed many areas of marketing, banking, economics, insurance and risk management, industrial and operation management, strategic management, and international and global business management.

After a reviewing process, a total of ten papers were selected for publication in this first issue of the UTCC IJBE. These ten papers can only provide readers with an overview of the scope of Business, Economics, and Accountancy.

In the first article, entitled ***"The Efficiency of Thai Commercial Banks between the First Quarter of 2007 and the Third Quarter of 2008"*** conducted by ***Ekachai Apisakul***. The paper seeks to evaluate the efficiency of 11 Thai commercial banks and to improve the efficiency under Data Envelopment Analysis (DEA) approach over the period of the first quarter of 2007 and the third quarter of 2008. It is found that all Thai commercial banks maintained in the high level of efficiency. It was found from the literature review that large commercial banks in the first tier had always produced their outputs on the production frontier along the studied periods. On the contrary, small commercial banks in the second and third tier could sometimes produce their outputs on the production frontier.

The second article deals with supply chain management issues. This paper is authored by ***Manisra Baramichai,*** and is entitled ***"Developing the Integrated Model to Support the Sourcing Decision under Uncertainty"***. This paper addresses two aspects of the purchasing decision, supplier selection and order allocation assignment. We particularly consider the purchasing decision in the contract environment when there is uncertainty on the demand of the purchased products. Our analysis includes the supplier selection, the contract selection, and the order allocation assignment.

The third article is co-authored by ***Robert J. Bianchi, Michael E. Drew, and Thanula R. Wijeratne,*** and is entitled ***"Systemic Risk, the TED Spread and Hedge Fund Returns"***. This study examines the effects of systemic risk on global hedge fund returns. We consider systemic risk as a conditional information variable to predict the underlying exposures to various asset market returns and risk factors. This study examines a proxy for global systemic risk employed by investment professionals known as the Treasury/Eurodollar (TED) spread. The findings reveal that increases in systemic risk causes some hedge fund investment styles to dynamically reduce their equity and stock momentum exposures while others increase their exposures to investment grade bonds and commodities. The information content of systemic risk via the TED spread assists us in better understanding the behaviour of global hedge fund returns.

The fourth paper is examined by ***Ornprapa Charoenphan***. Her paper is entitled ***"Factors Affecting Brand Loyalty towards Fermented Milk in Bangkok, Thailand"***. The purpose of this research is to examine the factors affecting brand loyalty towards fermented milk. This research explores and explains the relationship between family influence, brand awareness, brand associations, perceived quality and brand loyalty. The research is conducted with fermented milk consumers aged below 40 years old who are loyal to a brand and be working people in Silom, Sathorn and Surawong area. The primary data is gathered from 399 respondents. The result indicated that family influence has a positive relationship with brand awareness, brand associations and perceived quality. Brand awareness, brand associations and perceived quality have a positive relationship with brand loyalty. The most important factor that is affected to brand loyalty is brand associations which caused from family influence.

In the fifth article, entitled ***"Bank Consolidation in Nigeria: An Analysis of Strategic Characteristics of Banks in Mergers and Acquisitions"*** This study attempts to address this issue and analyze the factors that are expected to influence the success of mergers and acquisitions in the Nigerian banking sector during the 2004 bank consolidation exercises by analyzing the pre-merger and post merger strategic characteristics of these banks to establish whether those banks that merged are strategically related and hence could benefit mutually from consolidation. This is with a view to establishing whether merger and acquisition is an appropriate instrument the government can use to bring about improved banking operations in Nigeria. The study utilized data on sample that includes all the banks in existence two years before and after 2004 banking reforms. Findings generally indicate that broad similarities among merging banks had significant positive effects on bank performance. This implies that the union among these banks was mutually beneficial and hence led to improved operating performance of banks.

Article number six is entitled ***"Simultaneous Strategic and Operational Planning in Supply Chain Design for Notebook-Computer Industry"***, and is co-authored by ***Cheng-Min Feng and Chi-Hwa Chern***. This work develops an integrated multi-objective supply chain model for application in simultaneous strategic-level and operational-level planning. Multi-objective decision analysis is performed so that a performance measurement system based on cost, customer service levels (fill rates), and Flexibility (volume and delivery) can be adopted. This measurement system provides more comprehensive measurement of supply chain system performance. The model developed herein helps in (1) the design of efficient, effective, and flexible supply chain systems, and (2) the evaluation of competing supply chain for the notebook-computer industry in Taiwan.

The seventh article is conducted by ***André Grimaud***, and is entitled ***"Environmental policy and growth when utility is affected by the stock of resource pollution"***. This paper considers an endogenous growth model in which a non-renewable resource gives rise to pollution. The flow of pollution progressively accumulates and deteriorates the quality of environment that affects the utility of households. One shows that, in an unregulated decentralized economy, welfare can be increased by delaying extraction, i.e. by delaying pollution. This can be obtained by a failing ad valorem tax rate on the resource.

Article number eight is written by ***Taweesak Theppitak***, and is entitled ***"A Study on a Competitive Position and Readiness of Thai Logistics Services for International Trade Liberalisation"***. The main objective of this study is to examine the current capacities of Thai LSPs, including an assessment of their readiness and adaptability to services liberalisation with international trade partners. This study also examines issues related to the benefits and costs of logistics services liberalisation in Thailand.

The ninth article is conducted by ***Chris Tsoukis***, and is entitled ***"Public Services, the Keynesian Multiplier, and Growth"***. The author investigates an endogenous growth model with elastic labour supply, monopolistic competition in the product market, productive public services, and "keeping up with the Joneses" effects in order to analyse the nature of the Keynesian multiplier and its relation to a "supply side multiplier". The main finding is that the (reduced-form) balanced-budget multiplier is hump-shaped (against government size) and envelopes the "supply-side multiplier" of Barro (1990). Further, the growth- and welfare-maximising government size is that of Barro (1990). We also find that an increase in the "Joneses" effect and a decrease in monopoly power increase labour supply and growth.

Last but not the least, the article entitled ***"The Effectiveness of Managers' Leadership Styles: A Case Study from Retail Tire Companies in Thailand"*** is examined by ***Vissanu Zumitzavan, Jonathan Michie and Ian Clark***. This paper investigates leadership styles and organisational effectiveness, and discusses which styles of leadership are supportive to business. The research sampled 140 managers by survey questionnaire; in analysing the data, the statistical technique of hierarchical multiple regressions was applied. Results show that leadership styles do have an influence on organisational effectiveness.

It is hoped that you will enjoy reading these articles and that they will generate responses and discussions that will help advance our knowledge of the field of Business, Economics, and Accountancy. The Editors and the Editorial Board of the UTCC IJBE would like to welcome your future submissions to make this journal your forum for sharing ideas and research work with all interested parties.

Ungul Laptaned
Frederic Tournemaine
Editors-In-Chief

Suthawan Chirapandu
Supaporn Kiattisin
Associate Editors

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The Efficiency of Thai Commercial Banks between the First Quarter of 2007 and the Third Quarter of 2008

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The Efficiency of Thai Commercial Banks between the First Quarter of 2007 and the Third Quarter of 2008

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Abstract

The paper seeks to evaluate the efficiency of 11 Thai commercial banks and to improve the efficiency under Data Envelopment Analysis (DEA) approach over the period of the first quarter of 2007 and the third quarter of 2008. It is found that all Thai commercial banks maintained in the high level of efficiency in conformity with Rangkakulnuwat (2007)'s study which show that large commercial banks in the first tier had always produced their outputs on the production frontier along the studied periods. On the contrary, small commercial banks in the second and third tier could sometimes produce their outputs on the production frontier.

Keywords: Efficiency, DEA, Thai Commercial Bank

1. Introduction

In1997, the financial crisis represented one of the most important lessons for Thailand. Moreover, it also affected to other Asian financial markets. The Thai Government and private sectors needed to find the way out during the crisis. Indeed, government policies were existed to intervene in Thai economy. The private sector changed strategies to match with unexpected situations by minimizing cost or increasing efficiency. For example; gaining comparative advantage was necessary to focus on how domestic products could be exported to compete with other countries. Especially, after the crisis, the economy restoration made the competition become more aggressive because of business expansion and free trade agreement with other parties. Therefore, many countries started to enhance the invested capital, to develop technology, to train higher educated labor, and to create a better operation system. In short, all types of businesses should be developed their efficiencies to sustain success.

Recently, the financial crisis beginning in the United State on September 2007 has been led from subprime loan problem. The instability of world economic system was not only existed but also impacted all over the world. Even all kinds of business in Thailand got an indirect effect that world economy has reached to the recession state. As a result, all types of sector had profitability turned to decrease gradually until their liquidations were collapsed. Commercial banks have played the interesting role during the crisis since they have provided sources of funds for the private sector. Moreover, these all commercial banks have been considered before the Bank of Thailand determined

monetary policies. Hence, the government should know relative performance to design suitable plans for helping or protecting the banks' efficiency.

Data Envelopment Analysis (DEA) is one of the basis econometrics for estimating the efficiency and to figure out the way to increase the efficiency. Burger and Humphrey (1997) found that research papers about the efficiency of commercial bank were studied in 21 countries (up to 130 papers) and mostly published between 1992 and 1997. This research has been studied continually after this period such as Ayadi et. al. (1998), Ho and Zhu (2004), Mostafa (2007), Poomthan Rangkakulnuwat (2007). In respects of DEA advantages, the assumption about the relationship between inputs and outputs is not required (Coelli et. al., 1998). In order to evaluate the efficiency of commercial banks, the DEA approach is adopted extensively.

2. Theoretical Framework

DEA is not only a non-parametric approach or functional form but it can also evaluate relative efficiency in case of a number of producers having the same multiple inputs and outputs. Charnes, Cooper and Rhodes (1998) initially developed DEA by solving linear programming in which mathematics form has the consistency with constraint and possibly make objective functions maximized as expected (Cooperative Auditing Department, 2005).

The estimation for efficiency is to consider the level of comparative advantage of Decision Making Units (DMUs). If any DMU has single input and output, efficiency can be evaluated as follows

$$\text{Efficiency} = \frac{\text{Output}}{\text{Input}}$$

Relative efficiency evaluation is to compare between efficiency score in each DMU and standard score (Akarapong Unthong, 2004) can estimate as follows

$$\text{Relative Efficiency} = \frac{\text{Weighted Sum of Output}}{\text{Weighted Sum of Input}}$$

The above formulation can generate the mathematics equation as

$$\text{Relative Efficiency} = \frac{\sum \mu_r y_{rj}}{\sum \omega_i x_{ij}} \quad ; i = 1, \ldots, m, r = 1, \ldots, s, j = 1, \ldots, n$$

Where,

x_{ij} be amount of Input i of DMU j
y_{rj} be amount of Output r of DMU j
μ_r be weighted Sum of Output r
ω_i be weighted Sum of Input i
n be amount of DMU
s be amount of Output
m be amount of Input

Based on the study, the way to estimate the efficiency has an influence from mathematics pattern as the concept of Charnes *et al.* (1978). This is to evaluate the efficiency of DMU n, indeed, output r will be a result if input i is used. Nevertheless, the efficiency of DMU can figure out by

solving linear programming offered by Charnes. The pattern is necessary to consider input orientated measurement and constant returns to scale (CRS), the equation can be interpreted as

$$\begin{aligned} & \text{Min} \sum \omega_i x_{ij} \\ \text{s.t.} \quad & \sum \mu_r y_{rj} = 1, \\ & \sum \mu_r y_{rj} - \omega_i x_{ij} \leq 0 \\ & \mu_r , \omega_i \geq \varepsilon \geq 0 \qquad ; i = 1, \ldots, m, r = 1, \ldots, s, j = 1, \ldots, n \end{aligned}$$

Where,

x_{ij} be amount of Input i of DMU j
y_{rj} be amount of Output r of DMU j
μ_r be weighted Sum of Output r
ω_i be weighted Sum of Input i
n be amount of DMU
s be amount of Output
m be amount of Input
ε be non-archimedean

The above formulation is in the multiplier form of DEA. To evaluate the efficiency, it can be estimated by solving linear programming in pattern of dual problem as shown in the following equation as

$$\begin{aligned} & \text{Max } \theta + \varepsilon (\sum s^-_{ij0} + \sum s^+_{rj0}) \\ \text{s.t.} \quad & \sum x_{ij} \lambda_j + s^-_i = \theta x_{ij0}, \\ & \sum y_{rj} \lambda_j - s^+_r = y_{r0} \\ & \lambda_j, s^-_i, s^+_r \geq 0 \quad \forall i,j,r \; ; i = 1, \ldots, m, r = 1, \ldots, s, j = 1, \ldots, n \end{aligned}$$

Where,

s^-_i be slack of Input i of DMU j
s^+_r be slack of Output r of DMU j
θ be unconstrained

3. Data and Methodology

3.1 Scope of the Study and Collection Data

To study the efficiency of Thai commercial banks, this paper collects the secondary data in the pattern of financial statement from annual reports over the period of the 1st quarter of 2007 and the 3rd quarter of 2008. The data relies on eleven Thai commercial banks: ACL Bank, Bank of Ayudhya, Bangkok Bank, Bank Thai, Kasikorn Bank, Kiatnakin Bank, Krung Thai Bank, Siam Commercial Bank, Siam City Bank, Tisco Bank and Thai Military Bank. While Thanachart Bank, United Oversea bank and Standard Chartered Bank represent other three Thai commercial banks which are excluded due to non-existing financial statement from annual report in the studied periods.

3.2 Conceptual Framework

To determine the relationship between inputs and outputs is the most important to evaluate the efficiency. Sherman and Rupert (2006) argued that both of variables should be considered as expected efficiency, however, there was no evidence about how to imply "inputs and outputs" (Casu and Molyneus, 2003). Furthermore, Prasopchai Pasunon (2006) commented about the applications of input and output; for example a number of variables represented as inputs and outputs which must be

positive and all selected variables can possibly explain relative efficiency of the organization. According to figure 3.1, this study uses interest expenses and non-interest expenses as two inputs, and three outputs are composed of deposits, loans and profits.

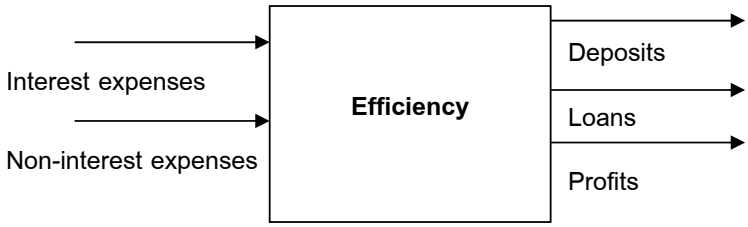

Figure 1 Inputs and Outputs

3.3 Data Analysis

There are two models under the DEA approach; CCR model represents input which is direct variation with output, in contrast, BBC model represents input which is reversed variation with output (Korchoke and Wittaya, 2006).

This study used Frontier Analyst Version IV program developed by Banxia (2008). To evaluate the efficiency score always consider input minimization and output maximization. Efficiency score is in range between 0 and 100%. If any DMU comes out maximum score or 100% which means that DMU reaches to efficiency. On the other hand, if the DMU efficiency score is less than 100%, it means that the DMU lacks of efficiency. Eventually, efficiency of any DMU is a direct variation as a studied DMU and variables of input and output (Boussofiane et. al., 1991).

According to Cooperative Auditing Department (2006), efficiency score of Thai commercial banks in pattern of CCR model is organized into four efficiency levels as the following:

Efficiency Score	**Efficiency Level**
More than 90 – 100%	Very high
More than 70 – 90%	High
More than 50 -70%	Intermediate
Less than 50%	Low

4. Results and Analysis

The results can be separated into two parts:

Part 1 – Efficiency score of Thai commercial banks classified by individual bank

Part 2 – Average efficiency score of Thai commercial banks' tiers grouped by total assets

Part 1 - Efficiency score of Thai commercial banks classified by individual bank

Table 1 Efficiency scores of eleven Thai commercial banks

Unit: Percentage

DMU	2007					2008			
	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Average first 3 quarters	Quarter 1	Quarter 2	Quarter 3	Average first 3 quarters
ACL	66.8	71.1	95.6	55.9	**77.8**	100.0	73.2	96.5	**89.9**
BAY	95.5	-	100.0	75.1	**97.8**	87.5	80.0	73.3	**80.3**
BBL	100.0	100.0	100.0	100.0	**100.0**	100.0	100.0	93.2	**97.7**
BT	100.0	-	-	-	**100.0**	-	70.9	100.0	**85.5**
KBANK	100.0	100.0	100.0	100.0	**100.0**	100.0	100.0	97.4	**99.1**
KK	88.7	100.0	100.0	100.0	**96.2**	89.4	83.6	100.0	**91.0**
KTB	100.0	100.0	100.0	100.0	**100.0**	100.0	100.0	100.0	**100.0**
SCB	88.9	99.0	100.0	100.0	**96.0**	100.0	100.0	100.0	**100.0**
SCIB	100.0	90.3	-	97.7	**95.2**	100.0	85.6	79.6	**88.4**
TISCO	100.0	96.3	91.7	100.0	**96.0**	95.8	96.6	96.7	**96.4**
TMB	100.0	-	-	-	**100.0**	90.1	79.8	74.8	**81.6**

Note: Signal – represents any number of input and/or output is negative

Table 4.1 shows efficiency scores of eleven Thai commercial banks classified by individual bank. The comparison between average efficiency scores over the study period showed that all of them maintained in "high" level of efficiency varying from 77.8 % to 100%. Most of individual efficiency scores were 100.0%, which means that they had produced their outputs on the production frontier in those periods. Considering individual banks are shown as follows:

1) ACL Bank's average efficiency score in the first three quarters increased from 77.8% in 2007 to 89.9% in 2008. The results had consistency when efficiency scores were compared with the same quarter in previous year. Their scores reached to 100.0%, 73.2% and 96.5% in the first, second and third quarter of 2008, rising from 66.8%, 71.7% and 95.6% in the first, second and third quarter of 2007, respectively.

2) Bank of Ayuthaya's efficiency scores decreased from 95.5 and 100.0% in the first and third quarter of 2007 to 87.5 and 73.3% in the first and third quarter of 2008, respectively. While its efficiency score in the second quarter of 2007 could not be identified because the amount of profits was negative. That was why it could not compare with the efficiency score in the second quarter of 2008.

3) Bangkok Bank's average efficiency score in the first three quarters decreased from 100.0% in 2007 to 97.8% in 2008, especially, the third quarter of 2008 had its efficiency score of 93.2% declined a lot from 100.0% in 2008. As a result, overall efficiency scores adjusted were worse than when they were compared with the same quarter in previous year.

4) Thai Bank could not identify the efficiency scores in any quarter because their amounts of profits were negative. That was why Thai Bank's efficiency scores could not compare with the same quarter in previous year significantly.

5) Kasikorn Bank's average efficiency scores in the first three quarters decreased a bit from 100.0% in 2007 to 99.1% in 2008. As a result, overall efficiency scores adjusted were worse than when they were compared with the same quarter in previous year.

6) Kiatnakin Bank's average efficiency scores in the first three quarters decreased from 96.2% in 2007 to 91.0% in 2008. Its efficiency score in the first quarter of 2008 was 89.4%, rising slightly from 88.7% in 2007. Moreover, the efficiency score in the second quarter of 2008 turned to be 83.6%, decreasing from 100.0% in 2007. As a result, overall efficiency scores adjusted worse than when they were compared with the same quarter in previous year.

7) Krung Thai Bank's average efficiency scores in the first three quarters were stable at 100.0% in both 2007 and 2008. It means that Krung Thai bank had always produced its outputs on the production frontier along those periods.

8) Siam Commercial Bank's average efficiency scores in the first three quarters increased from 96.0% in 2007 to 100.0% in 2008. Indeed, its efficiency score in the first quarter of 2008 was 100.0%, rising from 88.9% in 2007. In the second quarter of 2008 its efficiency score was 100.0%, also rising from 99.0% in 2007. As a result, overall efficiency scores adjusted were better than when they were compared with the same quarter in previous year.

9) Siam City Bank's efficiency score in 2008 decreased from the same quarter in previous year, especially, in the second quarter its efficiency score declined from 90.3% in 2007 to 85.6% in 2008. Moreover, its efficiency score in the third quarter of 2007 could not be identified because the amount of profits was negative. That was why it could not compare with the same quarter in previous year.

10) Tisco Bank's average efficiency scores in the first three quarters increased a bit from 96.0% in 2007 to 96.4% in 2008. Its efficiency score in the first quarter in 2008 was 95.8%, declining from 100.0% in 2007. However, its score turned to increase in the second and third quarter from 96.3 and 91.7% in 2007 to 96.6 and 96.7% in 2008, respectively. As a result, overall efficiency scores adjusted were better than when they were compared with the same quarter in previous year.

11) Thai Military Bank's efficiency score in 2008 decreased from the same quarter in previous year, especially; in the first quarter its efficiency score in 2008 was 90.1%, declining from 100.0% in 2007. However, it could not be identified the efficiency scores in the second and third quarter of 2007 because their amounts of profits were negative. That was why could not compare the efficiency scores along the same quarter in upcoming year.

Part 2 - Average efficiency score of Thai commercial banks' tiers grouped by total assets

According to the concept of Poomthan Rangkakulnuwat (2007), three of commercial banks were grouped by total assets. The banks in the first tier had total assets greater than 1 billion baht. The second tier was occupied by total assets between 500,000 million and 1 billion baht and the third was less than 500,000 million baht.

Table 2 Average efficiency scores of three Thai commercial banks' tiers

Unit: Percentage

Commercial Bank Tier	2007				2008		
	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Quarter 1	Quarter 2	Quarter 3
First Tier	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Second Tier	100.0	-	100.0	100.0	97.6	88.9	87.0
Third Tier	100.0	86.9	100.0	100.0	95.9	78.9	100.0

Note: Signal – represents any number of input and/or output is negative

Table 4.2 shows average efficiency scores of three Thai commercial banks' tiers grouped by total assets. The results found that average efficiency scores of all tiers in the first, third and fourth quarter of 2007 were 100.0%. It means that along these periods commercial banks in all tiers had produced their outputs on the production frontier. Except the second tier, commercial banks in the first tier average efficiency scores were 100.0%. Commercial banks in the second tier could not identify the efficiency score because the amount of profits was negative. Furthermore, Commercial banks in the third tier average efficiency score was 86.9% which was less than the others. In 2008, average efficiency scores of commercial banks in the first tier were 100.0% along those periods. Average efficiency scores in the second tier declined to 97.6, 88.9 and 87.0% in the first, second and third quarter, respectively. Commercial banks in the third tier average efficiency scores turned to be 95.9, 78.9 and 100.0% in the first, second and third quarter, respectively.

5. Conclusion Suggestion and Recommendation

The study concerned on the efficiency of Thai commercial banks over the period of the first quarter of 2007 and the third quarter of 2008. The secondary data was collected from eleven Thai commercial banks' financial statements. DEA was adopted extensively to evaluate the efficiency by using interest expenses and non-interest expenses as their two inputs, while three outputs captured deposits, loans and profits.

Considering the efficiency of eleven Thai commercial banks classified by individual bank, it was concluded that all Thai commercial banks were in high level of efficiency. This might lead from the lesson they faced with financial crisis among 1997 and the strengths of financial statement which did not have any effect on the business too much.

The results of evaluating the efficiency of three Thai commercial banks' tiers grouped by total assets could be concluded that commercial banks in the first tier their efficiencies were higher than the rests of tiers. Commercial banks in the first tier had always produced their outputs on the production frontier along the studied periods. However, commercial banks in the second and third tier could produce their outputs on the production frontier in some period. This had the consistency with Poomthan Rangkakulnuwat (2007). It possibly said that large commercial banks had the ability to supply the capital, and continued expanding to a group of new customers. Customers' confidential on large commercial banks was much better than small ones.

The way to improve the efficiency of Thai commercial banks and to response financial crisis is by the best solution. Seven Thai commercial banks' efficiencies in the third quarter of 2008 were

less than 100.0% or had not produced their outputs on the production frontier. In the final quarter of 2008, they might have to change their inputs and outputs to enhance the business with efficiency as shown in Table 3-9.

Table 3 Improving the efficiency of ACL Bank in the fourth quarter of 2008

Variable	Minimize Inputs			Maximize Outputs		
	Actual (M. baht)	Target (M. baht)	Potential	Actual (M. baht)	Target (M. baht)	Potential
Interest expenses	386.1	218.5	-43.4 %	386.1	226.3	-41.4 %
Non-interest expenses	326.3	315.0	-3.5 %	326.3	326.3	0.0 %
Loans	43,663.8	43,663.8	0.0 %	43,663.8	45,229.5	3.6%
Deposits	25,789.7	45,026.3	74.6 %	25,789.7	46,640.9	80.9 %
Profits	134.6	164.4	22.1 %	134.6	170.3	26.5 %

Table 4 Improving the efficiency of Bank of Ayuthaya in the fourth quarter of 2008

Variable	Minimize Inputs			Maximize Outputs		
	Actual (M. baht)	Target (M. baht)	Potential	Actual (M. baht)	Target (M. baht)	Potential
Interest expenses	3,820.7	2,760.1	-27.8 %	3,820.7	3,763.6	-1.5 %
Non-interest expenses	5,425.7	3,979.0	-26.7 %	5,425.7	5,425.7	0.0 %
Loans	551,572.7	551,572.7	0.0 %	551,572.7	752,114.1	36.4 %
Deposits	505,168.9	568,784.7	12.6 %	505,168.9	775,584.1	53.5 %
Profits	1,019.0	2,076.7	103.8 %	1,019.0	2,831.7	177.9 %

Table 5 Improving the efficiency of Bangkok Bank in the fourth quarter of 2008

Variable	Minimize Inputs			Maximize Outputs		
	Actual (M. baht)	Target (M. baht)	Potential	Actual (M. baht)	Target (M. baht)	Potential
Interest expenses	6,911.9	6,263.0	-9.4 %	6,911.9	6,720.5	-2.8 %
Non-interest expenses	9,688.5	9,0289.0	-6.8 %	9,688.5	9,688.5	0.0 %
Loans	1,180,411.8	1,251,610.4	6.0 %	1,180,411.8	1,343,033.4	13.8 %
Deposits	1,290,667.5	1,290,667.5	0.0 %	1,290,667.5	1,384,943.3	7.3 %
Profits	4,315.7	4,712.3	9.2 %	4,315.7	5,056.6	17.2 %

Table 6 Improving the efficiency of Kasikorn Bank in the fourth quarter of 2008

Variable	Minimize Inputs			Maximize Outputs		
	Actual (M. baht)	Target (M. baht)	Potential	Actual (M. baht)	Target (M. baht)	Potential
Interest expenses	4,641.5	4,521.3	-2.6 %	4,641.5	4,641.5	0.0 %
Non-interest expenses	8,309.9	7,058.1	-15.1 %	8,309.9	7,245.7	-12.8 %
Loans	871,971.8	871,971.8	0.0 %	871,971.8	895,144.9	2.7 %
Deposits	872,216.9	891,195.2	2.2 %	872,216.9	914,879.1	4.9 %
Profits	3,835.5	3,835.5	0.0 %	3,835.5	3,937.5	2.7 %

Table 7 Improving the efficiency of Siam City Bank in the fourth quarter of 2008

Variable	Minimize Inputs			Maximize Outputs		
	Actual (M. baht)	Target (M. baht)	Potential	Actual (M. baht)	Target (M. baht)	Potential
Interest expenses	2,192.5	1,744.2	-20.4 %	2,192.5	2,192.5	0.0 %
Non-interest expenses	3,123.2	2,484.7	-20.4 %	3,123.2	3,123.2	0.0 %
Loans	268,296.3	337,836.6	25.9 %	268,296.3	424,653.5	58.3 %
Deposits	351,592.3	351,592.3	0.0 %	351,592.3	441,944.2	25.7 %
Profits	1,315.7	1,315.7	0.0 %	1,315.7	1,653.7	25.7 %

Table 8 Improving the efficiency of Tisco Bank in the fourth quarter of 2008

Variable	Minimize Inputs			Maximize Outputs		
	Actual (M. baht)	Target (M. baht)	Potential	Actual (M. baht)	Target (M. baht)	Potential
Interest expenses	890.0	522.3	-41.3 %	890.0	540.1	-39.3 %
Non-interest expenses	755.1	730.3	3.3 %	755.1	755.1	0.0 %
Loans	98,304.6	98,304.6	0.0 %	98,304.6	101,650.5	3.4 %
Deposits	42,660.8	99,466.3	133.2 %	42,660.8	102,851.7	141.1 %
Profits	397.9	397.9	0.0 %	397.9	411.5	3.4 %

Table 9 Improving the efficiency of Thai Military Bank in the fourth quarter of 2008

Variable	Minimize Inputs			Maximize Outputs		
	Actual (M. baht)	Target (M. baht)	Potential	Actual (M. baht)	Target (M. baht)	Potential
Interest expenses	3,254.16	2,201.0	-32.4 %	3,254.16	2,942.3	-9.6 %
Non-interest expenses	4,179.84	3,126.8	-25.2 %	4,179.84	4,179.8	0.0 %
Loans	427,484.2	427,484.2	0.0 %	427,484.2	571,461.2	33.7 %
Deposits	433,499.5	436,947.7	0.8 %	433,499.5	584,111.9	34.7 %
Profits	1,666.0	1,666.0	0.0 %	1,666.0	2,227.2	33.7 %

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Developing the Integrated Model to Support the Sourcing Decision under Uncertainty

by

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Abstract

In this paper, we introduce the model that has been developed to support the decision-making under the multi-item, multi- period, and stochastic demand environment. The strategic decision related to the supplier and contract selection and the tactical decision related to the order allocation are considered simultaneously in order to optimize the expected profit. In this model, we take into consideration all the cost related to the purchasing decision (total cost of ownership, cost of lost sale and inventory-related cost). This approach is particularly meaningful for commodity items which are available from a large number of suppliers, each offering different types of contract (long-term, option and flexible contract). Companies may be interested in finding the appropriate mix of suppliers from low price, low flexibility (long-term contract), reasonable price but better flexibility (option and flexible contract) contracts or high price but no commitment (spot market) so as to reduce expected purchasing and inventory holding costs. The problem is formulated as a multi-period stochastic with recourse problem and demand uncertainty is incorporated into the model using the scenario-based probabilities. The solutions obtained from this model are the trade-off analysis between the additional cost for purchasing flexibility and the reduction of excess inventory/ supply shortage. The result from the initial case study has shown some savings over the traditional deterministic model.

1. Introduction

Globalization of competition has resulted in a highly competitive business environment. In this new environment, the purchasing function has been receiving increasing importance as a critical supply chain component. This is mainly due to the significant impact of material costs on the company performance and market value. However, in today's ever-changing markets, purchasing is always burdened with risk from uncertainties. Product demand is extremely hard to predict and volume and price of supplies are also varying. Many companies need to make an advance purchasing decision without the certain information on the future demands/ supply volume and price. Thus, one of the greatest challenges confronting these companies is to find the ways to make a purchasing decision that is efficient and able to hedge against the risk from these uncertainties.
In this study, we address two aspects of the purchasing decision, supplier selection and order allocation assignment. We particularly consider the purchasing decision in the contract environment

when there is uncertainty on the demand of the purchased products. Our analysis includes the supplier selection, the contract selection, and the order allocation assignment.

2. Backgrounds of the Problem

In order to make an effective purchasing decision under the environment where the supply/demand volume and price are uncertain, a buying company needs to make a trade-off between purchasing supplies now or waiting for better market conditions. Making an early purchasing commitment may reduce the purchasing cost, eliminate the over-reliance on volatile spot market purchases, and improve the ability of the buying company to meet the demand. However, it could increase the inventory holding cost and create risk from holding unused supplies.

One of the strategies for reducing the risk from uncertainties is to use an option contract. many industries take advantage from purchasing through the option contract since it can assure the buying companies certain amount of supply in future while provide some flexibility in adjusting the order quantity. This contract can postpone the purchase until uncertainties are resolved, and thus serve as risk hedging tools.

This has given rise to the following purchasing problem: A buying company has a small set of suppliers who compete for the business in the contract market, by offering fixed price (long-term) and option contracts with various reservation and execution fees. Besides, a buying company can also purchase from the spot market in the last minute to meet the demand, but the spot market price is usually higher. To make a purchasing decision related to supplier selection and order allocation assignment, the integrated performances of all suppliers, which may differ in cost, service, lead-time, and production capability, need to be considered. Suppliers that have a long lead-time may offer a lower purchasing price through a long-term contract without any flexibility in order quantity adjustment. More expensive suppliers may have a shorter lead time and allow greater flexibility in order quantity adjustment through an option contract. This situation forces a buying company to consider purchasing the items from an appropriate group of suppliers.

To support the decision problem addressed above, we develop the Supplier and Order Allocation Portfolio Model (S-SOAP) to help a buying company establish its purchasing portfolio. The set of solutions obtained from the S-SOAP model accommodates multiple items and multiple suppliers over a contract period and explicitly account for the demand uncertainties and the adjustments made in the initial agreement. The S-SOAP model addresses the decisions related to the supplier selection, the contract selection, and the allocation of purchased order to each supplier through each type of contract.

The S-SOAP model is most applicable to support the purchase of the leverage (non-strategic) commodities. This group of commodities has the great impact on the buying company's businesses and can be purchased from several suppliers (Lawless, 1991; Jayaraman et al., 1999). Due to the high expenditure level and the criticality of these commodities to the end-product manufacture, companies need a purchasing strategy that focus on driving the cost down and reducing the risk from excess inventory and supply unavailability. This strategy is incorporated into the S-SOAP model for making the decision.

3. Literature Review

In this study we limit our literature review to only the mathematical optimization-based models to support the supplier selection and order allocation decision under the stochastic environments. The model for supplier selection under stochastic environment includes the models developed by Paleg et al. (2002), Allonso-Ayusao et al. (2003), Burke et al. (2005). Peleg et al. (2002) proposed several stochastic models for the comparison of e-procurement strategies against long-term contracts. Allonso-Ayusao et al., (2003) described a two-stage stochastic 0-1 programming approach to the strategic planning of supply chain which includes vendor selection of raw material as one solution. Burke et al. (2005) introduced the approach for making the purchasing decision under stochastic demands by focusing on a two stage supply chain with multiple suppliers and a single buying company. The analysis utilized the framework from the traditional newsboy problem (Silver et al., 1998) to determine the appropriate order quantity for each supplier such that the expected profit associated with satisfying demand is maximized. Marti'nez-de-Albe'niz and Simchi-Levi (2005) and Fu et al. (2006) presented the models to support the purchasing decision in the contract market under uncertainties using the portfolio approach. Under this approach, the buying company can purchase the product from group of suppliers through different types of contract. Marti'nez-de-Albe'niz and Simchi-Levi (2005) characterized the policy for a portfolio contract consisting of the long-term and the option contracts. This work was later enriched by Fu et al., (2006) to take into account of both random spot prices and random demands when making a decision. However, these models haven't accounted for real-life constraints such as preferred suppliers, supplier's limited capacity, and transportation activity. In addition, the purchasing decision problem was formulated by evaluating only the purchasing price and the ordering cost, without considering the other costs related to the purchasing decision such as supplier qualification, transportation, receiving, inspection, rejection, replacement, and downtime cost.

In this paper, we enrich the existing literature by developing the S-SOAP model to help determine the set of solutions that accommodate multiple items and multiple suppliers over a contract period. In particular, we consider the decision related to the supplier selection, the contract selection, and the allocation of purchased order to each supplier through each type of contract. The decision is made under demand uncertainties with the objective to maximize the buying company's expected profit from the purchasing decision. The expected profit is calculated by including all the cost elements related to the purchasing decision (the total cost of ownership, the cost of lost sale and the inventory-related cost). The uncertainties are incorporated into the S-SOAP model using the scenario-based probabilities and the stochastic optimization technique is employed to determine the optimal solution.

4. The Problem Statement

The decisions considered in the S-SOAP model occur over a single contract period. At the beginning of the contract period (t = 0), before the realizations of actual demands, a buying company has to make the following decision;

1. What suppliers to purchase from.
2. What types of contract to make with each supplier.
3. How much to purchase from each supplier through each type of contract.
4. How much to leave uncommitted

Once the demand and the price of each item become available at the beginning of each subsequent period (t = 1, 2, 3, 4, …, T), a buying company has to take a recourse action that leads to the optimal purchasing decision. These decisions include;

1. The quantity of each item to be executed from each supplier through the option contract
2. The quantity of each item to be purchased from spot markets.

In this case, the inventory level needs to be determined at the end of each period. The items carried in inventory from the previous period plus the items purchased from all suppliers (including from spot markets) are used to satisfy the demand in that period and the unfulfilled demand is lost. The recourse action needs to be taken repetitively for every period until the end of the contract period. Figure 1 represents the decision-making sequence considered in the S-SOAP model.

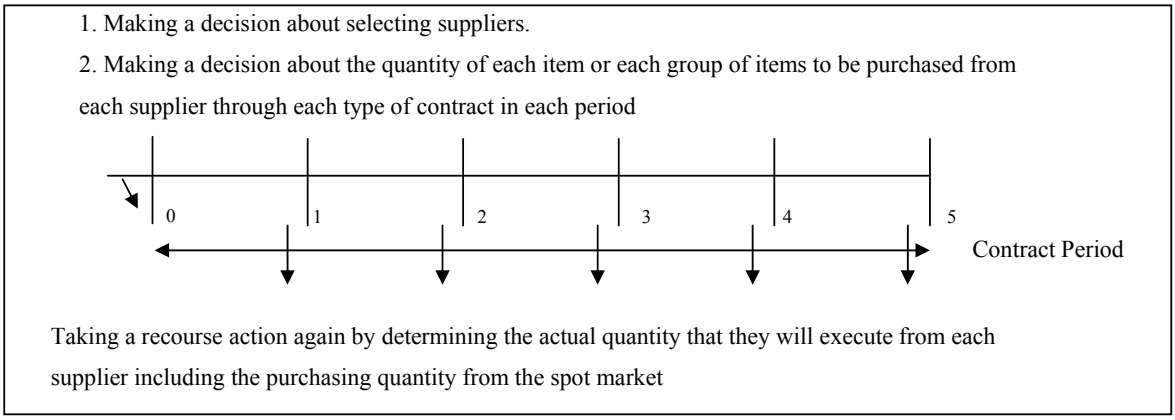

Figure 1 The Decision-Making Process

The decisions considered in the S-SOAP model consist of both strategic and tactical decisions. The first-stage decisions regarding supplier selection and order allocation through different types of contract are strategic, while the recourse decisions regarding option execution and spot market purchases are tactical. In this case, we particularly concern with the first-stage decisions that need to be made today (here and now) since it is not possible to wait for the information on demand.

4.1 Model Development

We model this problem as multi-stage recourse problem because it can reflect the ability of a buying company to hedge against future variability and take corrective action after the random events have taken place in each stage.

The multi-stage recourse problem can represent the situation when the buying company has to make a strategic decision before knowing the actual demands. Then, after the actual demands in each period have been realized, the tactical decision can be made to correct any unpleasant consequences. This process continues through a series of decisions and realizations.

Two primary approaches, the probabilistic approach and the scenario planning approach are normally used to model the uncertainty. Probabilistic approach considers the uncertainty aspects of the supply as random variables with known probability distributions. On the other hand, scenario planning attempts to capture uncertainty by representing it in terms of a moderate number of discrete realizations of stochastic quantities, constituting distinct scenarios (Mulvey, et al, 1997). Each

complete realization of all uncertain parameters gives rise to a scenario. The objective is to find solutions, which perform well under all scenarios. In some applications, scenario planning replaces forecasting as a way of taking into account potential changes and trends in a business environment.

In this study, we adopt a scenario planning approach for handling the uncertainty in product demand. In each time period, there is the finite number of purchasing demand realizations and each realization can occur with some discrete probability. In general, the scenarios to represent the future demand can be determined from the prediction. For example, if the historical data exist, a quantitative or statistical method such as a time series and regression model can be used to make a prediction. The unexplained variation can be estimated by fitting the cumulative probability distribution to the past data. In case the historical data are not available; the future demand can be predicted based on the subjective expertise of a person or a group of people. In practical situations, this estimation is generated from a more restricted set of information. For example, the suitable theoretical probability distribution (such as triangle distribution and truncated normal distribution) might be identified to represent the pattern of the future demand. With the information on the type of probability distribution governing this random parameter, a small number of scenarios can be generated by discretizing the relevant probability distributions.

The Model Formulation

In this section, we discuss the initial assumption, the parameter, the objective function, and the decision variables of the S-SOAP model.

Initial Assumption

Initial assumptions for the S-SOAP model are as following:

1. Decision is made for a specific planning horizon (T) subdivided into multiple period of =1, 2,3,…T.
2. Each supplier can supply single or multiple items.
3. Each supplier can offer an item through different types of contract. The contract types considered in the S-SOAP model include;
    - Long-term contract: A long-term contract or fixed-price contract is an agreement between two parties to buy and sell fixed amounts of items to be delivered at certain points in the future.
    - Option contract: An option contract requires a buying company to pre-pay an option as the fraction of the product price to reserve the supplier's capacity up to a certain level (the option level). The initial payment is referred to as a reservation price or a premium. A buying company has the right to execute the option up to the level agreed at the time the contract is signed by paying the execution price. However, some of the initial payment may be lost if the executed quantity is less than the reserved quantity.
    - Flexible contract: This contract is a special type of option contract that gives more flexibility to a buying company in adjusting the executed quantity to differ by no more than a given percentage of the reserved quantity. A buying company might incur some extra charges to execute the quantity that are greater than the reserved quantity.
    - Bundling contract: For suppliers that are able to supply multiple types of items to a buying company, it might be beneficial for them to offer a bundling contract, which is an option/flexible contract for a group of items. By implementing a bundling contract, a buying company can improve its flexibility by reserving the capacity of the supplier aggregately for all items in the same group. Then, after the demand has been realized, a

buying company has the right to adjust the executed quantity of each item in that group accordingly. However, the aggregation of the executed quantity of all items in the same group has to be less than the level agreed at the time the contract is signed. This aggregated quantity provides a buying company with less restriction when executing the option of each item after the uncertainties have been resolved.

4. The quantity discount determined when the contract is established based on the quantity purchased through long-term contract plus the quantity reserved in the option contract. Three policies;
   - Based on the purchased quantity of each item (traditional all unit discount)
   - Based on the purchased quantity of each group of items (group-item bundling discount)
   - Based on the purchased quantity of all items. (all-unit bundling discount)
5. Inventory at the end of contract period cannot be kept for future usage (need to be disposed or sold back).
6. There are possible to find the way to generate appropriate and reasonable scenario representations.

The Model Parameter

In order to make a decision using the S-SOAP model, the set of information need to be collected from a buying company and from its potential suppliers. The variables representing the related parameters are displayed in Appendix 1, Table 1-1, which include;

1. The first set of information is related to the unknown or random parameters, which include;
   - The probability distributions governing the purchasing demand.
   - The scenarios with their probability of occurrences that represent the realizations of the future demand. These scenarios are generated by discretizing the probability distribution.
2. The second set of information is related to the characteristics of purchasing decision, which include;
   - The set of pre-qualified supplier.
   - The set of items to be purchased.
   - The classification of the purchased items into multiple groups. (Each group consists of similar items).
   - The length of the planning horizon and the number and the length of the time period in each planning horizontal.
3. The third set of information is related to the purchasing requirements of a buying company, which includes;
   - The minimum demand of each purchased item that must be satisfied (the required service level)
   - The maximum and the minimum numbers of suppliers that a buying company need to do business with
4. The fourth set of information is required for calculating the profit margin contributed from the purchased item, which include;
   - The selling price of the end product (*)
   - The total cost of all other items used to produce the end product after excluding the cost of the purchased item (**)

   (*) - (**) = the contribution margin of that purchased item after excluding the purchased item (Martínez-de-Albéniz and Simchi-Levi, 2005)
5. The fifth set of information is related to the cost incurred by a buying company to keep inventory and perform purchasing activities. To calculate this cost, we essentially distinguish it

into four hierarchical levels of activity, which include the supplier level, the order level, the item /the group level and the unit level as follows;

- The inventory cost for holding each purchased item in each period (the unit level)
- The disposal cost/ or the buy back price for each item remaining in inventory at the end of the planning horizontal (the unit level)
- The transportation cost per container (if the purchased items are transported in full container) or the transportation cost per unit (if the purchased items are transported in less than container) (the unit level)
- The incoming inspection cost for each item or for each group of items purchased from each supplier in each period. This cost might differ from one supplier to the other suppliers because each supplier may need different levels of inspection (the item/ the group item level)
- The transactional cost (the ordering cost) for handling the order purchased from each supplier in each period (the order level).
- The supplier evaluation, the management and the development cost of each supplier (the supplier level).

6. The sixth set of information is related to the performance limitation of each supplier, which include;
   - The items that each supplier can offer
   - The types of contract each supplier can offer (a long-term, an option or a flexible contract). (One supplier can offer more than one type of contract).\
   - The maximum quantity of each item that a buying company can purchase from each supplier (the supplier's available capacity).
   - The minimum purchased quantity of each item required by each supplier.

7. The seventh set of information is related to the quantity discount offered by each supplier, which include;
   - The policy for determining the discount (see the discussion in section 4.5.2) which include the discount price and the quantity discount breakpoint
8. The eighth set of information is related to the contract terms and the payments required by each supplier under different types of contract as follows;
   - The purchasing price offered by each supplier for each item through each type of contract.
   - The payments required by each supplier
     - If suppliers offer a long-term contract, a single payment agreed at the time the contract is made need to be specified
     - If suppliers offer an option /flexible contract, the option payment need to be specified. This includes the initial payment required at the time the contract is made (the reserved price) to reserve the buying company's capacity and the payment required at the time the option (the purchased quantity) are executed for delivery (the executed price). (For an option /flexible contract, the buying company has a chance to adjust the executed quantity again after the contract has been made. This executed quantity cannot exceed the reserved quantity for a regular option contract while can be greater than the reserved quantity up to some specified level for a flexible contract.)
   - The percentage of the reserved quantity that can be executed by a buying company (Normally the percentage will be 100% for the regular option contract and more than 100% for the flexible contract)

9. The ninth set of information is related to the spot markets, which includes;
    - The price of each item if it is purchased from spot markets (or from suppliers that can supply items as needed without the initial reservation)
    - The maximum quantity of each item that can be purchased from spot markets (the spot market's available capacity)

The Decision Variables

There are a number of decision variables in the S-SOAP model as illustrated in Appendix 2, Table 1-2. However, the major decision variables can be classifieds into two groups. The first group consists of;

1. The set of selected suppliers.
2. The set of items purchased from each supplier.
3. The types of contracts made with each supplier for each purchased item.
4. The quantity committed to purchase from each supplier through each type of contract.

These variables are related to the decisions made before the realization of the actual demand and will be used to support the current decision.

The second group consists of

1. The quality executed from each supplier
2. The inventory level
3. The quantity purchased from spot markets.

These variables are related to the decision made after the realization of the actual demand. We particularly concern with the first-stage decisions that need to be made today (here and now) since it is not possible to wait for the information on demand.

Objective Function and Cost Elements

The objective considered in the S-SOAP model is to maximize the expected profit contributed from the purchasing decision. The expected profit contributed from the purchasing decision is calculated from the final price of the end products made by the purchased items, minus the loaded cost from other components used to make the end products, minus the expected cost related to the purchasing decision (the cost incurred after the demands are realized is represented by the expected values). The cost related to the purchasing decision considered in the S-SOAP model includes the total cost of ownership and the inventory holding cost. The total cost of ownership can be organized into the following categories:

1. The supplier relationship management cost
2. The transactional cost
3. The receiving cost
4. The quality inspection cost
5. The purchasing cost through the long-term contract
6. The initial cost and the execution cost for the items purchased through the option or the flexible contract
7. The cost to purchase items from spot markets
8. The quality cost of the defective items
9. The transportation cost

Equation (1) below, illustrates the objective function of the S-SOAP model, which is the total prices of the end-products ($\sum_{p \in P} p$), minus the total loaded cost from other components used to make the end products ($\sum_{p \in P} ldc$), minus all the costs incurred by the buying company to acquire, use and dispose of the purchased items. Because the S-SOAP model is developed as a multi-stage recourse problem, these costs are separated into the costs related to first stage decision and the expected cost related to the recourse decision. To calculate these costs, we consider from four hierarchical levels: the supplier level, the order level, the item/group level, and the unit level according to occurring activities. The equation for each cost elements is displayed in Appendix 3, Table 3-1.

$$MAX\left(\sum_{p \in P} p - \sum_{p \in P} ldc - \begin{pmatrix} sup\_c + purchase\_c + purchaseg\_c + purchase\_cl \\ + epurchaseex\_c + ereceive\_c + einspect\_c + eorder\_c \\ + epurchaseet\_c + epurchasespot\_c + escrap\_c \\ + etransport\_c + einventory\_c + eexcess\_c \end{pmatrix} \right) \quad 1$$

sup_c	Total cost for supplier relationship establishment and management
purchase_cl	Total cost for purchasing items through the long-term contracts
purchase_c	Total cost (paid in advance) for reserving supplier's capacity (for items purchased through the individual item option/flexible contracts)
purchase_cg	Total cost (paid in advance) for reserving supplier's capacity (for items purchased through the bundling option/flexible contracts)
eorder_c	Total expected ordering/transaction cost
einspect_c	Total expected incoming inspection cost
ereceive_c	Total expected receiving cost
epurchaseex_c	Total expected cost for executing the options
epurchaseet_c	Total expected cost for executing the excess options
etransport_c	Total expected cost of transportation
escrap_c	Total expected cost of quality (reworking, returning or disposing cost)
einventory_c	Total expected inventory holding cost
eexcess_c	Total expected cost of excess inventory (items left in inventory at the end of the contract period)
epurchase_cspot	Total expected cost for purchasing items from spot markets

The Model Constraints

In order to ensure the general applicability, the S-SOAP model is developed in the ways that it can take into account of several constraints related to the purchasing decision. The constraint equations are displayed in Appendix 4, Table 4-1. We classify these constraints into ten categories as follows;

1. Order quantity
2. Service level (maximum backorder)

3. Inventory balance
4. Supplier's quantity discount policy
5. Supplier's contracts and contract terms
6. Inventory/ backorder
7. Transportation methods
8. Supplier available capacity
9. Quality level
10. Maximum and minimum number of suppliers

Solution Approaches. Because the problem considered in the S-SOAP model is extended to a fully-fledged plan with multiple products and some level of joint-product capacity, it could become truly challenging to solve this problem using the linear programming or dynamic programming algorithm. For this type of problem, researchers have considered different solution approaches, including decomposition, the method that takes on a sample of scenarios and aggregation.

Several decomposition algorithms have been developed by both researchers and practitioners for solving stochastic programming problems. Examples are the L-shape method (Carøe & Tind, 1998), the Benders decomposition method (Benders, 1962; Birge, 1985), the progressive hedging method (Rockafellar & Wets, 1991), and the diagonal quadratic approximation method (Mulvey & Ruszczynski, 1995). With recent advances in LP solver technology in stochastic programming, the algorithms for solving the multi-stage recourse problem such as the L-shape, the Benders decomposition, and the nested Benders decomposition algorithm have been incorporated into commercial solver software for implementation. Therefore, we decided to take advantage of this commercial software to determine the solution for the S-SOAP model.

To implement the decomposition approach, it is necessary to develop the scenarios to represent the random demands. These scenarios can be organized in the form of a scenario tree, which is a structure representing the evolution of information over the stages. In such a tree, the scenarios that share a common history until stage t are indistinguishable until that stage, and thereafter, they are represented by distinct paths. Thus, every distinct scenario represents a path from the root node to a leaf node of the scenario tree. In the absence of appropriate approximations, these trees can become extremely large, and the model can become difficult to manage and solve.

Case study Illustrations

At this point, we illustrate the application of the S-SOAP model to support the realistic purchasing decisions. Our case study refers to the purchase of retailing packages for three premium products: Product A, Product B, and Product C. For each premium product, the company needs two types of retailing packages: a paper box, and a plastic bag with a product leaflet. The company competes in the business by providing the customer with some flexibility in adjusting the order quantity after the initial purchasing order has been made. This flexibility can be attributed to the company's ability to increase its production throughput and reduce its production lead-time. The profit margins of Product A, Product B, and Product C are $1.25, $1.35, and $1.35 respectively. This profit margin is the final price of each product minus the loaded costs from other components (except the retailing packages) ($\sum_{p \in P} p - \sum_{p \in P} ldc$).

Because the production of the company is constrained by the availability of materials and components, including the retailing packages, the company needs a new strategy for purchasing these items to ensure that they will arrive in the right quantity at the right time.

The current practice of the company is to purchase the retailing packages from a group of suppliers through a long-term contract and from a spot market as needed. In particular, the company relies on the expected demand information provided by its customer to determine the quantity to be purchased through the long-term contract, and selects suppliers based on the invoice price after considering the quantity discount and the transportation cost. Then, after the actual demand has been realized, the company decides again whether or not to purchase from a spot market in order to meet the demand in that period. In this case, the spot market refers to suppliers that are able to make the retailing packages in a short period. However, this practice is not efficient because the company incurs a large cost to carry excess inventory and to pay a premium price to acquire the products from a spot market.

In order to improve its operational efficiency, the company proposed to implement a new purchasing strategy, a portfolio contract. This strategy focuses on purchasing flexibility while keeping the cost at a competitive level. We considered the decision to purchase three retailing boxes (R_A, R_B, R_C) and three plastic bags (B_A, B_B, B_C) for three premium products (A, B, C). The planning horizontal for this decision is the winter selling season, which lasts four months. The S-SOAP model was applied to help the company select the right suppliers and determine the appropriate mix of different types of contract and spot market purchasing. The demand for each retailing package can be estimated from the premium product's demand information, provided by the customer.

Based on the customer's information, the demand for each premium product can be modeled by the "de-seasonalized" AR(1) process. This process is a time series model where the value of the series at time t, D_t, depends on the constant value, the previous period value (deterministic part), and the random disturbance value. To be more specific, the demand of each premium product is represented by the following model:

$D_t = \mu_t$ for t = 0

$D_t = \mu_t + \phi(D_{t-1} - \mu_{t-1}) + \varepsilon_t$ for t ≥ 0

where ϕ is the parameter of the model, μ_t is a constant (an expected function at time t), and ε_t is an error term which is a white noise process with zero mean and variance σ_t^2. In this case, the company takes the forecasted demand for each period as the expected demand μ_t. The forecasted demand is determined based on the pattern of the product life cycle. The term "$D_{t-1} - \mu_{t-1}$" is added to the forecasted value in order to account for the forecast error in the previous period. Table 1 – The demand information of the premium products below provides information on the demand for each premium product.

Table 1 The Demand Information for the Premium Products

	Product A	Product B	Product C
Forecasted demand for each time period μ_t			
Period 1	65,000	78,000	75,000
Period 2	110,000	132,000	127,000
Period 3	80,000	96,000	92,000
Period 4	50,000	60,000	57,000
The standard deviation of error term σ_t			
Period 1	8,250	9,800	10,750
Period 2	11,370	13,640	15,730
Period 3	13,385	16,060	15,390
Period 4	14,340	17,200	16,490

Six companies are qualified as potential suppliers for the retailing packages. These companies offer the retailing box and the plastic bags through different types of contract with different payments options. Most companies offer both option and long-term contracts. In addition, some suppliers also offer the discount and require some addition charge for transportation. To represent the characteristics of the purchasing decision, the data used in this case to represent the details of each potential supplier are summarized in Appendix 5, Table 5-1 – the information of the potential suppliers and Table 5-2 – The model parameters.

To develop the model to represent this problem, the information on the offered price, the quantity discount, the activity cost and the capacity limitation was collected from each supplier as illustrated in Appendix 5. Table 5-3 – The long-term contract payments provides information on the amount of payments required by each supplier under the long-term contract and Table 5-4 – The option/flexible contract payments provides information on the payments required by each supplier under the option/flexible contract. Table 5-5 shows the quantity discount offered by each supplier. The other costs for doing business with each supplier are summarized in Table 5-6 – The cost related to the purchasing decision**.** Table 5-7 – The other relevant requirements displays the inventory cost of each product and the capacity limitation of each supplier.

Problem Solving

To apply the S-SOAP model to solve the problem, we determined a set of scenarios that represents the occurrences of demand based on the assumptions that the demand for the retailing packages is correlated with and follows the "de-seasonalized" AR(1) process, as explained earlier.

$D_t = \mu_t \quad t = 0$

$D_t = \mu_t + \phi(D_{t-1} - \mu_{t-1}) + \varepsilon_t \quad t > 0$

In this case the μ_t and ϕ are determined before the decision is made. D_t can be determined in the model during the optimization process. The random error of the demand in each period (ε_t), which is the white noise process, is represented by five scenarios obtained from the discretization.

The problem is solved using Xpress – SP software. Table 6 below displays the results obtained from the S-SOAP model. In this case, supplier 2 (S2) and supplier 6 (S6) are selected and

the portfolio contract is created. The portfolio contract consists of the long-term contracts with supplier 2 and supplier 6 and the option contracts with supplier 6. The decision to purchase from supplier 6 offers the option for order adjustment, suggesting that the purchasing flexibility could influence the supplier selection. Although the company has to pay some extra charges to purchase the options and increase flexibility, the benefit it gets is greater than the exposure cost from carrying excess inventory and purchasing the items from spot markets.

Table 2 below displays the results obtained from the S-SOAP model. In this case, supplier (S2) and supplier 6 (S6) are selected and the portfolio contract is created. The portfolio contract consists of the long-term contracts with supplier 2 and supplier 6 and the option contracts with supplier 6. The decision to purchase from supplier 6 offers the option for order adjustment, suggesting that the purchasing flexibility could influence the supplier selection. Although the company has to pay some extra charges to purchase the options and increase flexibility, the benefit it gets is greater than the exposure cost from carrying excess inventory and purchasing the items from spot markets

Table 2 The Optimal Solution

Supplier selection								Supplier 2 and Supplier 6
Contract selection								Long-term contract, Option contract
Purchasing quantity through the long-term contract								
	November		**December**		**January**		**February**	
	S2	**S6**	**S2**	**S6**	**S2**	**S6**	**S2**	**S6**
$\mathbf{R_A}$	66,100	–	33,175	55,321	20,843	48,375	–	35,004
$\mathbf{R_B}$	79,300	–	58,900	44,189	41,918	40,680	–	42,025
$\mathbf{R_C}$	75,000	–	52,575	39,150	35,756	39,525	–	39,443
$\mathbf{B_A}$	–	71,979	–	83,541	–	68,671	–	34,848
$\mathbf{B_B}$	–	80,000	–	100,000	–	84,766	–	41,807
$\mathbf{B_C}$	–	80,000	–	100,000	–	72,925	–	39,820
The purchasing quantity through the option/flexible contract (in group)								
R	–	–	–	84,450	–	92,850	–	68,580
B	–	–	–	22,815	–	61,365	–	111,235

5. Analysis of Solution

As illustrated in Figure 2 – The allocation of the purchase order by supplier for the retailing box and Figure 3 – The allocation of the purchase order by supplier for the plastic bag/leaflet, the optimal portfolio consists of the quantity purchased through the long-term contract and the quantity purchased through the option contract. The optimal solution suggests that the company should purchase the retailing box from supplier 6 (through the long-term contract) and supplier 2 (through both long-term and option contract), and purchase the plastic bag/leaflet from just supplier 6 (through both long-term and option contract). In particular, the long-term contracts are used for the more predictable segments of demand, while the option contracts are used for the more speculative demand segments. Figure 4 – The allocation of the purchase order by contract type for the retailing box and Figure 5 – The allocation of the purchase order by contract type for the plastic bag/leaflet suggest that the options are used to increase amounts as the end of the contract period approaches.

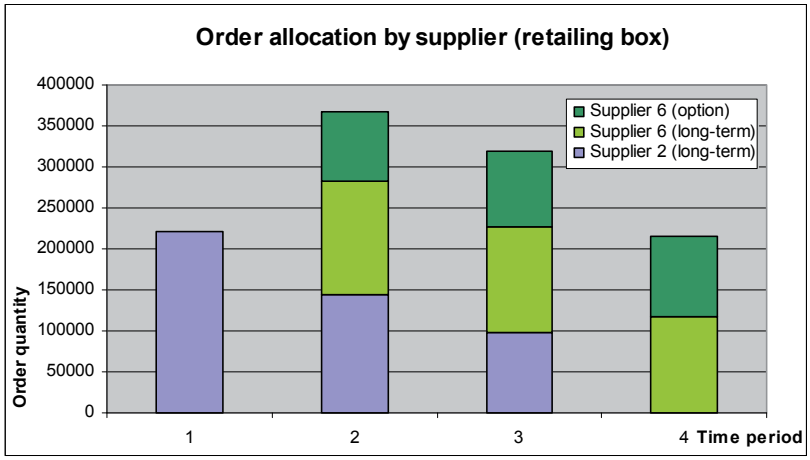

Figure 2 The Allocation of the Purchase Order by Supplier (Retailing Box)

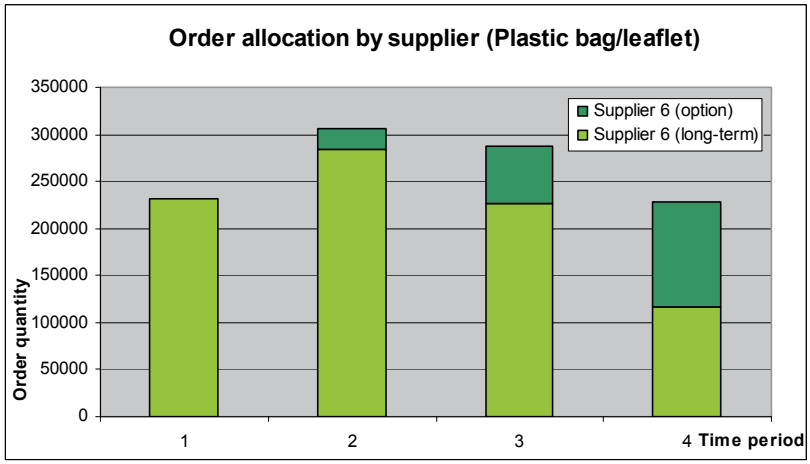

Figure 3 The Allocation of the Purchase Order by Supplier (Plastic Bag/ Leaflet)

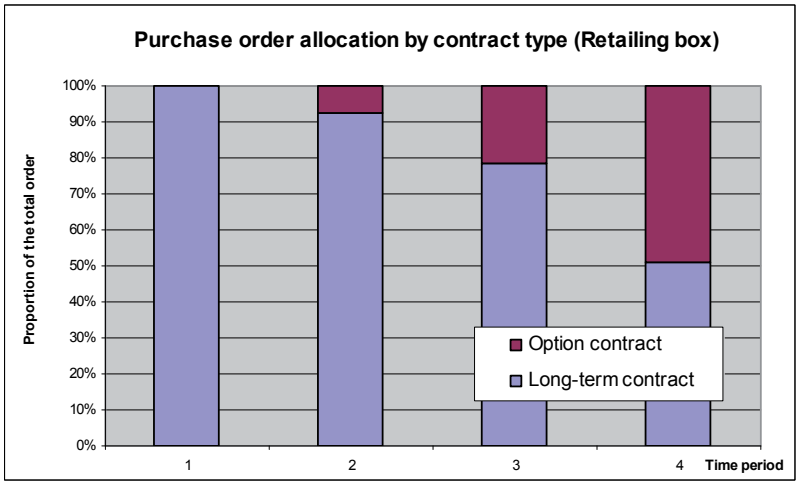

Figure 4 The Allocation of the Purchase Order by Contract Type (Retailing Box)

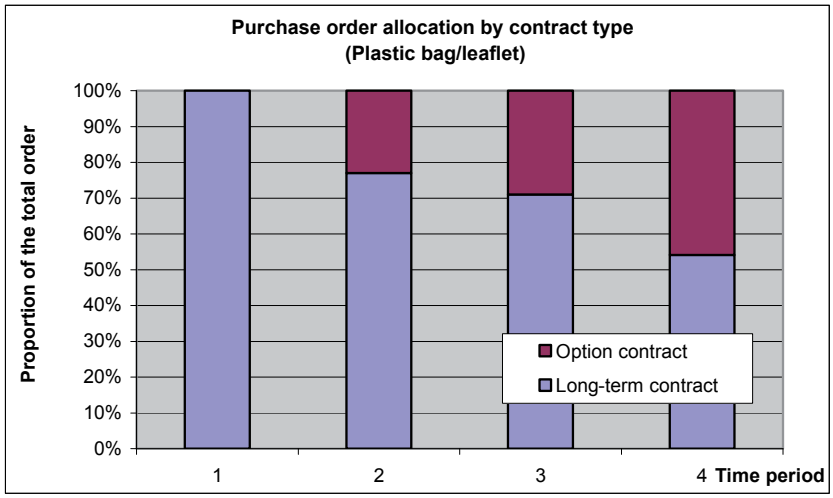

Figure 5 The Allocation of the Purchase Order by Contract Type (Plastic Bag/Leaflet)

Table 3 details all the cost elements related to the optimal purchasing decision. As displayed in Figure 6, the direct cost for purchasing the items through all types of contract and from spot market accounts for 82% of the total cost, while the other costs related to the purchasing decision account for 18% of the total cost. Specifically, 67% of the total cost is invested in the long-term contracts, 12% in the option contracts, and the remaining 3% in the spot market.

Table 3 The Cost Related to the Optimal Purchasing Decision – Case Study 2

Cost Category	
Purchasing cost through long-term contract	206,262
Expected purchasing cost through the option contract	36,469
Expected purchasing cost through the spot market	9,719
Supplier cost	21,000
Order-level cost	6,000
Expected item group-level cost	12,100 quality Cost 12,000 receiving Cost
Expected transportation cost	–
Expected inventory holding cost	2,409
Expected total cost related to the purchasing decision	305,959

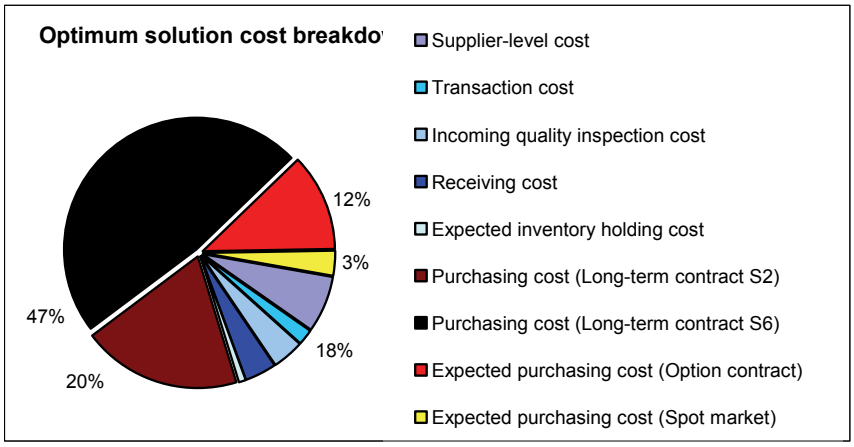

Figure 6 The Cost Allocation by Category – Case Study 2

6. Conclusion and Direction of Future Study

In this study, we introduced the Stochastic Supplier Selection and Order Allocation Portfolio model (S-SOAP), a detailed mathematical programming formulation that aims to help companies make a better purchasing decision under uncertainties. From our analysis, the use of purchasing long-term contracts are more appropriate for the predictable segments of demand, while the use of purchasing option contracts are more appropriate for the speculative demand segments. In addition, supplier that offers the lowest price may not necessarily be selected because the decision is made based on both purchasing price and cost from other related activities.

To extend the application of the SOAP model, additional case studies across industries need to be investigated. In addition, the risk associated with the optimal solution need to be evaluated because this decision is made under stochastic assumption and the optimum solution may not be "the best" under all condition. In this case the risk could be measured in term of Value-at-Risk resulting from the profit that the manufacturer will loss if it relies on the S-SOAP model to support the purchasing decision instead of the simple deterministic model.

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Appendix A: Model Parameter

Parameter	**Description**
S	Set of suppliers, index s
T	Set of time period, index t
G	Set of groups of items, index g
C	Set of items, index i
P	Set of end products made from the purchased items, index p
SL	Set of suppliers that offer a long-term contract
SLO	Set of supplier that offer only long-term contract
SD	Set of suppliers that offer an option/flexible contract for an individual item
SG	Set of suppliers that offer an option/flexible contract for a group of items
SLC	Set of suppliers that do not offer a long-term contract
SLTC	Set of suppliers that deliver items in less than container
STC	Set of suppliers that deliver items in full container
SDI	Set of suppliers that offer a discount based on the purchased quantity of each purchased item
SDG	Set of suppliers that offer a discount based on the purchased quantity of each group of purchased items
SDA	Set of suppliers that offer a discount based on the purchased quantity of all purchased items
SC	Set of scenarios for the future demands – spot market prices, index δ
IG_g	Set of items in group g
mins	Minimum number of suppliers needed by the buyer company
maxs	Maximum number of suppliers needed by the buyer company

Table 20 Model Parameters

Parameter		Description
d_{it}^{δ}	$\forall i \in C, \forall t \in T$ $\forall \delta \in SC$	Demand of item i at time t under scenario δ
$pspot_{it}^{\delta}$	$\forall i \in C, \forall t \in T$ $\forall \delta \in SC$	The unit price of item i purchased from spot markets at time t under scenario δ
p_p	$\forall p \in P$	The price of end product p
idc_p	$\forall p \in P$	Total loaded cost from other components used to make end product p
ser_i	$\forall i \in C$	Proportion of demands that the buying company need to fulfill in each time period
eva_s	$\forall s \in S$	Cost for evaluating the performance of supplier s
rel_s	$\forall s \in S$	Cost for establishing and managing the relationship with supplier s
con_s	$\forall s \in S$	Cost for initiating and making a contract with supplier s
rec_{si} rec_{sg}	$\forall s \in S, \forall i \in C$ $\forall s \in S, \forall g \in G$	Receiving cost per order of item i (rec_{si}) Receiving cost per order of item group g (rec_{sg}) purchased from supplier s
qal_{si} qal_{sg}	$\forall s \in S, \forall i \in C$ $\forall s \in S, \forall g \in G$	Incoming inspection cost per order of item i *(qal_{si})* Incoming inspection cost per order of item group g *(qal_{sg})* purchased from supplier s
h_i	$\forall i \in C$	Inventory holding cost per period of item i
shb_i	$\forall i \in C$	Disposal cost (+) or buy back price (-) per unit of item i left in inventory at the end of the contract period
ptc_s	$\forall s \in S$	Transaction cost per order when purchasing from supplier s
ltl_{si}	$\forall s \in SLTC$	Transportation cost per unit of item i purchased from supplier s
tl_s	$\forall s \in STC$	Transportation cost per container when purchasing from supplier s
$tlle_s$	$\forall s \in STC$	Capacity of a single container offered by supplier s (in unit container)
wtl_{si}	$\forall s \in STL$	The unit container for item i
$tolcap_{si}$	$\forall s \in SD$	Maximum amount of item i that supplier s can deliver in each time period

Parameter		Description
$gtolcap_{sg}$	$\forall s \in SG, \forall g \in G$	Maximum amount of item group g that supplier s can deliver in each time period
$miso_{si}$	$\forall s \in SD, \forall i \in C$	Minimum purchased quantity (in proportion of maximum capacity) of item i required by supplier s
$misog_{sg}$	$\forall s \in SG, \forall g \in G$	Minimum purchased quantity (in proportion of maximum capacity) of item group g required by supplier s
v_{i0}	$\forall i \in C$	Beginning inventory of item i
$breaki_{si}$	$\forall s \in SDI, \forall i \in C$	Discount break point of item i offered by supplier s (when the discount is determined based on the purchased quantity of each individual item)
$breakg_{sg}$	$\forall s \in SDG, \forall i \in C$	Discount break point of item group g offered by supplier s (when the discount is determined based on the purchased quantity of each group of items)
$breaka_{s}$	$\forall s \in SDA$	Discount break point of offered by supplier s (when the discount is determined based on the purchased quantity of all items)
prl_{si}	$\forall s \in SL, \forall i \in C$	Payment per unit of item i purchased from supplier s through a long–term contract
pr_{si}	$\forall s \in SD, \forall i \in C$	Initial payment per unit (reservation price) paid to supplier s in advance for purchasing item i
prg_{sg}	$\forall s \in SG, \forall g \in G$	Initial payment per unit (reservation price) paid to supplier s in advance for purchasing item group g
prr_{si}	$\forall s \in S, \forall i \in C$	Payment per unit (execution price) paid to supplier s upon delivery for item i
$prex_{si}$	$\forall s \in SD, \forall i \in C$	Additional payment per unit paid to supplier s for item i that is executed and exceeds the initial reserved quantity
$prgex_{sg}$	$\forall s \in SG, \forall g \in G$	Additional payment per unit paid to supplier s for item group g that is executed and exceeds the initial reserved quantity
dis_{si}	$\forall s \in S, \forall i \in C$	Discount rate per unit given by supplier s for item i
$flex_{si}$	$\forall s \in SD, \forall i \in C$	Flexible level of item i (specify as the multiplier of the maximum capacity)

Table 1-1 Model Parameter

Parameter		Description
$flexg_{sg}$	$\forall s \in SG, \forall g \in G$	Flexible level of item group g (specify as the multiplier of the maximum capacity)
mm		Big number (approximated by the total demand of that items in all periods)

Appendix B: Decision Variables

Variable		Description
z_s	$\forall s \in S$	Binary variable: 1 if supplier s is selected, 0 otherwise
u_{st}^{δ}	$\forall s \in SD \cup SG$ $\forall t \in T$	Binary variable: 1 if the items reserved from supplier s are executed in time t, 0 otherwise
y_{sit}^{δ}	$\forall s \in S, \forall i \in C$ $\forall t \in T$	Binary variable: 1 if item i delivered from supplier s in time t, 0 otherwise
$group_{stg}^{\delta}$	$\forall s \in S, \forall t \in T$ $\forall g \in G$	Binary variable: 1 if item group g delivered from supplier s in time t, 0 otherwise
x_{sit}	$\forall s \in S, \forall i \in C$ $\forall t \in T$	Total amount of item i purchased and reserved from supplier s in time t through the long-term and the option contract (this quantity = total amount committed to purchase through the long-term contract + total amount reserved in the option contract)
q_{stg}	$\forall s \in S, \forall t \in T$ $\forall g \in G$	Total amount of items in group g purchased and reserved from supplier s in time t through the long-term and the option contract (this quantity = total amount committed to purchase through the long-term contract + total amount reserved in the option contract)
ll_{sit}	$\forall s \in SL, \forall i \in C$ $\forall t \in T$	Total amount of item i purchased from supplier s in time t through the long-term contract
$lnor_{sit}$ lup_{sit}	$\forall s \in SL, \forall i \in C$ $\forall t \in T$	Total amount of item i purchased from supplier s in time t through the long-term contract at the regular price and at the discount price
lg_{stg}	$\forall s \in SL, \forall t \in T$ $\forall g \in G$	Total amount of items in group g purchased from supplier s in time t through the long-term contract
xo_{sit}	$\forall s \in SD, \forall i \in C$ $\forall t \in T$	Total amount of item i reserved with supplier s in time t through the option/flexible contract
$xonor_{sit}$ $xoup_{sit}$	$\forall s \in SD, \forall i \in C$ $\forall t \in T$	Total amount of item i reserved with supplier s in time t through the option/flexible contract at the regular price and at the discount price
qo_{stg}	$\forall s \in SG, \forall t \in T$ $\forall g \in G$	Total amount of items in group g reserved with supplier s in time t through the option/flexible contract
$qonor_{stg}$ $qoup_{stg}$	$\forall s \in SG, \forall t \in T$ $\forall g \in G$	Total amount of items in group g reserved with supplier s in time t through the option/flexible contract at the regular price and at the discount price

Table 2-1 Decision Variables

Variable		Description
qt_{st}	$\forall s \in S, \forall t \in T$	Total amount of all items purchased from supplier s in time t
$xxxo_{sit}^{\delta}$	$\forall s \in SD \cup SG, \forall i \in C$ $\forall t \in T, \forall \delta \in SC$	Total amount of item i delivered from supplier s in time t through the option/flexible contract (executed quantity)
$qqqo_{stg}^{\delta}$	$\forall s \in SD \cup SG, \forall t \in T$ $\forall g \in G, \forall \delta \in SC$	Total amount of item group g delivered from supplier s in time t through the option/flexible contract (executed quantity)
xxx_{sit}^{δ}	$\forall s \in S, \forall i \in C$ $\forall t \in T, \forall \delta \in SC$	Total amount of item i delivered from supplier s in time t through the long-term and the option/flexible contract
qqq_{stg}^{δ}	$\forall s \in S, \forall i \in C$ $\forall g \in G, \forall \delta \in SC$	Total amount of items in group g executed and delivered from supplier s in time t through the long-term and the option/flexible contract
xx_{sit}^{δ}	$\forall s \in SD \ \forall i \in C, \forall t \in T$ $\forall \delta \in SC$	Total amount of item i that exceeds the initial reserved quantity and is executed from supplier s in time period t
$xxgroup_{stg}^{\delta}$	$\forall s \in SG \ \forall g \in G, \forall t \in T$	Total amount of items in group g that exceed the initial reserved quantity and are executed from supplier s in time t
$xspot_{it}^{\delta}$	$\forall i \in C \ \forall t \in T, \forall \delta \in SC$	Total amount of item i purchased from the spot market in time t
v_{it}^{δ}	$\forall i \in C, \forall t \in T \ \forall \delta \in SC$	Inventory level of item i at the end of period t
aaa_{st}^{δ}	$\forall s \in SDA, \forall t \in T$ $\forall \delta \in SC$	Binary variable: 1 if we get discount from supplier s for item i in time t, 0 otherwise
aa_{sit}^{δ}	$\forall s \in SDI, \forall i \in C$ $\forall t \in T, \forall \delta \in SC$	Binary variable: 1 if we get discount from supplier s for item i in time t, 0 otherwise
a_{stg}^{δ}	$\forall s \in SDG, \forall t \in T$ $\forall g \in G, \forall \delta \in SC$	Binary variable: 1 if we get discount from supplier s for item i in time t, 0 otherwise
b_{st}^{δ}	$\forall s \in STL, \forall t \in T$ $\forall \delta \in SC$	Total number of containers to be moved in time t from the location of supplier s
qcc_{sit}^{δ}	$\forall s \in S, \forall i \in C$ $\forall t \in T, \forall \delta \in SC$	Total amount of defective item i purchased from supplier s in time t
wq_{s}^{δ}	$\forall s \in S, \forall \delta \in SC$	Total number of unit containers to be moved in time t from the location of supplier s.

Appendix C: Cost Elements of the Objective Function

Cost elements	
$\sum_{s\in S}(eva_s + rel_s + con_s)\times z_s = sup\_c$ Total cost for supplier relationship establishment and management	2
$\sum_{s\in S}\sum_{t\in T}\sum_{i\in C}\left[(prl_{si}\times lnor_{sit})+\left(((1-dis_{si})\times prl_{si})\times lup_{sit}\right)\right] = purchase\_cl$ Total cost for purchasing items through long-term contracts	3
$\sum_{s\in SD}\sum_{i\in C}\sum_{t\in T}\left[(pr_{si}\times xonor_{sit})+\left(((1-dis_{si})\times pr_{si})\times xoup_{sit}\right)\right] = purchaseex\_c$ Total cost (paid in advance) for reserving supplier's capacity (for items purchased through the option/flexible contracts)	4
$\sum_{s\in SG}\sum_{t\in T}\sum_{g\in G}\left[(prg_{sg}\times qonor_{stg})+\left(((1-disg_{sg})\times prg_{si})\times qoup_{stg}\right)\right] = purchaseg\_c$ Total cost (paid in advance) for reserving supplier's capacity (for items purchased through the bundling option/flexible contracts)	5
$\sum_{\delta\in SC}(\rho_\delta)\sum_{s\in S}\sum_{t\in T}(ptc_s)\times u_{st}^{\delta} = order\_c^{\delta}$ Total expected ordering/transaction cost	6
$\sum_{\delta\in SC}(\rho_\delta)\left(\sum_{s\in S}\sum_{t\in T}\sum_{g\in G}(qal_{si}\times group_{stg}^{\delta})+\sum_{s\in S}\sum_{t\in T}\sum_{i\in C}(qal_{si}\times y_{sit}^{\delta})\right) = einspect\_c^{\delta}$ Total expected incoming quality inspection cost	7
$\sum_{\delta\in SC}(\rho_\delta)\left(\sum_{s\in S}\sum_{t\in T}\sum_{g\in G}(rec_{sg}\times group_{stg}^{\delta})+\sum_{s\in S}\sum_{t\in T}\sum_{i\in C}(rec_{si}\times y_{sit}^{\delta})\right) = ereceive\_c^{\delta}$ Total expected receiving cost	8
$\sum_{\delta\in SC}(\rho_\delta)\left(\sum_{s\in S}\sum_{t\in T}\sum_{i\in C}(prr_{si}\times xxxo_{sit}^{\delta})\right) = epurchaseex\_c^{\delta}$ Total expected cost for executing the options	9
$\sum_{\delta\in SC}(\rho_\delta)\left(\sum_{s\in SD}\sum_{t\in T}\sum_{i\in C}\left(prex_{si}\times xx_{sit}^{\delta}\right)+\sum_{s\in SG}\sum_{t\in T}\sum_{g\in G}\left(prgex_{sg}\times xxgroup_{stg}^{\delta}\right)\right) = epurchaseet\_c^{\delta}$ Total expected cost for the excess options	10

Table 3-1 (Cont.) Cost Elements of the Objective Function

Cost elements	
$\sum_{\delta \in SC} (\rho_\delta) \left(\sum_{i \in C} \sum_{t \in T} (pspot_{it}^{\delta} \times xspot_{it}^{\delta}) \right) = epurchasespot\_c^{\delta}$ Total expected cost for purchasing items from spot markets	11
$\sum_{\delta \in SC} (\rho_\delta) \left(\sum_{s \in S} \sum_{t \in T} \sum_{i \in C} (qali_{si} \times qcc_{sit}^{\delta}) \right) = escrap\_c^{\delta}$ Total expected cost of quality (reworking, returning or disposing cost)	12
$\sum_{\delta \in SC} (\rho_\delta) \left(\sum_{s \in STL} \sum_{i \in C} \sum_{t \in T} (ltl_{si} \times xxx_{sit}^{\delta}) + \sum_{s \in SLTL} \sum_{t \in T} (tl_s \times b_{st}^{\delta}) \right) = etransport\_c^{\delta}$ Total expected cost of transportation	13
$\sum_{\delta \in SC} (\rho_\delta) \left(\sum_{i \in C} \sum_{t \in T} (h_i \times v_{t-1}^{\delta}) \right) = einventory\_c^{\delta}$ Total expected inventory holding cost	14
$\sum_{\delta \in SC} (\rho_\delta) \left(\sum_{i \in C} (shb_i \times v_{iT}^{\delta}) \right) = eexcess\_c^{\delta}$ + if items in in inventory can be sold back - if items in in inventory need to be disposed Total expected cost of excess inventory (items left in inventory at the end of the contract period)	15

Equations (2)–(6) represent the costs from the first-stage decisions. The buying company incurs these costs before the realizations of actual demands and spot market prices. Equation (2) represents the supplier-level cost, which is the initial cost for supplier relationship management. The supplier relationship management cost consists of the cost from supplier evaluation and selection, the cost from relationship establishment, and the cost from making the initial contract.

Equations (3)–(5) are the unit-level costs. Equation (3) denotes the total cost to purchase items through a long-term contract. The discount is applied to the normal prices if the purchased quantity meets the supplier's discount breakpoints. Equations (4) and (5) denote the total cost for reserving the supplier's capacity. Equation (4) is applicable to the case when items are purchased through the option/flexible contract for an individual item, while Equation (5) is applicable to the case when items are purchased through the bundling contract.

Equations (6)–(15) represent the costs from the recourse decisions. A buying company incurs these costs after the realizations of actual demands and spot market prices in order to adjust the initial decision. Equation (6) specifies the expected transactional cost to execute the options. Equation (7) represents the expected quality inspection cost and Equation (8) represents the expected receiving cost. Both costs are the item-level or group-level cost. A buying company incurs this cost when an order of items or an order of a group of items is delivered from their suppliers. Equation (9) denotes the expected cost to execute the purchasing options (the purchased quantity)

after the realizations of actual demands and spot market prices. Equation (10) denotes the expected cost for the quantity that is greater than the reserved quantity. This cost is needed to complement the execution cost and is equal to the initial cost for reserving the capacity plus the extra payment required by suppliers. Equation (11) denotes the expected cost for purchasing items from spot markets. Equation (12) denotes the expected cost for returning, reworking or scrapping the defective items. Equation (13) denotes the expected transportation cost (including the warranty cost), calculated based on either the number of containers used or the number of delivered items. Equation (14) denotes the expected cost for holding inventory. Equation (15) denotes the expected value of the items left in inventory at the end of the contract period (period T).

Appendix D: Model Constraints

Order quantity constraints		
$ll_{sit} = 0$	$\forall s \in SL^c, \forall i \in C, \forall t \in T$	16
$xo_{sit} = 0$	$\forall s \in SLO, \forall i \in C, \forall t \in T$	17
$qo_{stg} = 0$	$\forall s \in SLO, \forall i \in C, \forall t \in T$	18
$xxxo^{\delta}_{sit} = 0$	$\forall s \in SLO, \forall i \in C, \forall t \in T, \forall \delta \in SC$	19
$\sum_{i \in IG_g} ll_{sit} = lg_{stg}$	$\forall s \in S, \forall t \in T$	20
$\sum_{i \in IG_g} xxxo_{sit} = qqqo_{stg}$	$\forall s \in S, \forall t \in T, \forall g \in G$	21
$xo_{sit} + ll_{sit} = x_{sit}$	$\forall s \in SD \cup SLO, \forall i \in C, \forall t \in T$	22
$qo_{stg} + lg_{stg} = q_{stg}$	$\forall s \in SG \cup SLO, \forall t \in T, \forall g \in G$	23.a
$\sum_{i \in IG_g} x_{sit} = q_{stg}$	$\forall s \in SD, \forall t \in T, \forall g \in G$	23.b
$\sum_{g \in G} q_{stg} = q_{st}$	$\forall s \in S, \forall t \in T$	24
$xxxo^{\delta}_{sit} + ll_{sit} = xxx^{\delta}_{sit}$	$\forall s \in S, \forall i \in C, \forall t \in T, \forall \delta \in SC$	25
$qqqo^{\delta}_{sit} + \lg_{stg} = qqq^{\delta}_{stg}$	$\forall s \in S, \forall t \in T, \forall g \in G\_, \forall \delta \in SC$	26
$miso_{si} \times tolcap_{si} \times y^{\delta}_{sit} \le xxx^{\delta}_{sit}$	$\forall s \in SD \cup SLO, \forall i \in C, \forall t \in T, \forall \delta \in SC$	27
$misog_{sg} \times gtolcap_{sg} \times group^{\delta}_{stg} \le qqq^{\delta}_{stg}$	$\forall s \in SG, \forall t \in T, \forall g \in G, \forall \delta \in SC$	28

Order quantity constraints

$xxxo_{sit}^{\delta} \le xo_{sit}$	$\forall s \in SD, \forall i \in C, \forall t \in T, \forall \delta \in SC$	29
$\sum_{i \in IG_g} xxxo_{sit}^{\delta} <= qo_{stg}$	$\forall s \in SG, \forall t \in T, \forall \delta \in SC$	30
$xxxo_{sit}^{\delta} \le flex_{si} \times xo_{sit}$	$\forall s \in SD, \forall i \in C, \forall t \in T, \forall \delta \in SC$	31
$\sum_{i \in IG_g} xxxo_{sit}^{\delta} \le flexg_{sg} \times qo_{stg}$	$\forall s \in SG, \forall t \in T, \forall g \in G, \forall \delta \in SC$	32
$qqq_{stg}^{\delta} - q_{stg} \le xxgroup_{stg}^{\delta}$	$\forall s \in SG, \forall t \in T, \forall g \in G, \forall \delta \in SC$	33
$xxx_{sit}^{\delta} - x_{sit} \le xx_{sit}^{\delta}$	$\forall s \in SD, \forall i \in C, \forall t \in T, \forall \delta \in SC$	34

Service level

$ser_i \times d_{it}^{\delta} \le sd_{it}^{\delta}$	$\forall i \in C, \forall t \in T, \forall \delta \in SC$	35

Balance Equation

$\sum_{s \in S} xxx_{sit}^{\delta} + xspot_{it}^{\delta} - \sum_{s \in S} qcc_{sit}^{\delta} =$	$\forall i \in C, \forall t \in T$	36

Quality discount constraints

$lnor_{sit} + lup_{sit} = ll_{sit}$	$\forall s \in SL, \forall i \in C, \forall t \in T$	37
$xonor_{sit} + xoup_{sit} = xo_{sit}$	$\forall s \in SD, \forall i \in C, \forall t \in T$	38
$qonor_{stg} + qoup_{stg} = qo_{stg}$	$\forall s \in SG, \forall i \in C, \forall t \in T$	39

Quantity discount constraints (policy based on individual item)

$breaki_{si} \times aa_{sit} \le x_{sit}$	$\forall s \in SDI, \forall i \in C, \forall t \in T$	40
$lup_{sit} \le mm \times aa_{sit}$	$\forall s \in SL \cap SDI, \forall i \in C, \forall t \in T$	41
$lnor_{sit} \le mm \times (1 - aa_{sit})$	$\forall s \in SL \cap SDI, \forall i \in C, \forall t \in T$	42
$xoup_{sit} \le mm \times aa_{sit}$	$\forall s \in SD \cap SDI, \forall i \in C, \forall t \in T$	43

$xonor_{sit} \le mm \times (1 - aa_{sit})$	$\forall s \in SD \cap SDI, \forall i \in C, \forall t \in T$	44
Quantity discount constraints (policy based on group of items)		
$breakg_{sg} \times a_{stg} \le q_{stg}$	$\forall s \in SDG, \forall i \in C, \forall t \in T$	45
$qoup_{stg} \le mm \times a_{stg}$	$\forall s \in SG \cap SDG, \forall i \in C, \forall t \in T$	46
$qonor_{stg} \le mm \times (1 - a_{stg})$	$\forall s \in SG \cap SDG, \forall i \in C, \forall t \in T$	47
$xoup_{sit} \le mm \times a_{stg}$	$\forall s \in SD \cap SDG, \forall g \in G, \forall t \in T, \forall i \in IG_g$	48
$xonor_{sit} \le mm \times (1 - a_{stg})$	$\forall s \in SD \cap SDG, \forall g \in G, \forall t \in T, \forall i \in IG_g$	49
$lup_{sit} \le mm \times a_{stg}$	$\forall s \in SL \cap SDG, \forall g \in G, \forall t \in T, \forall i \in IG_g$	50
$lnor_{sit} \le mm \times (1 - a_{stg})$	$\forall s \in SL \cap SDG, \forall g \in G, \forall t \in T, \forall i \in IG_g$	51
Quantity discount constraints (policy based		
$breaka_s \times aaa_{st} \le qt_{st}$	$\forall s \in SDA, \forall i \in C, \forall t \in T$	52
$lup_{sit} \le mm \times aaa_{st}$	$\forall s \in SDA, \forall i \in C, \forall t \in T$	53
$lnor_{sit} \le mm \times (1 - aaa_{sit})$	$\forall s \in SDA, i \in C, t \in T$	54
$xoup_{sit} \le mm \times aaa_{st}$	$\forall s \in SD \cap SDA, \forall i \in C, \forall t \in T$	55
$xonor_{sit} \le mm \times (1 - aaa_{st})$	$\forall s \in SD \cap SDA, \forall i \in C, \forall t \in T$	56
$qoup_{stg} \le mm \times aaa_{st}$	$\forall s \in SG \cap SDA, \forall g \in G, \forall t \in T$	57
$qonor_{stg} \le mm \times (1 - aaa_{st})$	$\forall s \in SG \cap SDA, \forall g \in G, \forall t \in T$	58

Inventory/backorder constraints		
$v_{i0} = it_i$	$\forall i \in C$	59
Transportation-related constraints		
$\sum_{i \in C} (wtl_i \times xxx_{sit}^{\delta}) = wq_{st}^{\delta}$	$\forall s \in STL, \forall t \in T, \forall \delta \in SC$	60
$wq_{st}^{\delta} \le tlle_s \times (b_{st}^{\delta} - 1)$	$\forall s \in STL, \forall t \in T, \forall \delta \in SC$	61
$wq_{st}^{\delta} \le tlle_s \times b_{st}^{\delta}$	$\forall s \in STL, \forall t \in T, \forall \delta \in SC$	62
Supplier's capacity constraints		
$x_{sit} \le tolcap_{si}$	$\forall s \in SD, \forall i \in C, \forall t \in T, \forall \delta \in SC$	63
$q_{stg} \le gtolcap_{sg}$	$\forall s \in SG, \forall t \in T, \forall g \in G, \forall \delta \in SC$	64
Quality level constraint		
$qc_{si} \times xxx_{sit}^{\delta} \le qcc_{sit}^{\delta}$	$\forall s \in S, i \in C, t \in T, \forall \delta \in SC$	65
Maximum and minimum number of suppliers' constraints		
$\sum_{s \in S} z_s \le maxs$	$\forall s \in S$	66
$\sum_{s \in S} z_s \le mins$	$\forall s \in S$	67
Integer logical constraints		
$z_s \le \sum_{t \in T} \sum_{i \in C} x_{sit}, \sum_{i \in C} x_{sit} \le mm * z_s$	$\forall s \in S, \forall \delta \in SC$	68,69
$z_s \le \sum_{t \in T} \sum_{g \in G} q_{stg}, \sum_{g \in G} q_{stg} \le mm * z_s$	$\forall s \in SG, \forall t \in T, \forall g \in G, \forall \delta \in SC$	70,71
$\sum_{i \in C} xxxo_{sit}^{\delta} \le mm * u_{st}^{\delta}, u_{st}^{\delta} \le \sum_{i \in C} xxxo_{sit}^{\delta}$	$\forall s \in SD, \forall i \in C, \forall t \in T, \forall \delta \in SC$	72,73
$\sum_{g \in G} qqqo_{stg}^{\delta} \le mm * u_{st}^{\delta}, u_{st}^{\delta} \le \sum_{g \in G} qqqo_{stg}^{\delta}$	$\forall s \in SG, \forall t \in T, \forall g \in G, \forall \delta \in SC$	74,75
$group_{stg}^{\delta} \le qqq_{stg}^{\delta}, qqq_{stg}^{\delta} \le mm \times group_{stg}^{\delta}$	$\forall s \in S, \forall t \in T, \forall g \in G, \forall \delta \in SC$	76,77
$y_{sit}^{\delta} \le xxx_{sit}^{\delta}, xxx_{sit}^{\delta} \le mm \times y_{sit}^{\delta}$	$\forall s \in S, \forall i \in C, \forall t \in T, \forall \delta \in SC$	78,79

Non-negativity constraints		
$0 \le xxxo_{sit}^{\delta}$	$\forall s \in SD \cap SG, \forall i \in C, \forall t \in T\ , \forall \delta \in SC$	80
$0 \le qonor_{stg},\ 0 \le qoup_{stg}$	$\forall s \in SG, \forall t \in T, \forall g \in G$	81
$0 \le lnor_{sit}, 0 \le lup_{sit}$	$\forall s \in SL, \forall i \in C, \forall t \in T$	82
$0 \le xonor_{sit}, 0 \le xoup_{sit}$	$\forall s \in SD, \forall i \in C, \forall t \in T$	83
$0 \le sd_{it}^{\delta}$	$\forall i \in C, \forall t \in T\ , \forall \delta \in SC$	84
$0 \le v_{it}^{\delta}\ \ 0 \le xspot_{it}^{\delta}$	$\forall i \in C, \forall t \in T\ , \forall \delta \in SC$	85

Table 4-1 Model Constraints

Binary constraints		
z_s is binary	$\forall s \in S$	86
y_{sit}^{δ} is binary	$\forall s \in S, \forall i \in C, \forall t \in T\ , \forall \delta \in SC$	87
u_{st}^{δ} is binary	$\forall s \in SD \cap SG, \forall t \in T\ , \forall \delta \in SC$ $\forall \delta \in SC$	88
a_{stg} is binary	$\forall s \in SDG, \forall t \in T, \forall g \in G$	89
aa_{sit} is binary	$\forall s \in SDI, \forall i \in C, \forall t \in T$	90
aaa_{si} is binary	$\forall s \in SDA, \forall i \in C, \forall t \in T$	91
$group_{stg}^{\delta}$ is binary	$\forall s \in S, \forall t \in T, \forall g \in G\ , \forall \delta \in SC$	92

Integrality constraints		
$lnor_{sit}, lup_{sit}, ll_{sit}$ is integer	$\forall s \in SL, \forall i \in C, \forall t \in T$	93
$xo_{sit}, xonor_{sit}, xoup_{sit}$ is integer	$\forall s \in SD, \forall i \in C, \forall t \in T$	94
$xxxo_{sit}^{\delta}$ is integer	$\forall s \in SD \cap SG, \forall i \in C, \forall t \in T$ $\forall \delta \in SC$	95
$qo_{stg}, qonor_{stg}, qoup_{stg}$ is integer	$\forall s \in SG, \forall t \in T, \forall g \in G$	96
$xspot_{it}^{\delta}, v_{it}^{\delta}$ is integer	$\forall i \in C, \forall t \in T, \forall \delta \in SC$	97
b_{st}^{δ} is integer	$\forall s \in STL, \forall t \in T, \forall \delta \in SC$	98
qcc_{sit}^{δ} is integer	$\forall s \in S, \forall i \in C, \forall t \in T, \forall \delta \in SC$	99

Appendix E: Details of Each Potential Supplier

Table 5-1 Information of the Potential Suppliers

Category	Supplier information
Type of contract	• S1 offers the long-term contract only • S2 offers the long-term contract and the option contract for each individual item • S3 and S4 offer the long-term contract and the flexible contract for individual item • S5 and S6 offer the long-term contract and the flexible bundling contract (the option contract for a group of items)
Quantity discount	• S3, S5, and S6 offer a discount on the items purchased through the long-term contract • S3 offers a discount based on the purchased quantity of each individual item • S5 and S6 offer a discount based on the purchased quantity of each group of items
Transportation	• For S2, S3, S5 and S6, the transportation cost is already included in their purchasing price • To purchase from S1 and S4, the company needs to take responsibility for moving the items from the port to its facility. The transportation is by the full truckload
Incoming inspection	• S1 and S2 are the current suppliers. They require less incoming quality inspection
Capacity	• S2, S3, and S4 have capacity limits for each item • S5 and S6 have capacity limits for each group of items (joint capacity limit)

Table 5-2 Model Parameters

$S = \{S1, S2, S3, S4, S5, S6\}$ Set of suppliers
$C = \{R_A, R_B, R_C, B_A, B_B, B_C\}$ Set of item
$G = \{R, B\}$ Set of groups of items $IG_R = \{R_A, R_B, R_C\}$ Set of items in group R $IG_B = \{ B_A, B_B, B_C \}$ Set of items in group B $T = \{$November, December, January, February$\}$ Set of time period

$SL = \{S1, S2, S3, S4, S5, S6\}$ Set of suppliers that offer a long-term contract $SD = \{S2, S3, S4\}$ Set of suppliers that offer an option/flexible contract for an individual item $SG = \{S5, S6\}$ Set of suppliers that offer an option/flexible contract for a group of items $SF = \{S3, S4, S5, S6\}$ Set of suppliers that offer a flexible contract $SDI = \{S3\}$ Set of suppliers that offer a discount for each individual item $SDG = \{S5, S6\}$ Set of suppliers that offer a discount for each group of items $STL = \{S1, S4\}$ Set of suppliers that require the transportation service (in full truckloads)

Table 5-3 Long-Term Contract Payments

	Purchasing price (prl)					
	S1	**S2**	**S3**	**S4**	**S5**	**S6**
$\mathbf{R_A}$	18.9	19	19.2	19.1	19.2	19
$\mathbf{R_B}$	19.1	19.1	19.3	19.3	19.2	19.2
$\mathbf{R_C}$	19.2	19.2	19.5	19.5	19.2	19.3
$\mathbf{B_A}$	5.6	5.8	6.1	6.0	6.0	5.7
$\mathbf{B_B}$	5.6	5.8	6.1	6.0	6.0	5.7
$\mathbf{B_C}$	5.6	5.8	6.1	6.0	6.0	5.7

Table 5-4 Option/Flexible Contract Payments

	Individual item-reserved price (pr)					
	S1	**S2**	**S3**	**S4**	**S5**	**S6**
$\mathbf{R_A}$		2.8	2.1	2.4		
$\mathbf{R_B}$	Offer only	2.9	2.1	2.4	Offer the	Offer the
$\mathbf{R_C}$	the long-	2.9	2.2	2.4	bundling	bundling
$\mathbf{B_A}$	term	0.9	0.7	0.8	contract	contract
$\mathbf{B_B}$	contract	0.9	0.7	0.8		
$\mathbf{B_C}$		0.9	0.7	0.8		

	Group-reserved price (prg)					
	S1	**S2**	**S3**	**S4**	**S5**	**S6**
R	Offer only the long-term	Offer the individual-	Offer the individual-	Offer the individual-	2.7	2.3
B	contract	item contract	item contract	item contract	0.9	0.7

	Executed price (prr)					
	S1	**S2**	**S3**	**S4**	**S5**	**S6**
	Same as the long-term contract price					

	Flexible level of the group-executed quantity (flex, flexg)					
	S1	**S2**	**S3**	**S4**	**S5**	**S6**
	—	—	Up to 15% of the reserved quantity for each product	Up to 20% of the reserved quantity for each product	Up to 10% of the reserved quantity for each group of products	Up to 20% of the reserved quantity for each group of products

Table 5-5 Quantity Discount

Quantity Discount (dis)
The retailing box S2: 3% discount if the purchased quantity of each retailing box is greater than 70,000 S5: 3% discount if the purchased quantity of all retailing box is greater than 100,000 S6: 2% discount if the purchased quantity of all retailing box is greater than 150,000 **The plastic bag/leaflet** S2: 3% discount if the purchased quantity* of each plastic bag/leaflet is greater than 70,000 S5: 3% discount if the purchased quantity of all plastic bags/leaflets is greater than 100,000 S6: 2% discount if the purchased quantity of all plastic bags/leaflets is greater than 150,000 *The purchased quantity refers to the quantity purchased through the long-term contract plus the quantity reserved in the option contract

Table 5-6 Cost Related to the Purchasing Decision

Supplier-level cost						
	S1	**S2**	**S3**	**S4**	**S5**	**S6**
Relationship cost (rel)	0	0	5000	5000	5000	5000
Audit cost (aud)	4000	4000	8000	12000	10000	8000
Order-level cost						
	S1	**S2**	**S3**	**S4**	**S5**	**S6**
Transactional cost (ptc)	2000	2000	2000	2000	2000	2000
Group-level cost						
	S1	**S2**	**S3**	**S4**	**S5**	**S6**
Receiving cost (rec)						
Retailing box	1200	1200	1200	1200	1200	1200
Plastic bag/leaflet	1200	1200	1200	1200	1200	1200
Incoming quality Inspection cost (qal)						
Retailing box	800	600	1300	1300	1300	1300
Plastic bag/leaflet	800	600	1500	1500	1500	1500
Transportation-related Cost						
Transportation cost/container (tl)	800	0	0	800	0	0
Container size (tlle)	35000	0	0	35000	0	0
Equivalent unit truckload						
1 for the retailing box (R), 0.1 for the plastic bag/product leaflet (B)						

Table 5-7 Other Relevant Requirements

Capacity						
	S1	**S2**	**S3**	**S4**	**S5**	**S6**
Maximum option capacity (miso)	1	0.7	1	0.6	0.7	0.5
capacity (tolcap)						
$\mathbf{R_A}$	200,000	60,000	200,000			
$\mathbf{R_B}$	200,000	60,000	200,000			
$\mathbf{R_C}$	200,000	60,000	200,000	—	—	—
$\mathbf{B_A}$	200,000	80,000	200,000			
$\mathbf{B_B}$	200,000	80,000	200,000			
$\mathbf{B_C}$	200,000	80,000	200,000			

Group-capacity (gtolcap)						
R				240,000	180,000	240,000
B				300,000	270,000	300,000
Maximum level of the purchased quantity through the option contract (as a percentage of maximum capacity)	—	0.7	0.6	0.6	0.7	0.5
Inventory						
Inventory holding cost (h)	5.75	5.75	5.75	1.75	1.75	1.75

Systemic Risk, the TED Spread and Hedge Fund Returns

by

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Abstract

This study examines the effects of systemic risk on global hedge fund returns. We consider systemic risk as a conditional information variable to predict the underlying exposures to various asset market returns and risk factors. This study examines a proxy for global systemic risk employed by investment professionals known as the Treasury/Eurodollar (TED) spread. The findings reveal that increases in systemic risk causes some hedge fund investment styles to dynamically reduce their equity and stock momentum exposures while others increase their exposures to investment grade bonds and commodities. The information content of systemic risk via the TED spread assists us in better understanding the behaviour of global hedge fund returns.

Keywords: Systemic Risk, the TED Spread and Hedge Fund Returns

1. Introduction

The unfolding global financial crisis (GFC) and the events leading up to it have increased the attention of global hedge funds and their role in systemic risk. Systemic risk in the finance literature has been synonymous with hedge funds since the near collapse of Long Term Capital Management (LTCM) in 1998. The President's Working Group of Financial Markets (1999), Edwards (1999) and Chan, Getmansky, Haas and Lo (2006) have all concluded that LTCM and the global hedge fund industry significantly increased the level of systemic risk in 1998. Opposing literature from Eichengreen and Mathieson (1998a, 1998b) and Eichengreen and Mathieson, Chadha, Jansen, Kodres and Sharma (1998), Fung and Hsieh (2000) and Ferguson and Laster (2007) argue that hedge funds are not responsible for major market turmoil and therefore contribute little to systemic risk. Given this controversy, the association between hedge funds and systemic risk remains unclear. This paper seeks to explore systemic risk as an information variable to better understand the behaviour of global hedge fund returns.

This study does not focus on the causes of systemic risk as it has been covered elsewhere in the finance and economics literature including De Bandt and Hartmannn (2000) and the IMF (2009). This study considers whether changes in systemic risk can explain global hedge fund returns. Previous studies by Fung and Hsieh (2004), Capocci and Hubner (2004) and Bianchi, Drew and Stanley (2008) have demonstrated that the sources of hedge fund returns can, at times, be related to conventional market returns and risk factors of various asset markets. In a related strand of

literature, Amenc, El Bied and Martellini (2003) and Hamza, Kooli and Roberge (2006) suggest that hedge fund returns are predictable by employing market related returns and risk factors. Other studies in the mutual fund literature by Fama and French (1989), Ferson and Harvey (1991) and Chen (1991) argue that predictability in stock returns arises as a result of time-varying compensation for stages in the business cycle. This study integrates the above literature by examining systemic risk as a conditioning variable and considers whether global hedge fund returns reflect time-varying compensation for systemic risk.

As stated in IMF (2009), the term 'systemic risk' is notoriously difficult to define and measure. In this study, we contribute to the literature by employing a well recognised proxy for systemic risk employed by investment professionals which is known as the Treasury/Eurodollar (TED) spread. The TED spread is the difference between the 3 month LIBOR rate on Eurodollars and the 3 month U.S Treasury bill rate. We examine whether changes in this proxy for global systemic risk provides information in predicting global hedge fund returns.

The following paper explores three key ideas. First, we examine systemic risk as an explanatory variable for global hedge fund returns. Second, we employ the TED spread as a proxy for global systemic risk. Finally, we examine systemic risk in the form of the TED spread as a conditioning variable which may explain hedge fund returns via its interaction with independent variables. The main findings of this study reveal that some hedge fund investment styles reduce their equity and stock momentum exposure when systemic risk increases. At the same time, other hedge funds increase their exposures to investment grade bonds and commodities. It is our conjecture that systemic risk via the TED spread is an information variable which can assist in better understanding the behaviour of global hedge fund returns.

2. Review of Literature

Systemic risk, while being largely undefined, often refers to macroeconomic shocks or events that destabilise the macroeconomy. Studies such as Bhansali, Gingrich and Longstaff (2008), Das and Uppal (2004), Huang, Zhou and Zhu (2009) and Lehar (2005) demonstrate the destabilising effects that systemic risk imposes on equity and credit markets. Whilst voluminous literature has examined the impact of systemic risk on assets, credit markets and banks, little research attention has been given to the impact of systemic risk on global hedge fund returns.

Studies by Bianchi *et. al.,* (2008), Capocci and Hubner (2004) and Fung and Hsieh (2004) have demonstrated that some hedge fund styles exhibit low market related exposures while other hedge fund investments exhibit high beta exposure to various markets and risk factors. Although these studies measure the source of hedge fund returns, they remain silent on whether hedge fund returns themselves are affected by global systemic risk.

One of the first studies to examine the relationship between systemic risk and hedge funds comes from Fung and Hsieh (2000) who examine historical moments of market turmoil. Fung and Hsieh (2000) demonstrate that hedge funds do not cause or contribute to these destabilising financial market events. In another study, Chan, Getmansky, Haas and Lo (2005) explicitly examine hedge funds and systemic risk. Chan *et. al.,* (2005) refer to systemic risk as the possibility of a series of correlated defaults, such as bank runs, that occur over a short period of time, usually caused by a single major event. The research motivation stems from the LTCM collapse, which caused considerable stress on global financial markets. The focus of Chan *et. al.,* (2005) is the relationship between illiquidity in the hedge fund industry and macroeconomic shocks in global markets.

Employing the weighted serial correlation of hedge fund returns as a proxy for illiquidity within the industry, Chan *et. al.,* (2005) find that there is a strong relationship between illiquidity in the hedge fund sector and shocks to global markets[1]. When these systemic shocks occur, illiquidity in the hedge fund sector appears to rise dramatically. Chan *et. al.,* (2005) suggest that measures of liquidity exposures in the hedge fund industry can be a good measure of the degree of systemic risk.

Whilst the *Chan et. al.,* (2005) liquidity proxy for systemic risk is novel and innovative, it relies solely on hedge fund industry data. There are two issues associated with this definition of systemic risk. First, the hedge fund industry is just one of many important sectors of global financial markets. This information from the hedge fund industry may provide a partial measure of systemic risk within this sector of global financial markets, however, it is unlikely that such metrics can be employed to define systemic risk of the entire global financial system. Second, research by Fung and Hsieh (2000) and Liang (1999) have documented the reporting delays that are associated with hedge fund data, therefore, it is not practically feasible to employ the Chan *et. al.,* (2005) measure of systemic risk. While the contributions of Fung and Hsieh (2000) and Chan *et. al.,* (2005) are significant, the relationship between systemic risk and hedge fund returns remains a relatively unexplored area in the hedge fund literature.

As there is no single definition to describe systemic risk, the selection of a proxy for this metric is an important consideration. There is emerging evidence from the IMF (2009) and central bankers including Hildebrand (2007) that suggest that the TED spread is an efficient market proxy for global systemic risk. Studies such as Lashgari (2000) have revealed that the TED spread seems to fall during periods of high confidence, and rise during periods of low investor confidence. Changes in the TED spread also appear to be a source of equity volatility (see, Tse and Booth 1996). Lashgari (2000) finds that falling TED spreads are associated with rising equity markets, and vice versa. While this is indeed an interesting finding, the academic literature employing the TED spread is somewhat limited. Despite the lack of academic attention, practitioners and industry professionals have monitored the TED spread throughout the GFC as a barometer of global systemic risk. In order to examine the TED spread's significance, we test its effectiveness as an information variable against global hedge fund returns.

Given the dynamic shifts in systemic risk, it is important to consider how it interacts with hedge funds over time. The works of Fama and French (1989), Ferson and Harvey (1991) and Chen (1991) have demonstrated that key macroeconomic variables can explain the time-variation of equity returns. This raises the question of whether systemic risk can explain the variation of hedge fund returns as a risk factor and whether time-variation of hedge fund returns can be explained by systemic risk.

3. Data

This study employs data from January 1994 to December 2007 consisting of 168 monthly observations. This time period includes the Asian currency crisis of 1997, the Russian bond default crisis and the collapse of LTCM in 1998, the dot-com boom and bust from 1998-2000, 11th September 2001, and the commencement of the US subprime mortgage meltdown in 2007. The data section of this paper is divided into three parts. First, we describe the TED spread which is the proxy for systemic risk. The second section summarises the global hedge fund index returns employed in the study. Finally, the various independent variables in this study are considered.

[1] Serial correlation can also be interpreted as time-varying risk premia.

The data for the construction of the TED spread is sourced from the United States Federal Reserve. The LIBOR rate is the 3 month yield on Eurodollars which banks charge each other for US deposits outside the regulatory framework of the US banking system.[2] Since these deposits are outside the jurisdiction of the Federal Reserve, they are deemed to be riskier.[3] Investors therefore demand that they receive higher interest payments for accepting the lower liquidity and increased risk in Eurodollars. US Treasury bills on the other hand are regarded as one of the safest and most liquid investments in the world. Since Treasury bills are issued and backed by the USA government, there is a low to zero probability of default. It is well recognised that US Treasury Bills are highly liquid instruments that possess low risk and are often employed as the risk-free rate in finance studies. The yield difference between the premium on Eurodollars and Treasury bills is believed to capture the global credit risk premia, and is employed as a suitable proxy for systemic risk.

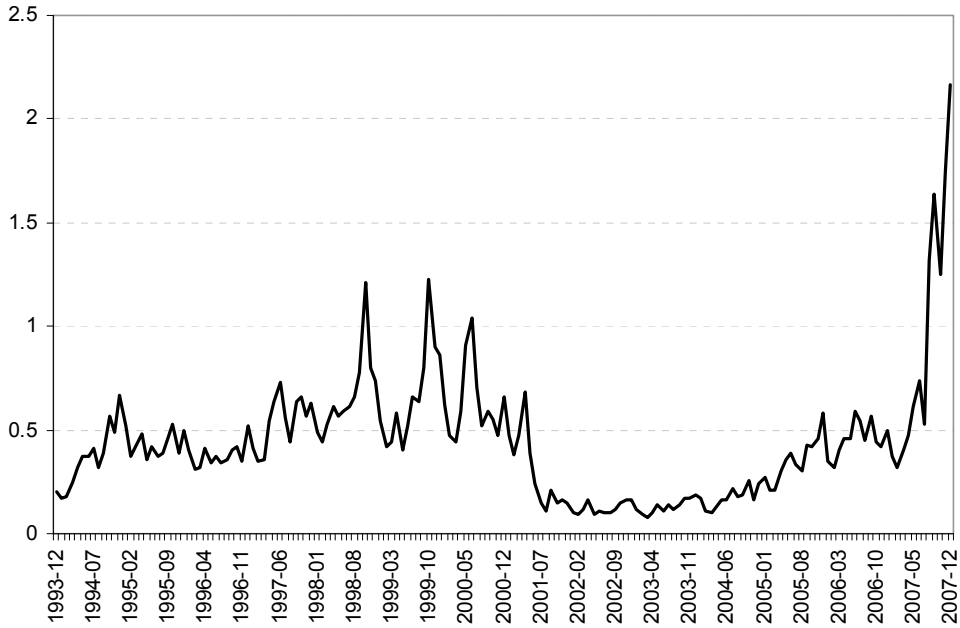

Figure 1 Treasury/Eurodollar (TED) Spread

This figure illustrates the yield difference between the 3 month LIBOR rate and the 3 month US Treasury Bill rate. Monthly yield data is employed from January 1994 to December 2007.

Figure 1 illustrates the TED spread from January 1994 to December 2007. In this study, it is important to note that the changes in the TED spread are employed rather than the level of the TED spread which ensures stationarity in this independent variable. Figure 1 shows that rapid increase in the TED spread during the 1997 Asian crisis, the 1998 Russian and LTCM crisis and the more recent 2007 subprime US mortgage crisis. The TED spread also reveals period of low systemic risk from 2002 to 2004.

[2] An example is an Australian resident depositing U.S dollars in an Australian bank.

[3] Foreign banks holding Eurodollar deposits do not have to maintain reserve requirements to protect Eurodollar depositors. Furthermore, there is no deposit insurance for depositors, nor are central banks obligated to bail out Eurodollar depositors. This lower liquidity, coupled with the inflexibility for depositors to withdraw holdings as they please increases the risk of Eurodollar depositors.

Table 1 Descriptive Statistics

This table reports the summary statistics of the data employed in this study. Panel A presents the monthly returns of the hedge fund index returns employed in this study. FOF=HFR Fund of Fund Index, CA=Convertible Arbitrage, DSB=Dedicated Short Bias, EM=Emerging Markets, EMN=Equity Market Neutral, ED=Event Driven, FIA=Fixed Income Arbitrage, GM=Global Macro, LSE=Long-Short Equity, and MF=Managed Futures. Panel B reports the monthly returns of the independent variables. Rm=US market value composite stock index, SMB=Fama-French Small-Minus-Big portfolio, HML=Fama-French High-Minus-Low Book to Market portfolio, UMD=Carhart 12 month momentum portfolio, WBIG= Citigroup World Broad Investment Grade (BIG) Bond Index, DJAIG=Dow Jones AIG Commodity Total Return Index, USDI=US Dollar Index, and MSCIXUS=MSCI World Equity Index excluding USA. Panel C presents the descriptive statistics of the basis point change in the TED spread. J-B Stat. and J-B p-val denotes the Jarque-Bera test statistic and p-value, respectively. * and ** denote statistical significance at the 5% and 1% levels, respectively.

Category	Mean	Std. Dev.	Skewness	Kurtosis	Median	Max.	Min	J-B Stat.	J-B p-val
Panel A:									
FOF	0.0065	0.0164	-0.2783	6.9657	0.0076	0.0685	-0.0747	112.26	0.001**
CA	0.0070	0.0133	-1.3569	6.2114	0.0102	0.0351	-0.0479	123.74	0.001**
DSB	-0.0015	0.0477	0.6285	4.1836	-0.0042	0.2047	-0.0909	20.87	0.003**
EM	0.0079	0.0456	-1.2115	10.0882	0.0148	0.1520	-0.2618	392.80	0.001**
EMN	0.0078	0.0081	0.3057	3.4329	0.0079	0.0321	-0.0116	3.93	0.101
ED	0.0093	0.0162	-3.625	29.7930	0.0105	0.0361	-0.1252	5392.98	0.001**
FIA	0.0051	0.0106	-3.0698	19.7535	0.0071	0.0203	-0.0721	2228.61	0.001**
GM	0.0108	0.0298	-0.2188	6.5757	0.0117	0.1008	-0.1227	90.84	0.001**
LSE	0.0096	0.0280	-0.0544	7.1682	0.0086	0.1223	-0.1214	121.70	0.001**
MF	0.0052	0.0343	-0.1078	3.2262	0.0034	0.0949	-0.0982	0.6834	0.500
Panel B:									
Rm	0.0062	0.0416	-0.7809	4.0773	0.0133	0.0818	-0.1620	25.20	0.002**
SMB	0.0013	0.0387	0.9069	10.5507	-0.0018	0.2218	-0.1670	422.12	0.001**
HML	0.0033	0.0349	0.0865	5.8981	0.0036	0.1380	-0.1280	59.00	0.001**
UMD	0.009	0.5958	-0.6607	8.5896	0.0088	0.220	-	230.93	0.001

	4					8	0.3006		**
WBIG	0.0019	0.0145	0.0930	3.1224	0.0023	0.0458	-0.0369	0.35	0.500
DJAIG	0.0012	0.0375	-0.0621	2.6978	0.0009	0.0947	-0.0817	0.74	0.499
USDI	-0.0046	0.0208	-0.0281	2.9873	-0.0038	0.0498	-0.0558	0.02	0.498
MSCIXUS	0.0059	0.0419	-0.7238	3.9908	0.0094	0.0981	-0.1538	21.54	0.002 **
Panel C:									
Δ TED Spread	0.0117	0.1467	1.0464	8.5875	0.0100	0.7900	-0.4100	249.21	0.001 **

This second part of the data section describes the hedge fund returns employed in this study. We employ monthly index returns from Credit Suisse First Boston/Tremont to represent the returns of the wide range of strategies employed in the global hedge fund industry. We use index returns instead of individual hedge fund returns so that we can measure the impact of the TED spread on the systematic returns of each hedge fund investment style. Amenc et al (2003) argue that the CSFB/Tremont hedge fund indices exhibit characteristics in index construction that offer substantial advantages over other competitors. The CSFB/Tremont indices only include funds that manage over certain amount of funds under management and provide audited financial statements. Approximately 300 funds are able to pass through this selection screen for inclusion in these indices. Furthermore, the CSFB/Tremont are the industry's only asset weighted hedge fund indexes. The allocation of funds to the indexes are recalculated quarterly and funds are not excluded from the database until they liquidate or fail to comply with reporting requirements. This index compliance requirements assists in minimising survivorship and backfilling bias in the database. To measure the overall returns from the global hedge fund industry, we also employ the HFR Fund of Funds Index. Fung and Hsieh (2000, 2002) have demonstrated that fund of funds (FOF) indexes exhibit the smallest levels of survivorship bias and backfilling bias and are therefore the most accurate measure of global hedge fund performance. The Ibbotson risk-free rate from the Kenneth French library is employed and continuously compounded returns are employed in the study.

Table 1 provides the descriptive statistics of the raw returns of the CSFB/Tremont indices and the HFR FOF Index. The statistics reveal the heterogeneous nature of the hedge fund universe with certain strategies exhibiting higher levels of volatility than others. The Dedicated Short Bias, Emerging Markets, Global Macro, Long-Short Equity and Managed Futures hedge fund indices exhibit higher levels of volatility in comparison to the other indices. In the sample period, Global Macro appears to exhibit the highest mean return.

Table 2 presents the correlation matrix of returns which further attests to the heterogeneous nature of the hedge fund universe. The highest level of correlation between the hedge fund indices is 0.85 between the HFR FOF Index and Long-Short Equity. This result is expected given that Long-Short Equity hedge funds represent a significant proportion of the global hedge fund industry.

Table 2 Correlation Matrix of Hedge Fund Returns

This table reports the correlation coefficients of the monthly returns of the hedge fund index returns. FOF=HFR Fund of Fund Index, CA=Convertible Arbitrage, DSB=Dedicated Short Bias, EM=Emerging Markets, EMN=Equity Market Neutral, ED=Event Driven, FIA=Fixed Income Arbitrage, GM=Global Macro, LSE=Long-Short Equity, and MF=Managed Futures.

Category	FOF	CA	DSB	EM	EMN	ED	FIA	GM	LSE	MF
FOF	1.000									
CA	0.504	1.000								
DSB	-0.626	-0.293	1.000							
EM	0.781	0.325	-0.545	1.000						
EMN	0.421	0.321	-0.346	0.251	1.000					
ED	0.803	0.579	-0.632	0.680	0.364	1.000				
FIA	0.446	0.536	-0.124	0.296	0.128	0.399	1.000			
GM	0.630	0.291	-0.151	0.425	0.213	0.379	0.440	1.000		
LSE	0.852	0.299	-0.727	0.606	0.353	0.670	0.227	0.434	1.000	
MF	0.117	-0.080	0.066	-0.040	0.150	-0.073	-0.005	0.258	0.056	1.000

This third part of the data section describes the independent variables employed as proxies for equity, bond, currency and commodity market returns and risk factors. The eight independent variables include the U.S. market weighted portfolio of all US stocks from the Kenneth French library, the Fama-French Small-Minus-Big (SMB) risk factor portfolio return, the Fama-French High-Minus-Low (HML) risk factor portfolio return, the Carhart (1997) Up-Minus-Down (UMD) 12 month momentum risk factor portfolio, the Citigroup World Broad Investment Grade (WBIG) Bond Index, the Dow Jones AIG Commodity Total Return Index, the U.S. Dollar Index and the MSCI World Equity Index excluding USA.

4. Methodology

The difficulty in modelling hedge fund performance has been the dynamic nature of hedge fund managers employing time-varying exposures to traditional asset classes. Managers tend to 'ride with the market' during bull market runs, and decrease their exposure during market downturns. This is one of the causes of the dynamic relationship between hedge fund returns and traditional asset classes that is often cited in the literature.

To examine the dynamic and time-varying nature of hedge fund exposures, we propose a conditional model of hedge fund performance. First, we employ the eight-factor unconditional model of Bianchi *et. al.,* (2008) and we then proceed to augment this unconditional model by conditioning it on changes in the TED spread. The TED spread will be employed as an information variable to examine whether changes in systemic risk can predict hedge fund returns. The motivation for this

conditional model is to capture the time-varying behaviour of hedge fund returns when they shift their exposures in traditional asset classes based on changes in systemic risk. This is more acute as rising levels of systemic risk are often associated with downward movements in equity markets.

To model hedge fund returns, we employ the Bianchi *et. al.,* (2008) unconditional model as an alternative to the Capocci and Hubner (2004) or the Fung and Hsieh (2004) models. There are three rationales for the use of the Bianchi *et. al.,* (2008) framework. First, it has been found to readily capture the systematic returns of individual hedge funds and indexes. Second, the Bianchi *et. al.,* (2008) eight-factor model is more parsimonious than the Capocci and Hubner (2004) eleven-factor model. Third, the Bianchi *et. al.,* (2008) model avoids the use of lookback option returns as independent variables (IVs) as proposed in Fung and Hsieh (2004). Studies by Conze and Viswanathan (1991) and Parsons (1994) have shown that lookback options exhibit nonlinear return patterns due to their multiple path dependencies. The nonlinearity of returns from the lookback option payoffs make it very difficult and undesirable to assess the true statistical power of the standard errors of this IV in an OLS regression framework.

The Bianchi *et. al.,* (2008) unconditional eight-factor model is expressed as:

$$R_{i,t} - rf_t = \alpha_i + \beta_{1,i}(Rm_t - rf_t) + \beta_{2,i}HML_t + \beta_{3,i}SMB_t + \beta_{4,i}UMD_t + \beta_{5,i}(CITI_t - rf_t) + \beta_{6,i}(DJAIG_t - rf_t) + \beta_{7,i}(USDI_t - rf_t) + \beta_{8,i}(MSCIXUS_t - rf_t) + \varepsilon_{i,t} \quad (1)$$

where $R_{i,t}$ is the return on a hedge fund style at time t, Rm is the return on the U.S. market-weighted portfolio, rf is the risk-free rate, HML is the Fama-French factor-mimicking portfolio for book-to-market equity, SMB is the Fama-French factor-mimicking portfolio return for size, UMD is the Carhart (1997) factor-mimicking portfolio for 12 month momentum, $CITI$ is the return on the Citigroup World Broad Investment Grade Index, $DJAIG$ is the return on the Dow-Jones AIG commodity Total Return index, $USDI$ is the return on the U.S. Dollar index, $MSCIXUS$ is the return on the Morgan Stanley World Equity Index ex U.S. and ε is the error term.

The unconditional model in (1) is estimated via OLS with Newey and West (1987) corrected standard errors to account for possible heteroskedasticity and autocorrelation in the regression residuals.

The second model employed in this study is the same as (1) but has been conditioned to changes in the TED spread. The conditional model employed in this study is expressed as follows:

$$R_{i,t} - rf_t = \alpha_i + \mathrm{X}'_t\beta_{1,i} + \mathrm{Z}_{t-1}\mathrm{X}'_t\beta_{2,i} + \varepsilon_{i,t} \quad (2)$$

where $R_{i,t}$ is the return on a hedge fund style at time t, rf_t is the risk-free rate, X'_t is a matrix of explanatory variables that include the eight factors in (1), and Z_{t-1} is the change in the TED spread at t-1, and ε_t is the error term.

$\mathrm{Z}_{t-1}\mathrm{X}'_t\beta_{2,i}$ measures the covariance between the betas in the model and the expected return based on the previous months change in the TED spread. It proxies as an interaction term between market factors and changes in the TED spread. $\mathrm{Z}_{t-1}\mathrm{X}'_t\beta_{2,i}$ provides a measure of the response of conditional betas to changes in the TED spread. If these coefficients are significant, it indicates that hedge fund managers exhibit time-varying exposure to asset class X based on the changes in the TED spread in

the previous month, Z_{t-1} (see Ferson and Shadt (1996) and Ferson and Warther (1996)). If this is the case, then the TED spread may be employed to predict hedge fund returns. We now proceed to present the results of the analysis.

Table 3 Unconditional Model Estimates

This table presents the OLS estimates of the respective hedge fund index returns regressed against the unconditional eight-factor model. The table reports the regression coefficient estimates with the associated t-statistics in parentheses. FOF=HFR Fund of Fund Index, CA=Convertible Arbitrage, DSB=Dedicated Short Bias, EM=Emerging Markets, EMN=Equity Market Neutral, ED=Event Driven, FIA=Fixed Income Arbitrage, GM=Global Macro, LSE=Long-Short Equity, and MF=Managed Futures. Statistical significance was estimated with Newey and West (1987) corrected standard errors. * and ** denote statistical significance at the 5% and 1% levels, respectively.

	FOF	CA	DSB	EM	EMN	ED	FIA	GM	LSE	MF
A	0.0023**	0.0035*	0.0022	0.0066*	0.0044**	0.0051**	0.0018**	0.0072**	0.0023	0.0011
	(2.8179)	(2.3473)	(0.9997)	(2.0806)	(5.5944)	(4.6892)	(1.9984)	(3.1592)	(1.9031)	(0.4513)
ß(Rm_t)			-0.9157**							
	0.0865*	0.0477	(-	-0.0640	0.0470	0.1264**	-0.0155	0.1496	0.4090**	-0.1514
	(2.3928)	(1.3012)	11.0734)	(-0.4563)	(1.7877)	(3.3437)	(-0.3697)	(1.3422)	(7.9515)	(-0.9792)
ß(SMB_t)			-							
	0.1458**	0.1114**	0.2762**	0.2214**	-0.0032	0.1389**	0.0549	0.1101	0.2078**	0.0108
	(6.5491)	(3.4819)	(-3.2845)	(2.8293)	(-0.1997)	(5.3535)	(1.9160)	(1.7885)	(5.8861)	(0.1359)
ß(HML_t)	0.0265*	0.0998**	0.0719	-0.0030	0.0077	0.1211**	0.0556	0.1176	-0.0508	0.0649
	(0.9514)	(3.0146)	(0.8467)	(-0.0329)	(0.3606)	(3.8070)	(1.6669)	(1.3688)	(-1.0337)	(0.5894)
ß(UMD_t)	0.0058**	-0.0009	-0.0020	0.0071*	-0.0005	0.0008	0.0008	0.0101*	0.0172**	0.0059
	(4.4527)	(-0.6649)	(-0.4754)	(2.0242)	(-0.5816)	(0.6568)	(0.5354)	(2.2674)	(6.8327)	(1.6458)
ß($WBIG_t$)	0.2318**	0.1708*	-0.0706	0.4749*	0.0723	0.1239*	0.2171*	0.9450**	0.2126*	0.4010
	(3.6585)	(2.1515)	(-0.4203)	(2.2956)	(1.2098)	(2.0656)	(2.3559)	(4.2178)	(2.4658)	(1.2877)
ß($DJAIG_t$)	0.0533*	0.0075	-0.0081	0.0741	0.0191	0.0250	0.0215	0.0593	0.0489*	0.1766**
	(2.5862)	(0.3072)	(-0.1294)	(1.1232)	(1.3663)	(1.0943)	(1.5279)	(1.1034)	(2.2170)	(2.5262)
ß($USDI_t$)	0.2807**	0.1508	-0.0345	0.8620**	0.0361	0.1908**	0.1587	0.7830**	0.0801	-0.0799
	(5.9770)	(0.3072)	(-0.3319)	(4.2536)	(0.8098)	(2.7880)	(1.6872)	(4.0908)	(1.3350)	(-0.3532)
ß($MSCIXUS_t$)	0.1844**	0.0316	0.0266	0.7470**	0.0247	0.1603**	0.0555	0.0941	0.0693	0.1095
	(5.4203)	(0.6015)	(0.3515)	(5.2950)	(1.0186)	(2.5552)	(1.4144)	(0.9944)	(1.4507)	(0.7211)
Adjusted R^2	0.6769	0.1115	0.7494	0.4902	0.1169	0.5353	0.0901	0.3095	0.8045	0.1015

Table 4 Conditional Model Estimates

This table presents the OLS estimates of the respective hedge fund index returns regressed against the eight-factor model conditioned on lagged changes in the TED spread. The table reports the regression coefficient estimates with the associated t-statistics in parentheses. FOF=HFR Fund of Fund Index, CA=Convertible Arbitrage, DSB=Dedicated Short Bias, EM=Emerging Markets, EMN=Equity Market Neutral, ED=Event Driven, FIA=Fixed Income Arbitrage, GM=Global Macro, LSE=Long-Short Equity, and MF=Managed Futures. Statistical significance was estimated with Newey and West (1987) corrected standard errors. * and ** denote statistical significance at the 5% and 1% levels, respectively.

	FOF	CA	DSB	EM	EMN	ED	FIA	GM	LSE	MF
α										
	0.0021*	0.0031*	0.0023	0.0062	0.0041**	0.0047**	0.0015	0.0069**	0.0020	0.0004
	(2.2961)	(2.0441)	(1.0287)	(1.8982)	(5.2022)	(3.8849)	(1.7106)	(3.2551)	(1.5549)	(0.1396)
ß(Rm_t)			-							
			0.9371**				-0.0235			-0.1732
	0.0777	0.0440	(-	-0.0572	0.0452	0.1255**	(-	0.1250	0.4038**	(-
	(1.8234)	(1.1155)	11.2005)	(-0.4000)	(1.6356)	(3.1322)	0.4641)	(1.0363)	(7.8867)	1.1054)
ß(SMB_t)			-							-0.0163
	0.1402**	.1100**	0.2986**	0.2131**	-0.0128	0.1301**	0.0498	0.0988	0.1903**	(-
	(4.9218)	(3.2142)	(-3.8850)	(2.6838)	(-0.7245)	(5.0764)	(1.4551)	(1.3809)	(5.5740)	0.1920)
ß(HML_t)										
	0.0301	0.1084**	0.0572	-0.0088	0.0070	0.1229**	0.0679	0.1340	-0.0460	0.0694
	(0.9050)	(2.8394)	(0.6453)	(-0.0925)	(0.3169)	(3.7624)	(1.8579)	(1.6047)	(-0.9759)	(0.6077)
ß(UMD_t)										
	0.0058**	-0.0014	-0.0010	0.0082*	-0.0002	0.0010	0.0001	0.0093**	0.0170**	0.0070
	(3.9687)	(-0.9414)	(-0.2360)	(2.2577)	(-0.2289)	(0.8040)	(0.0824)	(2.7000)	(7.5081)	(1.8152)
ß($WBIG_t$)										
	0.2384**	0.1865*	-0.0946	0.4373	0.0548	0.1177	0.2231*	1.0028**	0.2364**	0.3750
	(3.1803)	(2.1767)	(-0.5374)	(1.9119)	(0.9505)	(1.8304)	(2.1390)	(4.0942)	(2.6435)	(1.1711)
ß($DJAIG_t$)										
	0.0558**	0.0049	-0.0055	0.0770	0.0257	0.0293	0.0292	0.0571	0.0588*	0.1993*
	(3.2918)	(0.1974)	(-0.0856)	(1.1363)	(1.9405)	(1.1472)	(1.8148)	(1.1129)	(2.1740)	(2.5768)

ß($USDI_t$)										-0.1042
	0.2849**	0.1548	-0.0620	0.8428**	0.0154	0.1850*	0.1541	0.8395**	0.0965	(-
	(3.9918)	(1.5294)	(-0.5729)	(3.8657)	(0.3448)	(2.5715)	(1.5080)	(3.913)	(1.4851)	0.4506)
ß($MSCIXUS_t$)										
	0.1965**	0.0292	0.0627	0.7492**	0.0251	0.1636*	0.0565	0.1424	0.0815	0.1383
	(4.1975)	(0.5540)	(0.9155)	(5.1289)	(1.0248)	(2.5087)	(1.3435)	(1.4269)	(1.7161)	(0.9191)
ß(Rm_t)(Z_{t-1})							-0.0840			
	0.0975	-0.3136	1.5559*	0.8895	0.1975	0.1607	(-	-0.0319	-0.2298	1.1027
	(0.5566)	(-1.3313)	(2.3310)	(1.1696)	(0.9998)	(0.7708)	0.3198)	(-0.0664)	(-0.9012)	(1.4908)
ß(SMB_t)(Z_{t-1})	0.0396	0.1062	-0.2482	0.1614	0.1416	0.0719	0.2220	-0.5093	-0.1934	0.5658
	(0.2665)	(0.7048)	(-0.5050)	(0.4061)	(1.5116)	(0.4945)	(1.3671)	(-1.7820)	(-1.1009)	(1.3111)
ß(HML_t)(Z_{t-1})	-0.0821	-0.1593	0.1568	-0.0273	-0.0393	-0.0966	0.2616	-0.5941	-0.0672	0.4228
	(-0.3755)	(-0.8580)	(0.2059)	(-0.0502)	(-0.3074)	(-0.4843)	(1.4661)	(-1.4508)	(-0.1802)	(0.8067)
ß(UMD_t)(Z_{t-1})										-
	-					-	-0.0028		-	0.0365*
	0.0131*	-0.0104	-0.0027	-0.0123	-0.0092	0.0142*	(-	-0.0360	0.0227**	(-
	(-2.2485)	(-1.4157)	(-0.1543)	(-0.5691)	(-1.8380)	(-2.5188)	0.4898)	(-2.5086)	(-3.1389)	2.0014)
ß($WBIG_t$)(Z_{t-1})										
	0.8205	1.7136**	-0.0422	0.1845	1.0043**	0.8676	1.9158*	1.2609	0.3035	2.4540
	(1.5131)	(2.7265)	(-0.0306)	(0.1097)	(2.7380)	(1.7698)	(2.4142)	(0.9215)	(0.4857)	(1.3918)
ß($DJAIG_t$)(Z_{t-1})										
	0.2204*	0.0404	-0.0848	0.0741	-0.0238	0.1056	0.1169	1.0425**	0.2130	0.3947
	(2.4801)	(0.3910)	(-0.3087)	(0.2267)	(-0.3148)	(0.9642)	(0.8908)	(3.9952)	(1.6325)	(1.3678)
ß($USDI_t$)(Z_{t-1})	0.3935	0.3936	-0.3272	-0.4269	0.3691	0.2793	0.8874	1.1992	0.6679	0.9713
	(1.2017)	(1.0007)	(-0.5107)	(-0.3541)	(1.2673)	(0.9297)	(1.9268)	(1.1390)	(1.7743)	(0.9265)
ß($MSCIXUS_t$)(Z_{t-1})			-							-0.9451
	-0.2397	0.2864	1.6823**	-0.7124	-0.0871	-0.1043	0.2596	-0.7266	0.2595	(-
	(-1.2908)	(1.7369)	(-3.4160)	(-0.8133)	(-0.4513)	(-0.4638)	(1.4882)	(-1.4278)	(1.0817)	1.5275)
Adjusted R^2	0.6758	0.1169	0.7540	0.4685	0.1270	0.5233	0.1108	0.3498	0.8119	0.0850

5. Results

The results section of the paper is divided in two parts. First, we present the regression results of the unconditional eight-factor model in (1). These results provide an understanding of the market returns and risk factors that are explanatory variables of various hedge fund returns and investment styles. Second, we report on the regression results of the eight-factor conditional model in (2) when conditioned to changes in the TED spread.

(i) Unconditional Model

Table 3 presents the regression results of the hedge fund index returns against the unconditional eight-factor model from (1). The results in Table 3 reveal that the simple eight-factor model is relatively successful at identifying the market exposure of hedge funds to traditional asset classes. The HFR Fund of Funds (FOF) Index is regarded as the overall measure of the global hedge fund industry and reports an R^2 of 0.6769 with positive and statistically significant factor loadings for all eight factors. These results are consistent with Capocci and Hubner (2004) and Fung and Hsieh (2002) who suggest that the overall returns of the global hedge fund industry can be explained by conventional market returns and risk factors.

The performance of the Fixed Income Arbitrage model reports the poorest result with an R^2 of 0.0901, however, the high R^2s in the Long-Short Equity (0.8045) and Dedicated Short Bias (0.7494) models reveal that these hedge fund index returns are derived from conventional market factors. Another striking feature of Table 3 is that each hedge fund index return exhibits different statistical significant factor loadings for the eight-factor model. The results in Table 3 demonstrate the heterogenous nature of the hedge fund universe, as various hedge fund strategies are exposed to different market factors. However, the statistical significance of all factor loadings for the Fund of Funds (FOF) index indicates that the industry as a whole bears significant exposure to conventional market factors.

(ii) Conditional Model

In this section, the independent variables employed in the eight-factor model in Eq. (1) are conditioned to the changes in the monthly TED spread. Statistically significant conditioning variables will suggest that hedge fund managers employ dynamic exposures to market risk factors in response to changes in systemic risk, and thus, systemic risk may be used as a predictor of hedge fund returns. In the conditional model in (2), it is the sign of the statistically significant conditional variable that is important, rather than the actual factor loading. Since the market factors are conditioned on the TED spread, a positive coefficient indicates that a hedge fund style is increasing its exposure to that particular market factor as the TED spread widens. On the other hand, if the conditional variable is negative, it means that as the TED spread widens (narrows), the hedge fund style is decreasing (increasing) its exposure to a particular market factor. The significance of a conditional variable implies that hedge fund managers are exhibiting time-varying exposures to a certain market factor, which results in changing betas through time.

Table 4 presents the hedge fund index returns regressed against the eight-factor model with the TED spread conditioning information variable as detailed in (2). An examination of the factor loadings with the TED spread information variable reveal the following general discoveries. At first glance, we can see that the TED spread provides statistically significant information for every hedge fund index except Emerging Markets. First, all significant UMD conditional factor loadings are negative which reveals that as the TED spread (systemic risk) increases or widens, hedge funds

reduce their systematic exposure to the momentum risk factor. Second, the significant WBIG and DJAIG conditional factor loadings are positive in Table 4 which reveals that as the TED spread increases (systemic risk rises), hedge funds increase their systematic exposure to world bonds and commodities. The results in Table 4 demonstrate that the TED spread provides important information content on the general behaviour of hedge funds and how their exposures change with fluctuations in systemic risk.

A closer examination of each hedge fund index group in Table 4 reveals the following observations. The HFR FOF index exhibits statistically significant time-varying exposures to the momentum risk factor (-0.0131) and commodity returns (0.2204). These significant interaction coefficients for the HFR FOF index demonstrates that the global hedge fund industry reduces their time-varying exposures to the momentum risk factor and increases their exposure to commodities in response to increasing levels of systemic risk as measured by the TED spread.

Another striking result from Table 4 is the behaviour of the Dedicated Short Bias (DSB) hedge fund index returns. The unconditional factor loading for US equity returns in Table 3 is -0.9371, however, Table 4 reports a significant interaction coefficient of 1.5559. These two coefficients which imply that DSB funds increase their short US stock beta market factor as the TED spread widens. Put simply, short sellers increase their short exposures in the US as systemic risk increases. This finding is economically rational for short sellers as rising systemic risk usually results in falling stock markets (see, Lashgari 2000).

The behaviour of Fixed Income Arbitrage (FIA) reveals a significant unconditional factor loading for world investment grade bonds (WBIG) returns of 0.2231 in Table 3 with a significant interaction coefficient of 1.9158 reported in Table 4. These results imply that FIA funds increase their long exposure to investment grade bond returns with increases in the TED spread. This behaviour represents a type of 'flight to quality' purchasing of investment grade bonds during times of rising systemic risk.

Overall, the conditional regression R^2s in Table 4 do not significantly improve the unconditional regression R^2s in Table 3. The findings in Table 4 reveal that the TED spread as a conditioning variable does not improve the explanatory power of unconditional eight-factor model, however, it is clear that the TED spread provides important information content on the dynamic behaviour of hedge fund exposures in conventional markets and risk factors. It is also important to acknowledge that Table 4 provides evidence that hedge fund index returns reflect compensation for the time-variation of conventional market factors, however, the statistically significant intercept terms suggest that systemic risk as an information variable is not the sole conditioning factor that can explain hedge fund returns.

6. Conclusion

This study examines the fluctuations of the TED spread and considers whether this surrogate measure of systemic risk explains the time-variation of hedge fund returns. When employed as a conditioning variable in a multifactor model, the TED spread reveals new information on the behaviour of hedge fund returns. First, we reveal that increases in the TED spread results in hedge fund managers decreasing their exposure to the momentum risk factor. The TED spread also reveals that short sellers increase their short exposure when confronted with rising systemic risk. As shown in Lashgari (2000), rising levels of systemic risk are generally associated with rapidly falling stock markets and the TED spread in this study reveals the opportunistic behaviour of short sellers under

these types of market conditions. We also discover that as the TED spread widens, it is shown that Convertible Arbitrage, Equity Market Neutral and Fixed Income Arbitrage hedge funds increase their exposures to world investment grade bonds.

This study contributes to the hedge fund literature in finding that a proxy for systemic risk such as the TED spread can predict dynamic shifts in market related exposures by hedge funds. A small limitation of the TED spread is that it appears to be insignificant at predicting changes in exposures to other investment markets such as currencies, world equities, value and small stocks. Another limitation of the conditional regression model is that it does not seem to increase the explanatory power of the unconditional model.

The study introduces the TED spread to the hedge fund literature as a new explanatory variable which assists us in understanding the behaviour of global hedge fund returns. The TED spread demonstrates that rising systemic risk results in changes in exposure to US equities and global bond markets in the global hedge fund industry. An avenue for future research is the examination of the TED spread in predicting bull/bear markets or the volatility of hedge fund returns. Another potential area of future research is whether hedge funds adjust their portfolio positions based on expected states of the economy which is captured by the TED spread. We leave these interesting considerations for future research.

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Factors Affecting Brand Loyalty towards Fermented Milk in Bangkok, Thailand

by

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Abstract

The purpose of this research is to examine the factors affecting brand loyalty towards fermented milk. This research explores and explains the relationship between family influence, brand awareness, brand associations, perceived quality and brand loyalty. The research is conducted with fermented milk consumers aged below 40 years old who are loyal to a brand and be working people in Silom, Sathorn and Surawong area. The primary data is gathered from 399 respondents. The result indicated that family influence has a positive relationship with brand awareness, brand associations and perceived quality. Brand awareness, brand associations and perceived quality have a positive relationship with brand loyalty. The most important factor that is affected to brand loyalty is brand associations which caused from family influence.

1. Introduction

In current situation, Thai consumers are more concerned with their health. The way of consuming has been changed as people get higher education and also the various choices of food. People concern more on the usefulness of products providing to their lives. As the result of this, we cannot deny one product that has been well- known in the food market for several years. Fermented milk is a nutritious food containing lactic acid bacteria like Lactobacillus which helps the process of digestion. Fermented milk is favorite food/drink of a lot of people who are concerned about nutritions. Therefore, there's an intense competition in fermented milk market, leading to higher growth.

Nevertheless, consumers are considered brands at first because brands can be defined by its name, price, product's attribute, reputation and its history. Also, brand has been considered as a whole part of marketing strategy. In other words, brand can represent the information provided by the companies which aim to provide brand awareness, brand associations and make the consumers perceive the quality of the product. All of these may lead to repurchase of the same brand for several times which is known as brand loyalty.

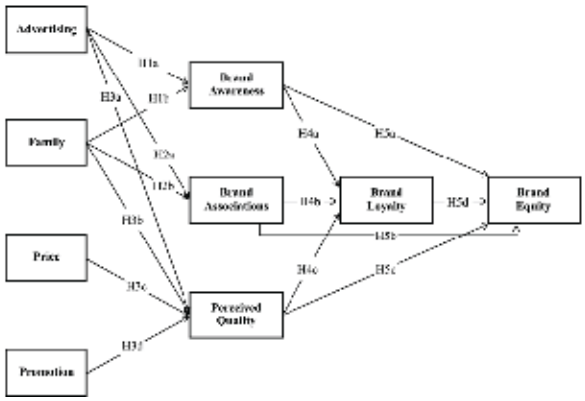
However, deeply-felt brand loyalty cannot be built by only marketing activities, but it can also be established from family. As Gil, Andres and Salinas (2007) stated that consumers get more information from their family than marketing activities which may establish from close relationship. Besides, Moor et al (2002) indicated that family has similarity to "lighting and passing the torch". It means that family conveys general skills, attitudes and consumption behaviors to children. Family may also provide the knowledge of the brand to them when the family consumes the product at home. Moreover, Olsen (1993) and Fournier (1998) stated that brand may be related to family's

memories, which the family provides the information by using emotional meaning to explain. Then, the family has been considered as consumer-brand relationship; the family is a powerful influencer in consumers' behavior. Shahh & Mittal (1997) and Feltham (1998) asserted that family is a close and reliable reference because family has previous experience or preceded trial and error, so consumers believe their parents more than others.

In this study, the researcher focuses on the families who provide the information of brand to their families' member which are the current fermented milk's consumers by passing contact at home up to the stage. Also, brand loyalty is built in consumer's mind through their families. This research was conducted with fermented milk company to study the factors affecting brand loyalty towards fermented milk in Bangkok, Thailand.

2. Literature Review

This research emphasizes on some variables that have an effect towards brand loyalty. This study applied the research model from Gil, Andres and Salinas, (2007). In previous study, the researchers have considered the factors affecting brand equity. As a result, family is relevant to brand equity. Family has been considered as powerful influencer to consumers' decision making in consumption. Also, this literature describes marketing activities that have an effect on brand loyalty. Then, research framework has precise explanation about sources of information that have occurred from brand awareness, brand associations and perceived quality. All of these variables have an effect on brand loyalty and brand equity.



Source: Gil, B. R. & Andres, F. E. & Salinas, M. E. (2007), Journal of Product & Brand Management, Vol. 16 No. 3, pp 188-199.

Figure 1 Family as a Source of Consumer-Based Brand Equity

From Figure 1, framework has been considered the effects of information provided by family, advertising, price and promotion through its marketing actions. These variables are the sources of information that consumers perceive. Also, Gil, Andres, Salinas (2007) stated that brand loyalty is much closer to the concept of overall brand equity than brand awareness-associations and perceived quality.

The research framework of this study is adapted from the research model of Gil, Andres and Salinas (2007). This research uses some variables that had been already studied in the previous literatures. However, this research provides more precise explanations by identifying the variables.

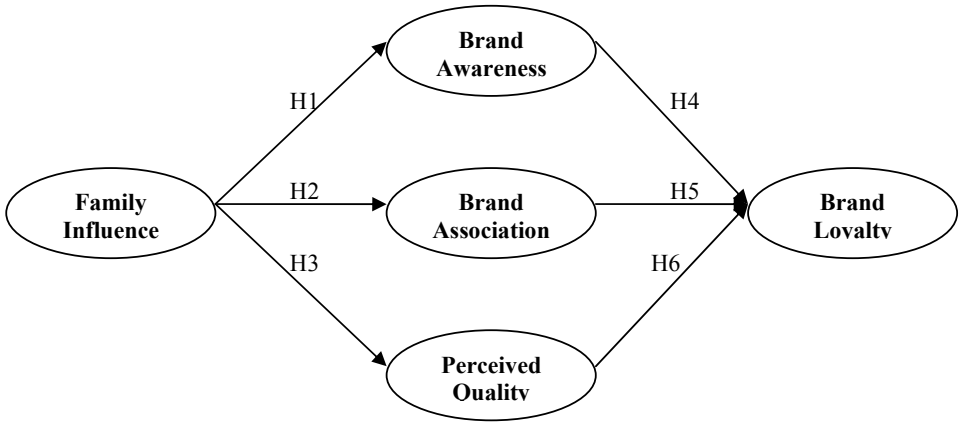


Figure 2: Conceptual Framework

Based on Figure 2, the researcher has identified family influence, brand awareness, associations, perceived quality and brand loyalty that are related to this study. This conceptual framework has been classified in three sections; source of information, perception and repurchase behavior.

The first section is concerned with the effects of the information provided by the family.

2.1 Family Influence

Moore et al. (2001) and Olsen (1993) acknowledged that a family has been considered as a powerful influencer in consumer behavior. Family provides knowledge and recommends the brands that have been consumed at home. Children may perceive the information from their parents' suggestion or observation of their parents' behavior through frequent consumption of brands at home. Thus, family has been considered as influencer towards brand or consumer-brand relationship. Childers & Rao (1992) and Moore et al., (2002) stated that children believe in their parents as a close and reliable source of information because parents have many experiences in consumption. Then, they trust on a brand that their parents purchased and consumed at home. So family has an influence on purchasing the brand. Moreover, Shahh & Mittal (1997) and Feltham (1998) indicated that consumers often turn to their family to ask for suggestions when they purchase some brand that they are not familiar with.

Besides, Moore et al. (2002) stated that family is "lighting and passing the torch". It refers to transfer of information of a brand and establish general skills, attitudes and consumption behavior to children. Then, children may learn from the experiences of their parents. Olsen (1993) and Fournier (1998) inserted that family provides knowledge of a brand from experiences and memories which family puts in the emotional meaning for precise explanations. Then, consumers may evaluate a brand from experiences of their parents. Also, Family has influence on providing the knowledge of a brand. The second section is concerned with the relationship between all variables towards brand loyalty as a construct preceded by the other three variables:

2.2 Brand awareness

Aaker (1991) indicated that brand awareness refers to consumers' memory about brand. They can be recognized or recalled as which brand is being a component of product category. In addition, Alba & Hutchinson (1987) stated that brand awareness is an exposure to a brand which can be measured from consumers' recognition. Thus, brand awareness is an important segment to build a

brand. This is supported by Sovina & Collins (2003) who defined brand awareness as to the strength of a brand in the consumers' memory which can identify the brand under different conditions. Therefore, the company should establish distinctive point of the product for consumers' brand recognition.

Moreover, Aaker (1996) and Keller (1998) had more precise explanations that brand awareness can be defined in two components which are brand recognition and brand recall. The researcher defined brand recognition as "the ability of the consumers to confirm prior exposure to the brand", while brand recall is "the ability of the consumers to remember the brand when given the product category".

In other words, Aaker (1991) stated that brand awareness is providing familiarity with a brand in the mind of the consumers, creating trust in the brand and being enough reason for consumers to purchase the brand.

2.3 Brand Associations

Brand associations are the imagination of consumers that recognized the messages that was provided by a company. Aaker (1991) acknowledged that brand associations are "anything linked to the memory to a brand" and are valuable to consumers. Also, Biel (1992), Keller (1993) and Park & Srinivasan (1994) indicated that brand associations represent knowledge and feelings with a brand that happened from consumers' experience which defines different classifications to product features.

Furthermore, Keller (2003) implied that new experience with a brand can create or modify the meaning of brand attributes in consumer's memory. Thus, brand associations help consumers to extract the information of a brand. According to Osselaer & Alba's (2000) study, the researcher stated that brand associations determine the boundary of information searching for purchasing decision. However, Aaker (1991) and Fournier (1998) implied that brand association is closely related to brand awareness because it arises from consumer-brand contact.

2.4 Perceived Quality

Zeithaml (1988) acknowledged that perceived quality is the judgment of consumers about a product's overall excellence or superiority. Thus, perceiving quality provides the value to consumers by giving the reason to purchase and attempts to differentiate the brand from others which the company has to offer. Na et al., (1999) stated that consumer perceives quality from intrinsic and extrinsic attributes. Also, Ries (1998) stated that if the company wants to build a powerful brand, and then it should build a powerful perception of quality or product attribute in the mind of consumers.

Furthermore, Kotler (2003) indicated that quality has an influence on pricing. If the product has high quality, the company is able to set high price. However, it depends on consumers' judgment, which consumers will weigh between quality and price by themselves. If consumers are satisfied with the product, they repeat the purchase. If not, they will memories the brand and will not purchase this brand again. Gronroos (1984) and Yoo et al., (2000) mentioned that consumers perceive the quality of a brand from their direct experiences and relevant knowledge to the environmental factors.

The third section is concerned with the relationship between each variable (brand awareness, brand associations and perceived quality) and brand loyalty.

2.5 Brand Loyalty

Schultz (2005) defines brand loyalty as consumer behavior who has repeated purchasing. Moreover, consumers will not change their mind to others although there are reasonably substitutable selections. In other words, consumers will be loyal to a brand when they recognize and have a good experience with a brand. Then, consumers will continue to repurchase the product of that brand over times and will not switch to other brands.

Furthermore, Kotler & Keller (2006) mentioned that brand loyalty occurs from consumers' experience with a brand based on familiarity that has been accumulated in previous consumption. In other words, consumers are more probable to repurchase from their experiences. Then, this achievement leads to elimination of some expenditure which is relevant to promote the product to new consumers. According to Aaker's (1992) study, the researcher stated that brand loyalty can decrease overall marketing costs and extend long-term revenues as a profit for a company. Besides, brand loyalty helps to protect the market share from competitors that have new competitive actions to scramble the consumers all the times.

In addition, Keller (1998) indicated that brand loyalty can be measured the relationship of the consumers with a brand by counting from how often that consumers purchase. Dick & Basu, 1994 and Taylor et al., (2004) stated that brand loyalty is positive attitude of consumers with a brand by using experience in repurchase decision which can be divided by two components: attitudinal and behavioral. Attitudinal happens from positive commitment between consumers and brand which arise from the relationship between brand attributes and consumer's preferences. Besides, behavior is the way that the consumers behave which result in a certain purchase habit.

3. Research Hypotheses

There are six hypotheses as follows:

- H1o: There is no relationship between family influence and brand awareness.
- H2o: There is no relationship between family influence and brand associations.
- H3o: There is no relationship between family influence and perceived quality.
- H4o: There is no relationship between brand awareness and brand loyalty.
- H5o: There is no relationship between brand associations and brand loyalty.
- H6o: There is no relationship between perceived quality and brand loyalty.

4. Research Methodology

This study applied a descriptive research method to describe or interpret the characteristics of a population or a phenomenon in each situation (Sekaran, 1992). The sampling procedure was non-probability method. The consumers' areas are selected in judgment sampling basis, which are collected from 399 fermented milk consumers who purchase fermented milk more than five times per month. The researcher focused on respondents who are working people in Silom, Surawong and Sathorn area because these places are the center of commercials. The number of questionnaires distributed in each area is assigned by quota sampling technique. It's divided into followings: 133 respondents in Silom, 133 respondents in Sathorn and 133 respondents in Surawong. The researcher applied convenience sampling technique in order to reach the targets who are most available to answer and are willing to complete the whole questionnaire.

The questionnaire is divided into 7 parts: part 1 consists of 3 questions to screen respondents to answer the questionnaire; part 2 consists of 5 questions relating to family influence on information given about a brand; part 3 consists of 3 questions relating to memory of a brand; part 4 consists of 4 questions relating to associate with consumption; part 5 consists of 3 questions relating to perceived quality of a brand; part 6 consists of 5 questions relating to brand loyalty; and part 7 consists of 5 questions relating to respondents' demographic information. Also, the respondents can be provided other opinion in this questionnaire.

There are 28 questions that included five demographic questions and three prescreening questions, both of which applied category scales. In addition, majority of the questions (20 questions) uses a 5-point Likert scales varying in five points from strongly disagree-strongly agree. Respondents have to evaluate to what they agree or disagree with a statement.

Table 1 Summary of results from the hypothesis testing

Null Hypothesis Statement	Statistical Test	Correlation Coeffici ent	Results
H1o: There is no relationship between family influence and brand awareness.	Pearson's Correlation	0.567**	Rejected Ho
H2o: There is no relationship between family influence and brand associations.	Pearson's Correlation	0.614**	Rejected Ho
H3o: There is no relationship between family influence and perceived quality.	Pearson's Correlation	0.575**	Rejected Ho
H4o: There is no relationship between brand awareness and brand loyalty.	Pearson's Correlation	0.708**	Rejected Ho
H5o: There is no relationship between brand associations and brand loyalty.	Pearson's Correlation	0.796**	Rejected Ho
H6o: There is no relationship between perceived quality and brand loyalty.	Pearson's Correlation	0.788**	Rejected Ho

5. Results and Conclusion

5.1 Results of Respondent Characteristics

Based on descriptive analysis, the majorities of all respondents were females, age of 30-39 years old, hold bachelors' degree, private employees, and earn below 15,000 baht per month.

In addition, for consuming experience, 5-10 years and more than 10 years have the same proportion of 29.3%. Most respondents purchase more than ten times in one month, accounting for 38.1%. Moreover, majority of respondents purchase fermented milk 1-3 bottles each time.

5.2 Results of the Hypothesis Testing

Hypothesis one: The researcher finds that there is a significant relationship between family influence and brand awareness of fermented milk brand. By using Pearson Product Moment Correlation Coefficient (Bivariate), the null hypothesis was rejected. The correlation is at 0.567, or two variables move to the same direction, indicates that both variables have a moderate positive relationship.

Hypothesis two: There is a significant relationship between family influence and brand associations of fermented milk brand. By using Pearson Product Moment Correlation Coefficient (Bivariate), the null hypothesis was rejected. The correlation is at 0.614, or two variables move to the same direction, indicates that both variables have a strong positive relationship.

Hypothesis three: There is a significant relationship between family influence and perceived quality of fermented milk brand. By using Pearson Product Moment Correlation Coefficient (Bivariate), the null hypothesis was rejected. The correlation is at 0.575, or two variables move to the same direction, indicates that both variables have a moderate positive relationship.

Hypothesis four: The result of testing is a significant relationship between brand awareness and brand loyalty of the fermented milk brand. By using Pearson Product Moment Correlation Coefficient (Bivariate), the null hypothesis was rejected. The correlation is at 0.708, or two variables move to the same direction, indicates that both variables have a strong positive relationship.

Hypothesis five: The researcher discovers that there is a significant relationship between brand associations and brand loyalty of the fermented milk brand. By using Pearson Product Moment Correlation Coefficient (Bivariate), the null hypothesis was rejected. The correlation is at 0.796, or two variables move to the same direction, indicates that both variables have a strong positive relationship.

Hypothesis six: There is a significant relationship between perceived quality and brand loyalty of the fermented milk brand. By using Pearson Product Moment Correlation Coefficient (Bivariate), the null hypothesis was rejected. The correlation is at 0.788, or two variables move to the same direction, indicates that both variables have a strong positive relationship.

6. Recommendations

The study has revealed that family has an influence on brand awareness, brand associations and quality perception that lead to brand loyalty. In addition to fermented milk brand, family has an influence on consumers' brand loyalty which consumers recognize some characteristics of fermented milk brand that they have consumed since they were young. Nevertheless, fermented milk company should be continued to improve brand loyalty. This research provides useful information for fermented milk producer in terms of factors affecting brand loyalty as follows:

Family influence: In current situation, fermented milk company has a few channels to distribute the products, so fermented milk brand is rare product for consumers. As a result, consumers cannot find fermented milk brand on shelf of modern trade such as 7-11 shops, Lotus Express shops and Central department stores. Also, family has reduced the amount of bought fermented milk to consume at home. Therefore, fermented milk company should expand its marketing channels for product distribution. This recommendation may lead to an increase in fermented milk consumption. Moreover, family may also recommend fermented milk to children.

Brand awareness: Today, fermented milk market has many competitors who are new entrants. They conduct event marketing activities to attract consumers to try their products. Also, other brands have more roles in this market. Therefore, fermented milk company should launch new advertising campaigns to stimulate consumers to purchase fermented milk brand. This is because, advertising can create awareness among consumers and also make the brand seems different from other competitors. Fermented milk company should also design the advertisement which focuses on values provided to consumers (or compared to other brands). Moreover, fermented milk company should provide souvenir for the consumers' recognition. Furthermore, fermented milk company should set a training program for sale representatives to provide information or knowledge of fermented milk to new consumers and existed consumers at consumers' convenience.

Brand associations: In fermented milk market, the other brands try to imitate fermented milk attribution because fermented milk is a brand leader that has been successful until now. Therefore, many competitors attempt to launch new products that are similar to fermented milk brand such as products with the same packaging; similar flavor, and almost the same price setting. Therefore, fermented milk company should change new packaging by designing unique packaging because the company has never changed the packaging since it was imported. Then, if the company changes the packaging to differentiate from others, it may draw attention from consumers. On the other hand, the company should keep the same taste because this flavor is unique and consumers are familiar with it. For price, fermented milk is cheap, so everyone can buy it. Therefore, the price should remain the same.

Perceived quality: fermented milk provides the best quality fermented milk. Fermented milk is full of friendly bacteria (Lactobacillus Casei Shirota). Lactobacillus Casei Shirota raises acidity in intestines. Thus, fermented milk is suitable for vegetarians and can be drunk as part of a normal balanced diet by pregnant and breastfeeding women. Moreover, fermented milk contains only a very small amount of lactose (1.0g), so may be suitable for some individuals who are intolerant to lactose. However, fermented milk should stimulate sales by creating a special offer based on an existing model (Lactobacillus Casei Shirota). For special offering, fermented milk may suggest consumers that fermented milk can be mixed with breakfast cereal. Fermented milk company may enter joint venture-ship with Manufacturers of the breakfast cereal such as Nestle as it is the market leader in breakfast cereal. This suggestion may lead to more market share.

Brand loyalty: Brand loyalty can be shown in positive behaviors, repeat buying of a product and word of mouth. The research results show that many consumers demand to consume fermented milk, but it's difficult to purchase which may be because of fermented milk company has only one channel (direct sale). Also, fermented milk company has production capacity only 2 million bottles per day, which is not enough for consumers. As a result, consumers purchase the other brands or substitute products. Therefore, the company should increase its production capacity and expanding channel. In term to increase customers or market share, the company should find a superstar to be a presenter of fermented milk brand. This is because, a superstar is a popular person, so he/she may persuade consumers to consume fermented milk brand.

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Bank Consolidation in Nigeria: An Analysis of Strategic Characteristics of Banks in Mergers and Acquisitions

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Abstract

Shared characteristics among merging institutions could create or destroy shareholder value or operating performance. This study attempts to address this issue and analyze the factors that are expected to influence the success of mergers and acquisitions in the Nigerian banking sector during the 2004 bank consolidation exercises by analyzing the pre-merger and post merger strategic characteristics of these banks to establish whether those banks that merged are strategically related and hence could benefit mutually from consolidation. This is with a view to establishing whether merger and acquisition is an appropriate instrument the government can use to bring about improved banking operations in Nigeria. The study utilized data on sample that includes all the banks in existence two years before and after 2004 banking reforms. Findings generally indicate that broad similarities among merging banks had significant positive effects on bank performance. This implies that the union among these banks was mutually beneficial and hence led to improved operating performance of banks.

1. Introduction

The relevance of banks as the lubricant and a critical factor in the development process of an economy is well established in the literature, irrespective of whether the economy is bank based or financial market based. This is because bank promotes economic growth directly and indirectly through the smoothening of the investment activities in the financial market. Banks generally provides the medium to channel funds from the surplus unit to deficit unit of the economy. Indeed, economic activity could not be smooth sailing without the continuing flow of money and credit. The economies of market-oriented nations depend on the efficient operation of complex and delicately balanced systems of money and credit. Banks are indispensable element in these systems. They provide the bulk of the money supply as well as the primary means of facilitating the flows of credit. Consequently, the economic well being of a nation is a function of advancement and development of her banking industry (Afolabi, 2004).

Banking institutions occupy a central position in the country's financial system and are essential agents in the development process. By intermediating between the surplus and deficit savings' units within an economy, banks mobilize and facilitate efficient allocation of national savings, thereby increasing the quantum of investments and hence national output. Through financial intermediation, banks facilitate capital formation and promote economic growth.

All over the world, restructuring and re-strengthening the banking system has become a phenomenon. Hardly is there any country in the world whose financial institution remained the same after the global economic recession and resurgence of economic liberalism in the 1980s that resulted in the introduction of reforms and global integration. One fundamental strategy of consolidation mostly adopted is merger and acquisition. Economic theory provides possible reasons for mergers: efficiency-related reasons that often involve economies of scale or other "synergies", attempt to create market power by forming monopolies or oligopolies, market discipline as in the case of the removal of incompetent target management, and to take advantage of opportunities for diversification like by exploiting internalizing finance, (Andrade et al 2001).

Because of the apparent advantage of efficiency related benefits and internalizing finance, mergers and acquisitions especially in the banking industry is now a phenomenon. In the United States of America, there had been over 7000 cases of bank mergers since 1980 while the same trend occurred in the United Kingdom and other European countries. Specifically, in the period 1997-1998, 203 bank mergers and acquisitions took place in the Euro area. In many emerging markets including Argentina, Brazil and Korea, consolidation has also become more prominent as banks strive to become more competitive and resilient to shocks as well as reposition their operations to cope with the challenges of the increasingly globalised banking system. In Korea, for example, the system was left with only 8 commercial banks with about 4550 branches after consolidation. In South Africa a bank in that country – Amalgamated Banks of South Africa (ABSA) has assets base larger than all of Nigerian commercial banks put together after consolidation. Malaysian banks were required to raise their capital base from about $70 million to $526 million in one year. Also, Singapore, (with about three million people), banks had stunk to six and further moving down to three – with the second largest bank having a capital base of about US$67 billion(Soludo 2004).

In sharp contrast, Nigeria, Africa's most populous country and potentially its largest economy, had 89 banks with many banks having less than US$10 million as capital base and about 3300 branches. Compare this to 8 banks in South Korea with about 4500 branches or the one bank in South Africa with assets larger than all the 89 banks in Nigeria. It indeed shows that Nigerian banking system remains very marginal relative to its potentials and in comparison to other countries – even in Africa. The inability of the Nigerian banking system to voluntarily embark on consolidation in line with the global trend necessitated Central bank adoption of appropriate legal frameworks to facilitate mergers and acquisitions in the industry as a crisis resolution option and to promote the soundness, stability and enhanced efficiency of the system.

Merger and acquisition is like marriage or union in social relations between two corporate entities. Therefore the union should be complementary and mutually reinforcing. A deeper look at the 25 banks that emerged after the consolidation shows that most banks that were regarded as distressed and unsound regrouped under new names or fused into existing perceived strong banks not necessarily to correct the inefficiency in their operating system but just to meet the mandatory requirement to remain

afloat and to continue business as usual[1]. While this consolidation no doubt has benefits, what is less clear is the effect of this consolidation on the operating efficiency of the banks. In view of these observation certain issues arise on the desirability or otherwise of this imposed 'one fit all consolidation' exercises. The most germane question remains that, are the characteristics of those banks that consolidated strategically related? Recent studies (Morgan Stanley 2003; Amihud, Delong and Saunders, 2002, Beitel and Schiereck 2001 and Houston and Ryngeart, 1994) have provided an interesting contribution by sub sampling the population of merged banks according to product or market relatedness, to analyse whether the shared characteristics among merging institutions could create or destroy shareholder value or operating performance. By and large the main conclusion of these studies is that while mergers among banks showing substantial elements of product or market relatedness create value, dissimilarities tend to destroy overall shareholder value and reduce overall bank performance and increase operating cost (Albuntas and Ianez 2004).

Consequently, this study attempts to address this issue and analyse the factors that are expected to influence the success of mergers and acquisitions by analyzing the pre-merger and post merger strategic characteristics of these banks to establish whether those banks that merged are strategically related and hence could benefit mutually from consolidation.

A reading of the literature suggests that the value gains that alleged to accrue to the large and growing wave of merger and acquisition activity have not been verified (Pautler 2001). Thus leading the research community in quandary on whether the industry has followed a path of massive restructuring on a misguided belief of value gains or whether the financial regulators and operators are lying to the public and shareholders about the effects of their activity on shareholders value and banking performance. It is important to address this issue by reconciling data with empirical reality of continued merger and acquisition activity.

2. Theoretical and Empirical Considerations

Schenk (1996) on the assumption that players are well-informed, developed a minimax-regret model that makes such mergers strategically, though not economically, rational if there is a high degree of interdependence among players and much uncertainty with respect to the prospects of individual actions. Especially when shareholders are likely to use peer grading in assessing their agent's performance, it appears that bandwagon mergers are likely.[2] When regret is defined as the loss of pleasure due to the knowledge that a better outcome might have been attained if a different choice had been made then, under conditions of uncertainty, the minimax-regret routine selects that strategy which minimizes the highest possible regret. Given a particular action of firm A that is sufficiently important to be monitored by her strategic peer- i.e. a merger or an acquisition – firms B,.., *n (n*=small) will have to contemplate what the repercussions for their own positions might be. Suppose that there is no way that firms B,…, *n* can tell whether A's move will be a successful one. A's move could be genuinely

[1] As reported in the Punch November 6 2006 page 24, under the ending ***Consolidation: Regulators, Operators seek end to bank's failure*** by Festus Akanbi that the 14 liquidated banks have been offered to the surviving 25 banks that meet up with the deadline for acquisition under a programme tagged Cherry picking. For instance Ecobank have emerged as the successful bidders for All State trust bank, While Afribank emerged as the successful bidders for Assurance banks and Lead Bank

[2] Notice that Mibourn et al. (1999) have developed a model that leads reputationally sensitive CEOs into herd behaviour, i.e. into imitating first movers, as well.

motivated by a realistic expectation that her cost position will improve or that her move will increase her ratings with stakeholders or even her earnings. That is, A's competitiveness position vis-à-vis her peers may be ameliorated as a result of that move, say in terms of a first mover advantage. But then again, it may not. For example, A's move might be purely motivated by the pursuit of managerial goals, or it may simply be a miscalculation caused by hubris. What should firms B,…, *n* do?

Leaving out, for simplicity, all firms but B, suppose that A's move will be successful, but that B has not reacted by imitating that move herself (which we call scenario *a*). To what extent will B regret not having reacted? Alternatively, suppose that A's move will not be successful but that B has imitated it solely inspired by the mere possibility of A's move being a success (scenario ß). To what extent will B regret this when the failure of A's move – and thus of her own move – becomes apparent? Within a minimax-regret framework, it is likely that B's regret attached to scenario *a* will be higher than the regret attached to scenario ß. For in scenario *a,* B will experience a loss of competitiveness, while in scenario ß her competitive position vis-à-vis A will not have been harmed. Moreover, in scenario *a* firm B's reputation will suffer, while in scenario ß it will be able to share any blame of its stakeholders with A. Thus, under conditions of uncertainty, a strategic move by firm A is likely to elicit an imitative countermove by her rivals.

As Bikhchandani et al. (1992) have shown, this sort of imitation may easily develop into a cascade. In a sense, mergers and acquisitions have then become "taken-for-granted" solutions to strategic interdependence. It implies that firms may have become locked into a solution in which all players implicitly prefer a non-optimal strategy without having ready possibilities for breaking away from it. Even if some firms do not adopt minimax-regret behaviour, it will be sensible for them to jump on a merger bandwagon too. For, an M&A cascade implies that the likelihood of becoming an acquisition target increases. Since relative size is a more effective barrier against take-over than relative profitability firms may therefore enter the M&A game for no other reason than to defend themselves against its effects. By doing so, however, they will simply help amplify a merger wave that has just started.

In conclusion, it would seem quite possible that the high incidence of non-wealth creating mergers, outside or within banking, is not the result of failed implementation techniques as many management consultants would like one to believe. Rather the existence of strategic interdependence under uncertainty, conditioned by the availability of funds, may compel management teams to undertake mergers even if it is known that it is very unlikely that these will increase real performance.[3] With multi-market oligopoly omnipresent, and given the increasing weight assigned to stock market performance appraisals – which to a large extent are reputationally determined – the ultimate result will be an economy-wide merger boom.

Mergers with these properties are dubbed here as "purely strategic mergers". These are mergers that are intended to create strategic comfort rather than economic wealth (or, for that matter, monopoly rants). It will be clear, that a minimax-regret game can only be played if market mechanisms are insufficiently potent to block it. The repeated occurrence of non-wealth creating mergers, however, is sufficient proof of this possibility. Put differently, one implication of the minimax-regret game is that

[3] Perhaps, this explains why so many mergers remain virtual. Indeed, just like has previously been found for manufacturing mergers, there is in fact little evidence that overlapping bank operations and branches are discarded post-merger (Peristiani, 1997).

firms instead of being disciplined by the market for corporate control mechanism are perverting just this mechanism: they use it to prevent it from operating efficiently. For the special case of banking, we should probably add to this that banks, being institutions that fulfill a servicing task, would by strategic necessity have to go along when their clients are becoming bigger and bigger. As a matter of fact, this motivation is frequently invoked by bank CEOs when asked for the logic of their mergers. Indeed, the evidence that we have seems to point out that economy-wide merger waves are only rarely started in services industries.

If, indeed, many mergers are strategically motivated instead of economically, then it becomes almost superfluous to ask why so many mergers fail. Still, it is obvious that the following factors will add to the difficulties of realising wealth-creating mergers: expenses paid to banks, consultants and legal experts; the costs of changing operating procedures; the high level of premiums necessary to seduce target shareholders to sell; and the diversion of managerial attention for other important activities, particularly long-term investments such as developing and bringing new products to the market and the optimization of attendant production processes. In this latter respect, Hoskisson et al. (1994) have suggested that target firms are likely to enter a state of 'suspended animation' in which decisions requiring long-term commitments such as investments in R&D are postponed, pending the outcome of the acquisition negotiations. Apparently, if there are any gains from consolidating branches, computer operations, payment systems, etc, then these will often in practice be offset by control losses due to larger size, conflicts in corporate culture, or problems in integrating especially electronic systems.

An obvious implication of so many mergers being unproductive is, of course, that much managerial time and talent as well as significant funds are simply being wasted. It would seem that the prevalence of strategy considerations leads to significant opportunity costs from an economic point of view. In other words: our economies would have (even) better performed if all those resources would have been spent productively. Yet, as long as the game is being played, no party to it can withdraw until its effects become clear in a real sense. By that time, however, large firms in manufacturing and banking may have sown the seeds of a serious recession. For it seems quite likely that economic actors cannot indefinitely pursue such strategic behaviour with impunity. In the short run the bill will be, and have to be, footed by consumers, clients and investors, but in the long run the economy as a whole will suffer since merger-active firms, be they in manufacturing or in banking, have become so big that their investment behaviour directly affects the fate of our economies. It could be argued that the billions that are fruitlessly expended on mergers do not vanish from the economic process. Indeed, it maybe so that shareholders at the receiving end instead of creating a consumption bubble, or overindulging themselves in Veblen-type conspicuous consumption (Veblen, 1899), will reinvest their newly acquired pecuniary wealth in investment projects that do create economic wealth. If so, then we would merely have to worry about a retardation effect. Still, such an effect may be significant, especially following a merger wave, i.e. a time period during which one retardation follows the other. Indeed, Mueller (1999) has suggested that the vigorous pursuit of what he calls 'unprofitable' mergers maybe one of the factors that contribute to the decline of nations. When professional managers as well as a whole industry of investments bankers, stock analysts, lawyers 'and even economists' are occupied with transferring assets instead of creating them, when cash flows get used to buy existing plants, offices and new economy facilities rather than improve their performance or build new ones, then decline is almost inevitable. Noticing that, indeed, all previous merger waves were followed by years of economic distress and restructurings, it would therefore seem unjustifiable at the least to neglect the importance of the productive and/or dynamic losses that result from mergers.

With the exception of Houston et al. (2001) the large sample evidence is relatively sparse on the detailed determinants of success. Large sample evidence in Mitchell and Mulherin (1996) and Andrade et al. (2001) suggest that mergers are driven by technological and regulatory change. The clinical studies in Kaplan (2000) and Bower (2001) are consistent with this. The clinical studies as well as consulting based studies suggest that acquisitions are more likely to be successful when the acquirer (1) has a deep understanding of target firm's business (which is likely correlated with related versus diversifying acquisitions); (2) imposes an organization design and organizational structures that are appropriate for the acquired business: and (3) introduces appropriate compensation systems and incentives. These three factors seem to be clearly associated with efficiency gains and less so with market power.

3. Measurement and Definition of Variables

The objective of this study involves analyzing the strategic characteristics of the set of banks in each merger group. The characteristics of the banks before the merger are compared with the characteristics after merger. To do this, the difference between the financial ratios of these banks is calculated and discussed. Banks whose differences between pre and post merger are positive are assumed to be better after merger.

To analyze the impact of mergers on banks, several indicators have been selected which seek to measure the effects of the merger on various aspects of bank activity. Five groups of indications are specified. First are those which attempt to measure profit-generating capacity; second, indicator of the level of efficiency and productivity; third, indicators of changes in market share; fourth, indicators of business structure; and lastly, indicators of capital adequacy. In each merger these indicators will be calculated annually for the two years prior to the operation and the two years after. The indicators have been obtained from the information in the financial statements of the merged institution during the period subsequent to the merger and by aggregating the corresponding items in the financial statements of the institutions intervening in the merger process for the previous period.

The relevant variables considered in analyzing the strategic characteristics of the banks are summarized in Table 1 below:

Table 1 Key Performance Indices of Banks in Nigeria

Group	Indicators	Measurements
1	Profit generating Capacity	Total income: interest income + commissions Interest Expenses Net income: total income – interest expenses – operating expenses Returns on equity
2	Efficiency and productivity	Operating expenses/ average total assets Operating expenses/total income Operating expenses/gross income
3	Market share & Assets growth	Growth rate of total assets Market share in terms of total assets
4	Business Structure	Lending –deposits activity as percentage of total assets
5	capital adequacy	Capital/total asset

3.1 Data Sources and Sampling Procedure

The study sourced its data from published books from the regulatory authority such as Central Bank of Nigeria (CBN), the Nigerian Deposit Insurance Corporation (NDIC) and the Nigerian Stock Exchange (NSE). It collects data on identified banks for the periods of time 2002 to 2007.

The population for the study is the 89 banks in existence in 2004. The sample includes all the banks in existence two years before and after 2004 banking reforms. Since some of the banks do not provide all the necessary statistics from the base period 2002, to the lead period 2007, the sample contains 75 (84%) of the 89 banks in existence in 2004, the remaining 14 (16%) could not consolidate and were liquidated. Out of these 75, only 6 (8%) did not combine in any form with any other banks while 69 (92%) fused into one another to form 19 (75%) of the final 25 banks that were in existence in 2005 after consolidation.

4. Empirical Analysis and Interpretation of Data

The strategic characteristic of the banks that merged were analysed and compared with those that did not merge. Out of the 25 banks that consolidated, 6 banks did not merge or acquire any other banks. They merely increase their capital base to meet the mandatory 25 billion naira capital base. These six (6) banks are the control group. The idea behind the control group is to determine whether banks that merged are better than those that did not merge and therefore suggesting that merger and acquisition are more operationally efficient than ordinary capital improvement. The financial ratios of the remaining 19 banks that engaged in merger and acquisitions are compared with the financial ratio of the 6 non merging banks ratios.

The analysis attempts to locate potential improvements in the values of these indicators for each entity vis-à-vis the values of the control group. A significant improvement in the compared values of a

high positive number of indicators in a specific activity would be indicative of the fact that the merger has proven positive for the entity in that area of activity.

Whether the merged banks are strategically related and perform better than those that did not merge are addressed together. The second column in Table 2 addresses the issues of relatedness among the banks that form the mergers. As shown in this column, almost all the banks (85%) in the groups are related with one another. In all the performance measures used, only between 3 and 5 banks were found to be unrelated in some key performance areas. With about 80 percent of the banks in the groups found to be strategically related, then the next task is to examine whether these banks in merger and acquisition are better off than those that did not merger. The outcomes of these comparisons are tabulated in the Table 2 in column three to column seven.

Table 2 Strategic Relatedness and Performance in Nigerian Banks

Profit Generating Capacity	Remarks	Acquiring more efficient	Total Revenue/Average Total Assets(%)	Interest income/ Average Total Assets (%)	Gross Income/ Average Total Assets(%)	Operating Expenses/ Average Total Assets (%)	Net Income/ Average Total Assets (%)
	Better off	16	15	12	8	12	10
	Worse Off	3	4	7	11	7	9
Efficiency & Productivity		Acquiring more efficient	Operating expenses/ Average Total Assets (%)	Operating expenses/Total Revenue (%)	Operating expenses/Gross Income (%)	Assets per Employee	Assets per Branch
	Better off	14	11	12	15	18	13
	Worse off	5	8	7	4	1	6
Market share, Business Structure and Capital Adequacy		Acquiring more efficient	Total Assets growth rate	Market share	Loans & deposits as % of Total Assets	Capital & Reserves as % of Total Assets	
	Better off	14	11	10	14	13	
	Worse off	5	8	9	5	6	

4.1 Profit-Generating Capacity

Using the profit generating capacity of the banks, in most of cases, the merged and acquired banks performed credibly well than the non merged and acquired banks. Except in gross income and net income, the number of banks that perform better nearly doubled those that perform below expectation. For instance in the case of total revenue, 15(79%) out of the 19 banks had significant positive improvement in the profit generating capacity. Similar pattern was observed in the case of interest expenses and operating expenses ratios where 12 out of 19 were found to be better off than those banks that did not merge. Since according to theory, only strategically related banks can achieve greater efficiency then these banks are certainly related to have achieved this improvement in their operating performance over the period. Also the improved performance by these banks suggests that most of these banks that enter into merger agreement did so not because they could not survive but rather to take the advantage of economies of scale and wider market that expansion through merger will bring.

4.2 Efficiency and Productivity

In term of efficiency and productivity, the trend in the indicators is similar to what obtained in the case of profit generating capacity. As Table 5.1 illustrates, most of the banks are also more efficient as a group in merger and acquisition than be alone. Indeed, a comparison of profit generating capacity and efficiency shows that there is an overlap between those institutions showing improvements in the generation of profit and those showing improvements in this efficiency ratio (see table 5.1A and Table 5.2B in the appendix). Most of the banks that have improved profit generating capacity are also more efficient in their operations.

More importantly the number of banks that performed better in terms of efficiency and productivity is higher than those reported in the case of profit generating capacity. This suggests that most of the banks in merger and acquisitions are more efficient and less wasteful and they are able to reduce areas of unnecessary duplication, reduction in management and administrative cost and even ensure optimal staff conditions. The consequence of this cost reduction strategy is to reduced expenses and increase income, which translate to higher efficiency.

4.3 Capital Adequacy Ratio

One element determining the possibilities for balance-sheet growth after mergers is the increase which mergers tend to produce in the value of the capital-adequacy ratio. Like the cases of efficiency and profit generating capacity, the post performance of merged and acquired banks have improved significantly in terms of capital adequacy ratio also. The asset growth increase significantly in 11 out of 19 banks, 10 out of the 19 banks experienced improved market share; 14 banks had improved business structure in terms of loan and deposit as ratio to total asset. 13 banks also performed better in the case of capital/asset ratio. Increased performance of the merged and acquired banks in the case of loans and deposits is a signal to increased financial intermediation. It shows that more banks are giving loan and mobilizing more deposits than those that did not merge. The main primary function of banks is financial intermediation and increase in this ratio suggests that more financial resources are being provided for economic activities. The loans generate income for the banks and the deposits increase the fund flow of the banks and hence enhancing the operational efficiency of the banks. Indeed increase in deposits is a sign of people confidence in the financial system. The increased capital base is an indication of greater

stability and soundness while the increase in market share implies that more banks are being established and the access to banking facilities by the public is being enhanced.

A further cross examination of the performance of the banks revealed that there are significant correlation between those banks that performed better in profit generating capacity and capital adequacy ratio. This link is important as the main essence of recapitalization is to generate greater revenue and profit. All the banks that post higher asset growth also post an increase in their net income as a percentage of average total assets, 8 in terms of increase in their net income as a percentage of average total assets, 8 net income deteriorated, the capital adequacy ratio diminished in 5 instances. The improvement in entities' capital adequacy may have something of a positive influence on the cost of resources obtained from financial markets, thus contributing to increase the operating margins of those entities which experienced greater increases in their capital adequacy ratio.

The broad objective of the study is to examine the effect of recent merger and acquisition in the Nigerian banking industry on the operational performance of these banks.. Specifically, the study investigates whether the banks that are involved are strategically related and at same time examine the relative contribution of merger and acquisitions on the post reform performance of these banks. This is in a view to establishing whether merger and acquisition is an appropriate instrument the government can use to bring about improved banking operations in Nigeria. Findings generally indicate that broad similarities among merging banks had significant positive effects on bank performance. This implies that the union among these banks was mutually beneficial and hence led to improved operating performance of banks.

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Simultaneous Strategic and Operational Planning in Supply Chain Design for Notebook-Computer Industry

by

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Abstract

Excellent process control and products quality makes Taiwanese contract manufacturers enable continuing growth in global notebook-computer market share through cooperation with multinational brands. More integrated and coordinated operations are required in shortening lead-time and responding quickly to customers' needs. These challenges motivate Taiwanese manufacturers to redesign the supply chain in order to gain successive advantages in global operations. This work develops an integrated multi-objective supply chain model for application in simultaneous strategic-level and operational-level planning. Multi-objective decision analysis is performed so that a performance measurement system based on cost, customer service levels (fill rates), and Flexibility (volume and delivery) can be adopted. This measurement system provides more comprehensive measurement of supply chain system performance. The model developed herein helps in (1) the design of efficient, effective, and flexible supply chain systems, and (2) the evaluation of competing supply chain for the notebook-computer industry in Taiwan.

Keywords: Supply Chain Design, Notebook-Computer Industry, Multi-objective Decision

1. Introduction

Excellent process control and products quality make Taiwanese contract manufacturers enable continuing growth in global notebook-computer market share via cooperation with multinational brands. More integrated and coordinated operations are required in shortening lead-time and responding quickly to customers' needs. These challenges motivate Taiwanese manufacturers to make efforts to redesign the supply chain in order to gain successive advantages in global operations.

Supply-production, production-distribution, and inventory-distribution systems have been examined for many years with most studies focusing only on a single component of the overall supply-production-distribution system, such as procurement, production, transportation, or scheduling. Limited progress has been made towards integrating these components in a single supply chain. Supply chain management (SCM) can be divided into strategic and operational levels. Models have been presented for optimizing supply chain operations at each of these levels. Strategic optimization models determine the most cost-effective location of facilities, flow of goods

throughout the supply chain, and assignment of customers to distribution centers. However, these models do not attempt to identify operational parameters such as required inventory levels, and customer service levels. Operational optimization models focus on determining the safety stock for every product at each location, the size and frequency of the product batches that are replenished or assembled, the replenishment transport and production lead times, and the customer service levels.

As an extremely challenging but significant issue in SCM, uncertainty represents a primary difficulty in the practical analysis of supply chain performance. Supply chain planning should address flexibility, reflecting the ability to absorb uncertainty from randomness in material/product supply and market demand. This work proposes an integrated multi-objective supply chain model based on the decisions tradeoffs in strategic-level and operational-level planning. Multi-objective decision analysis is performed so that a performance measurement system based on cost, customer service levels (fill rates), and Flexibility (volume or delivery) can be adopted. This measurement system provides more comprehensive measurement of supply chain system performance. The proposed model herein helps in (1) the design of efficient, effective, and flexible supply chain systems and (2) the evaluation of competing supply chain for the notebook-computer industry.

2. Literature Review

A supply chain (SC) consists of a network of facilities that procure raw materials, transform raw materials to intermediate and end products, and finally, distribute finished products to customers. These facilities are composed of production plants, distribution centers, and end-product stockpiles. They are integrated in an interactive network, such that a change in any one of them influences the performance of others. Many works have been conducted in optimal SC control. Various SC strategies and different aspects of SCM have been presented. However, most of the developed models study only isolated components of the SC.

2.1 Deterministic Supply Chain Models

The production/distribution model (PILOT) of Cohen and Lee(1987) is a global, deterministic, periodic, mixed integer mathematical program with a nonlinear objective function. This model extends the classic, multi-commodity distribution system model of Geoffrion et al.(1978). PILOT is concerned with the global supply strategy for manufacturing, and it determines the number and locations of plants and distribution centers, material (raw material, intermediate, and finished products) flows, plant production volumes, and the allocation of customers to distribution centers. Cohen and Moon (1990,1991) adopted PILOT to investigate the effects of certain variables (unit transport costs and plant fixed cost) on the optimal supply chain structure. The objective function minimizes the total cost subject to constraints on demand, raw material supply, production and distribution center (DC) capacities, production-distribution network structure, and customer location.

Cohen and Lee (1988) presented a deterministic, non-linear model that adopts a cost objective that addresses before- and after-tax profitability. Their model also incorporates trades balance constraint to the model since some countries set a minimum level of manufacturing inside these countries before companies can gain entry into their markets. Importantly, this model includes fixed vendor costs and trade balance constraints. Robinson et al.(1993) presented a mixed-integer programming, cost function model for a two-echelon un-capacitated distribution location problem. The authors provide sensitivity, cost-service tradeoffs, and what-if analyses to clarify all major costs and service tradeoffs. A fixed-charge network programming technique is applied to determine

the best shipment routings and shipment size via the distribution system.

Camm et al. (1996) presented an interactive tool for re-engineering P&G's North American product sourcing and distribution system. They adopted a decomposition approach to split the overall SC problem into two easily-solved sub-models, an ordinary un-capacitated distribution location mix integer model and a transportation linear model. Near-optimal solutions are generated to help couple the two sub-models. Voudouris(1996) presented a mixed-integer linear programming model to streamline operations and improve the scheduling process, while avoiding material stock-out or resource violation for a formulation and packaging chemical plant. The objective function is formulated to maximize flexibility, as represented by capacity slacks, to absorb unexpected demand.

2.2 Stochastic Supply Chain Models

Cohen et al.(1986) presented a non-linear, stochastic, multi-echelon inventory model to identify the optimal stocking policy for a spare parts stocking system, based on accomplishing an optimal trade-off between holding costs and transportation costs, subject to response time constraints. Among the unique features of this service system include low demand rates, a complex echelon structure, and the existence of emergency shipments to comply with unforeseen demand. Cohen and Lee(1988) presented a stochastic optimization supply chain model that applies raw material, production, inventory, and distribution sub-models. All locations utilize (s, S) or (Q, R) control policies. A decomposition approach is adopted to optimize each sub-model individually. These sub-models are linked together by target fill rates, but these sub-models are not optimized simultaneously. In this work, the network in this study is restricted to a single manufacturing site.

Lee and Billington(1993) presented a stochastic heuristic model for managing material flows in decentralized supply chains by determining either stock levels subject to a target service level (the fill rate) or the service level performance in given stock levels. The authors assume a pull-type, periodic base stock inventory system and a normally distributed demand pattern. Newhart et al.(1993) presented a two-phase design model to help access various production/inventory location strategies. The first phase employs mathematical programming and heuristic techniques to minimize the number of product types. The second phase employs a spreadsheet inventory model to estimate the minimum safety stock based on the service level, demand level, lead-time, demand variability, lead-time variability, and product size flexibility. Finally, capital investment and competitors' strategies are also addressed before finally recommending the best strategy.

Lee and Feitzinger(1995) examined the impacts of postponement strategy on SC cost. They presented a simplified analytical model to locate the optimal decoupling point, which means the point of product differentiation, by minimizing the cost function. The problem addresses a supply chain with one factory serving multiple distribution centers (DC). The authors concluded, from the case example, that the inventory level is the main factor in locating the product configuration (decoupling) point, dwarfing the fixed costs of enhancing DC postponement capabilities.

2.3 Literature Summary

SC literature reveals a gap in the development of comprehensive supply chain models. Models that assume that demand is stochastic either address only two echelons or exclusively consider the operational level of the supply chain. Other models that deal with larger networks at the strategic level do not address supply chain uncertainty. Additionally, the following significant observations can be drawn from the existing literature review.

- Few works address SC flexibility as a performance measure. Most studies measure performance from only the capacity slacks of operational resources.
- All strategic-level models are deterministic. All deterministic models have been established either for optimizing SC cost alone or maximizing profitability. Other performance measures are not addressed.
- Strategic and operational considerations have not been extensively discussed and integrated in a comprehensive way of thinking and model formulation.

This work presents a supply chain model that facilitates simultaneous strategic and operational planning. This model incorporates production, delivery, and demand uncertainty, and provides a suitable performance measure by using a multi-objective analysis for the entire SC network. The proposed model will be valuable for designing efficient, effective, and flexible supply chains and for assessing competing SC networks.

3. Conceptual Framework in Supply Chain Design

This work proposes a supply chain design model that reflects the characteristics of the Taiwanese NB industry. The model structure is established from the BTO/CTO model, based on the views of NB manufacturers. Figure 1 illustrates the modeling scope. The NB manufacturer receives orders from different brands. Logistics activities, such as component modules procurement, bare-bone assembly and full-set configuration can be arranged based on the bill of materials (BOM). Supply Chain Flexibility is considered in the planning stage, and the NB manufacturer can then react quickly to uncertainty from market demand. All the components are supplied in module items, the supply of GC-modules and KC-modules are based on VMI in the supplier hub. All component module suppliers operate according to the inventory control policy of the appropriate NB manufacturer.

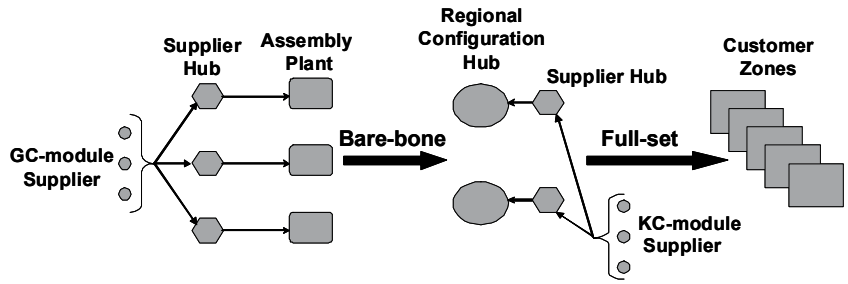

Figure 1 Conceptual Framework in Modeling

The strategic-level planning model attempts to optimize the SC configuration and material flow. Since a typical supply chain contains numerous sources of uncertainty, applying deterministic supply chain models is unrealistic. A stochastic operational-level planning model is incorporated into the solution approach in order to accommodate uncertainty and to provide insight into the tradeoffs among cost, customer service level, and flexibility. Various sources of uncertainty, such as customer demand, production lead-time, and supply lead times throughout the SC, are addressed within the operational-level planning model. At this operational-level model, the SC is decomposed into "GC-module Control", "Bare-bone Assembly Control", "Bare-bone Stockpile Control", and "Full-set Configuration Control" sub-models. The actual production, distribution and transportation costs are estimated by simultaneously optimizing the entire SC system. Figure 2 illustrates the overall concepts in the model structure.

Outputs of Decision variables through optimizing strategic-level planning are the same as the inputs in operational-level planning model. Based on these initial decisions, the total cost and relative performance measures are determined by optimal operations in each control sub-model. Values of operational parameters, such as unit cost in each control activities, are the same as inputs in strategic-level planning model. Such a relationship forms an iterative feedback control system until the optimal solution is achieved.

This model involves a multi-objective problem due to consideration of multiple performance measures at each sub-model. This study adopts the ε-constraint method (Goicoecha et al., 1982) for the following reasons: (1) it can solve non-linear models; (2) it requires no specific conditions to achieve the solutions, and (3) it is simple, since it converts the multi-objective problem into a single-objective optimization problem. This algorithm enables the analyst the ability to specify bounds on the objectives sequentially. The magnitude of ε reflects the relative significance of the various objectives to decision-makers.

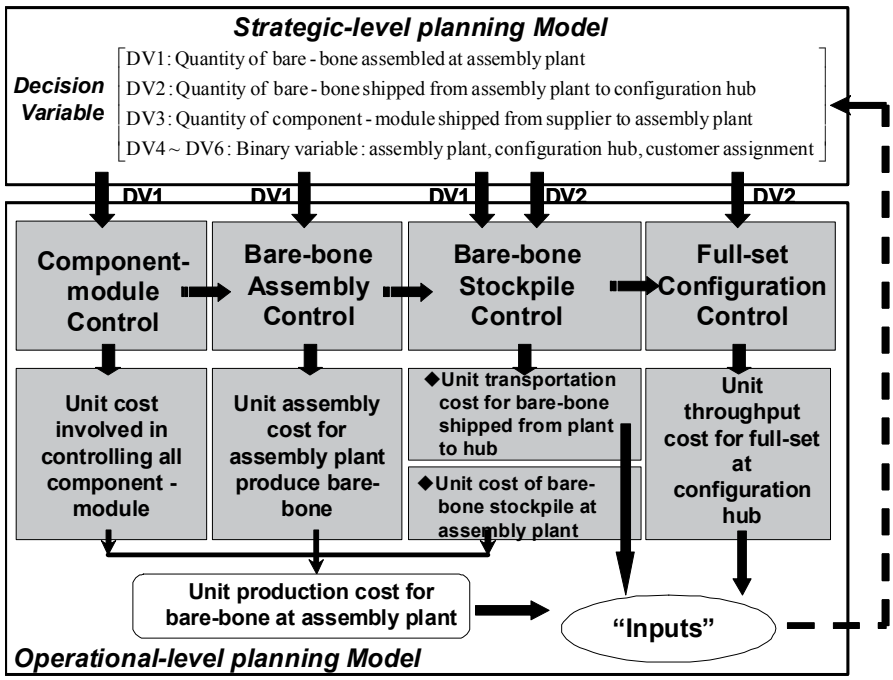

Figure 2 Tradeoffs between Strategic-Level and Operational-Level Planning

4. Model Structure and Formulation

In this work, the supply chain structure of NB industry consists of four components: (1) GC- and KC-suppliers, (2) assembly plants, (3) configuration hubs, and (4) customer zones. Each SC echelon has a set of control parameters that influences the performance of other components. The strategic-level and operational-level models simultaneously optimize the performance of each echelon.

4.1 The Strategic-Level Planning Model

The strategic-level planning model addresses an integrated, multi-product, multi-echelon problem in a flexible facility network configuration, consisting of component procurement, bare-bones assembly, full-set configuration and full-set distribution system design. It optimizes bare-bone and full-set flows throughout the supply chain, gives the optimal number and locations of assembly plants and regional configuration hubs, and provides the ideal assignment of configuration hubs to customer zones. A multi-objective function is formulated to minimize cost, while ensuring a sufficient level of volume flexibility, subject to supplier, assembly plant and configuration capacities, production and configuration hub throughput limits and customer demand requirements. The total costs include production and distribution fixed costs, and production, distribution and transportation variable costs. This model is integrated with the operational -level planning model to incorporate the uncertainty and variable production, distribution, and transportation costs. These variable costs have different values derived from the strategic-level decisions. This model addresses four echelons: (1) GC- and KC-component suppliers (vendors), (2) assembly plants (bare-bone production), (3) regional configuration hubs (full-set production), and (4) customer zones. Table 1 presents the notations utilized in the operational sub-model.

The strategic-level planning model is formulated as follows:

$$\begin{aligned} Z = & \sum_r \sum_v \sum_k (a_{rvk} + \lambda_{rv}) A_{rvk} \\ & + \sum_k f_k q_k + \sum_i \sum_k U_{ik} X_{ik} + \sum_i \sum_k \sum_m c_{ikm} B_{ikm} \\ & + \sum_s \sum_m \left\{ \left[a_{sm} + \lambda_s \right] \left[e_{si} \left(\sum_k B_{ikm} \right) \right] \right\} \\ & + \sum_m f_m q_m + \sum_j \sum_m U_{jm} \left(\sum_z D_{jz} y_{mz} \right) \\ & + \sum_j \sum_m \sum_z d_{jmz} \left(D_{jz} y_{mz} \right) \end{aligned} \tag{1}$$

$$\begin{aligned} W = & \left[\sum_k \left(q_k \Phi_k - \sum_i \delta_{ik} X_{ik} \right) \right] w_k \\ & + \left[\sum_m \left(q_m \beta_m - \sum_j \sum_z \delta_{jm} D_{jz} y_{mz} \right) \right] w_m \geq \varepsilon \end{aligned} \tag{2}$$

Subject to:

$$\sum_k A_{rvk} \leq \Psi_{rv} \quad \forall (r, v) \tag{3}$$

$$\sum_m \left[e_{si} \sum_k B_{ikm} \right] \le \Psi_s \quad \forall(s) \tag{4}$$

$$\sum_i \tau_{ri} X_{ik} \le \sum_v A_{rvk} \quad \forall(r,k) \tag{5}$$

$$\sum_j \tau_{sj} D_{jz} y_{mz} \le e_{si} \sum_k B_{ikm} \quad \forall(s,m) \tag{6}$$

$$\sum_i \delta_{ik} X_{ik} \le \Phi_k q_k \quad \forall(k) \tag{7}$$

$$\zeta_{ik} q_k \le X_{ik} \le \xi_{ik} q_k \quad \forall(i,k) \tag{8}$$

$$\sum_j \sum_z \delta_{jm} D_{jm} y_{mz} \le \beta_m q_m \quad \forall(m) \tag{9}$$

$$\alpha_{jm} q_m \le \sum_z D_{jz} y_{mz} \le \gamma_{jm} q_m \quad \forall(j,m) \tag{10}$$

$$X_{ik} = \sum_m B_{ikm} \quad \forall(i,k) \tag{11}$$

$$\sum_k \sum_m B_{ikm} = \sum_j R_{ij} \left(\sum_m \sum_z D_{jz} y_{mz} \right) \quad \forall(i) \tag{12}$$

$$\sum_k B_{ikm} = \sum_z R_{ij} D_{jz} y_{mz} \quad \forall(i,m) \tag{13}$$

$$\sum_m y_{mz} = 1 \quad \forall(z) \tag{14}$$

$$A_{rvk}, X_{ik}, B_{ikm} \ge 0 \quad \forall(r,v,k,i,m) \tag{15}$$

$$q_k, q_m, y_{mz} = 0, 1 \quad \forall(k,m,z) \tag{16}$$

Table 1 Notations for Strategic-Level Planning Model

Variables	Definitions		
i	Bare-bone type index, *i = 1.....I*	*v*	General-component module supplier index, *v = 1.....V*
j	Full-set type index, *j = 1……..J*	*r*	General-component module type index, *r = 1.....R*
k	Assembly plant index, *k = 1.....K*	*s*	Key-component module type index, *s =1.....S*
m	Configuration hub index, *m = 1.....M*	*z*	Customer zone index, *z = 1.....Z*

Inputs	Definitions		
ε	Volume flexibility performance index	Φ_k	Production capacity at assembly plant k (units/period)
w_k, w_m	Weight factors for capacity utilization [0, 1]	δ_{ik}	Standard (Equivalent) unit at assembly plant k for unit of bare-bone i
a_{rvk}	Unit transportation cost from v to k for GC-module r ($/unit)	β_m	Maximum configuration throughput at hub m (units/period)
λ_{rv}	Unit cost of GC-module r for supplier v ($/unit)	δ_{jm}	Standard (Equivalent) unit at hub m for unit of full-set j
f_k	Fixed charges for assembly plant k ($/period)	ψ_{rv}	Production capacity of GC-supplier v for GC-module r (units/period)
U_{ik}	Unit production cost for bare-bone i at plant k ($/unit)	ψ_s	Production capacity of KC-module s (units/period)
c_{ikm}	Unit transportation cost from k to m for bare-bone i ($/unit)	τ_{ri}	Utilization rate for each r per unit of bare-bone i
a_{sm}	Unit transportation cost for KC-module s shipped to hub m ($/unit)	τ_{sj}	Utilization rate for each s per unit of full-set j
λ_s	Unit cost of KC-module s ($/unit)	ζ_{ik}	Minimum production volume for bare-bone i at plant k (units/period)
e_{si}	Utilization rate of KC-module s for bare-bone i (BOM)	ξ_{ik}	Maximum production volume for bare-bone i at plant k (units/period)
f_m	Fixed charges for configuration hub m ($/period)	α_{jm}	Minimum throughput at configuration hum m (units/period)
U_{jm}	Unit cost of throughput (final configuration and inventory) for full-set j at hub m ($/unit)	γ_{jm}	Maximum throughput at configuration hum m (units/period)
D_{jz}	Average demand for full-set j at customer zone z (units/period)	R_{ij}	Transfer index for full-set j and bare-bone i
d_{jmz}	Unit transportation cost from m to z for full-set j ($/unit)		
Outputs	**Definitions**		
A_{rvk}	Quantity of GC-module r shipped from supplier v to plant k (units/period)	Z	Total cost ($/period)
X_{ik}	Quantity of bare-bone i assembled at plant k (units/period)	W	Volume flexibility
B_{ikm}	Quantity of bare-bone i shipped from plant k to hub m (units/period)		
Binary	**Definitions**		
q_k	1, if assembly plant k is open; 0 otherwise	y_{mz}	1, if hub m serves customer zone z; 0 otherwise
q_m	1, if configuration hub m is open; 0 otherwise		

The first mixed-integer linear objective function (Z) minimizes the total fixed and variable costs, and is divided into five components: (1) the GC-module purchase price and transportation cost from vendors to assembly plants; (2) the fixed and variable costs associated with assembly plant operations (bare-bone assembly), and transportation cost from assembly plant to configuration hub; (3) the KC-module purchase price and transportation cost from vendors to configuration hubs; (4) the fixed costs and variable costs of handling and inventory at configuration hubs, and (5) the transportation cost of full-sets from configuration hubs to customer zones.

The second linear objective function (W) indicates the volume flexibility, which is the sum of the following flexibility performance measures:

1. Assembly plant volume flexibility, which is calculated as the differences between the plant capacity and plant capacity utilization, and thus represents the available plant capacity.
2. Configuration hub volume flexibility, which is calculated as the differences between the available throughput and demand requirements, and thus represents the available configuration capacity.

Eqs. (3)—(16) of the strategic level sub-model are described as follows. Eq. (3)/Eq. (4) ensure that the required quantities of GC-modules/KC-modules are within the supplier's capabilities. Eq. (5)/Eq. (6) match GC-modules/KC-modules to the requirements of bare-bone assembly/full-set configuration. Eq. (7) specifies that the total production quantities must not exceed the assembly plant capacity. Eq. (8) enforces the minimum and maximum production capacities for assembly plants. Eq. (9) specifies that the total throughput must not exceed configuration hub capacity. Eq. (10) enforces the minimum and maximum throughput capacities for configuration hubs. Eq. (11) ensures that the amount shipped from assembly plant is equal to what is available at that plant. Eq. (12) ensures that all demand requirements are satisfied (i.e., that total shipments to customer zones are exactly equal to the forecasted demands there). Eq. (13) ensures that the demand requirements at each configuration hub be satisfied. Eq. (14) specifies that each customer zone must be assigned to exactly one single configuration hub. Eq. (15) ensures that all variables are non-negative. Eq. (16) restricts the binary variables to assembly plants, regional configuration hubs and the assignments of customer zones.

4.2 The Operational-Level Planning Model

The variable costs are estimated from the output (decision variables) of the strategic-level sub-model, customer demand requirements, minimum required service and flexibility levels, cost and lead-time data, and bill of material data. Additionally, variable costs are estimated under uncertainty. Also, various operational variables are calculated by optimizing inventory variables including lot sizes, reorder points and safety stock. A multi-objective function is developed incorporating all tradeoffs in cost, customer service level (fill rate), and flexibility (delivery). Four sub-models are addressed at the operational level: (1) GC-module control, (2) bare-bone assembly control, (3) bare-bone stockpile control, and (4) full-set configuration control. The GC-module control and full-set configuration control sub-models are solved with analytical techniques, while the bare-bone assembly control and bare-bone configuration control sub-models are simultaneously optimized using non-linear programming. A single solution for the operational-level planning model is derived by a heuristic approach, as described in the following subsections. Table 2 presents the notations utilized in the operational sub-model.

4.2.1 GC-Module Control Sub-Model

This model assumes continuous review of the inventory position for each GC-module r involved in producing bare-bone set F_{rk} at plant k, using an (s, Q) inventory control policy. A fixed quantity (Q_{rk}) is ordered whenever the inventory position drops to the exact reorder point s. The demand requirement for GC-module *r* is calculated from the assembly requirement of bare-bone *i* at plant *k* (X_{ik}), which is determined at the strategic level, and the unit usage rate of *r* in *i* (τ_{ri}) is specified in the BOM data. The GC-module shortages are assumed to be back-ordered. The GC-module control analytical sub-model is formulated as the following equations.

To simplify the computations, a normal lead-time demand distribution is also assumed. Using standard terms, as in Silver and Peterson (1985), Eq. (17) indicates the total cost of controlling GC-module inventory at assembly plant *k*, which involves setup, holding, and backorder (delay) costs. Eq. (18) calculated the on-hand inventory level (average inventory level plus safety stock) is given by. The safety factor n_{rk} is selected to control the safety stock associated with a specified customer service level.

$$TC_{rk}^{G} = q_k \left[\left(\sum_{i \in F_{rk}} \frac{\tau_{ri} X_{ik}}{Q_{rk}} \right) \theta_{rk} + H_{rk} I_{rk} + \pi_{rk} \sigma_{rk} \right] \tag{17}$$

$$I_{rk} = \frac{Q_{rk}}{2} + n_{rk} \sigma_{rk}, \quad n_{rk} \approx \left(\frac{1}{2} \sqrt{\frac{\pi}{2}} \right) \ln \left(\frac{p_{rk}}{1 - p_{rk}} \right) \tag{18}$$

The approximate expression for n_{rk} is given as Silver and Peterson (1985) and Johnson et al. (1996). The required reorder point s_{rk} can be calculated directly using Eq. (19), where L_{rk} indicates the expected demand over a replenishment lead-time, and Θ_{rk} indicates the average total replenishment lead-time of *r* at *k*. Θ_{rk} is calculated as the sum of the GC-module lead-time and delay time, considering all suppliers.

Table 2 Notations for Operational-Level Planning Model

Inputs	**Definitions – GC-Module Control Sub-Model**		
θ_{rk}	Order setup cost of replenishing *r* at *k* ($)	u_{rvk}	Expected lead-time of *r* from *v* to *k* (period)
H_{rk}	Unit holding cost of *r* at *k* ($/period/unit)	ρ_{rv}	Expected delay time of *r* at *v* (period)
π_{rk}	Unit backorder penalty cost for shortage *r* at *k* ($/unit)	p_{rv}	Module availability (fill rate) for *r* at *v*
Outputs	**Definitions**		
Q_{rk}^{*}	Optimal batch size of module *r* at plant *k* (units)	P_{rk}^{*}	Optimal fill rate for *r* at *k*
I_{rk}	Inventory holding level of *r* at *k* (units/period)	n_{rk}	Safety stock factor of *r* at *k*

σ_{rk}	Standard deviation of replenishment lead-time demand of r at k	S_{rk}	Reorder point for r at k (units)
L_{rk}	Expected demand of r over a replenishment lead-time at k	u_{rk}	Unit cost involved in controlling r required at k ($/unit)
Θ_{rk}	Average total replenishment lead-time for r at k	u_{ik}^{G}	Unit cost involved in controlling all r required at k for i ($/unit)

Inputs	**Definitions -- Bare-Bone Assembly Control and Bare-Bone Stockpile Control Sub-Models**		
θ_{ik}	Production setup cost of i at k ($)	H_{ik}	Unit holding cost of i at k ($/period/unit)
Γ_{ik}	Unit processing cost of i at k ($/unit)	x_{ikm}	Unit holding cost for i en-route from k to m ($/period/unit)
Ω_{ik}	Unit work-in-process holding cost for i at k ($/period/unit)	N_{ikm}	Normal transportation lead-time for i from k to m (period)
g_{ik}	Production setup time for i at k (period)	E_{ikm}	Expedited transportation lead-time for i from k to m (period)
l_{ik}	Waiting time at the work station for i at k (period)	e_{ik}	Cost of initiating an expedited production order for i at k
η	Customer service performance index	T'_{ikm}	Standard delivery time at k when i is out of stock at m (period)
υ	Delivery flexibility performance index		

Output	**Definitions**		
TC_{ik}^{p}	Total cost of assembling i at k	TC_{ik}^{S}	Total cost of stockpile for i at k
Q_{ik}^{*}	Optimal production batch size for i at k (units)	P_{ik}^{*}	Optimal fill rate of i at k
u_{ik}^{p}	Unit production cost for i at k ($/unit)	u_{ik}^{S}	Unit cost of stockpile for i at k
t_{ik}	Total production lead-time for i at k (period)	s_{ik}	Reorder point of i at k (units)
h_{ik}	Production processing time for i at k (period)	L_{ik}	Expected demand of i over production lead-time at k
Θ_{ik}	Module supply delay time for i at k (period)	T_{ikm}	Expected replenishment lead-time for i from k to m
TC_{ik}	Total expected cost of production and stockpile of i at k	n_{ik}	Safety stock factor of i at k
PS_{ik}	Customer service (fill rate) availability of i at k	σ_{ik}	Standard deviation of replenishment lead-time demand of i at k
PD_{ikm}	Delivery flexibility availability of i from k to m		

Inputs	**Definitions – Full-Set Configuration Control Sub-Model**		
H_{jm}	Unit holding cost of j at m ($/period/unit)	I_{jm}	Unit final assembly cost of j at m ($/unit)
θ_{jm}	Order setup cost of j at m ($)	Ω_{sj}	Utilization rate for each

			KC-module *s* per unit of *j*
π_{jm}	Unit backorder penalty cost for shortage *j* at *m* ($/unit)		
Outputs	**Definitions**		
TC^{F}_{jm}	Total cost of full-set configuration of *j* at *m*	S_{jm}	Order-up-to level for *j* at *m* (units)
Q^{*}_{jm}	Optimal final assembly batch size of *j* at *m* (units)	L_{jm}	Expected demand of *j* over a replenishment lead-time at *m*
U_{jm}	Unit cost of throughput for *j* at *m* ($/unit)	n_{jm}	Safety stock factor of *j* at *m*
s_{jm}	Reorder point for *j* at *m* (units)	σ_{jm}	Standard deviation of replenishment lead-time demand of j at *m*

$$s_{rk} = L_{rk} + n_{rk}\sigma_{rk}$$

$$L_{rk} = \left[\sum_{i \in F_{rk}} \tau_{ri} X_{ik}\right]\Theta_{rk}, \quad \Theta_{rk} = \frac{\sum_{v}\left[u_{rvk} + \rho_{rv}(1 - p_{rv})\right]}{v} \tag{19}$$

The variance of Θ_{rk} is calculated as Eq. (20). The variance of L_{rk} is calculated as Eq. (21). The optimal lot size (Q^{*}_{rk}) is then considered by Eq. (22), by finding the first derivative of the total cost with respect to Q_{rk}, and setting it equal to zero.

$$\text{var}(\Theta_{rk}) = \text{var}\left(\frac{\sum_{v} u_{rvk}}{v}\right) + \text{var}\left(\frac{\sum_{v} \rho_{rv}(1 - p_{rv})}{v}\right) \tag{20}$$

$$\text{var}(L_{rk}) = \left[\sum_{i} \tau_{ri} X_{ik}\right]^{2} \text{var}(\Theta_{rk}), \quad \sigma_{rk} = \sqrt{\text{var}(L_{rk})} \tag{21}$$

$$Q^{*}_{rk} = \frac{\partial TC^{G}_{rk}}{\partial Q_{rk}} = \sqrt{\frac{2\theta_{rk}\sum_{i} \tau_{ri} X_{ik}}{H_{rk}}} \tag{22}$$

The optimal service level (P^{*}_{rk}) for GC-module *r* at assembly plant k is calculated as Eq. (23). The unit cost associated with GC-module *r* control at plant *k* is given by Eq. (24). The unit cost associated with controlling all GC-module required for bare-bone *i* at assembly plant *k* is given by Eq. (25).

$$P_{rk}^{*} = \frac{\partial TC_{rk}^{G}}{\partial p_{rk}} = 1 - \frac{H_{rk}}{\pi_{rk}} \tag{23}$$

$$u_{rk} = \frac{TC_{rk}^{G}}{\sum_{i} \tau_{ri} X_{ik}} \tag{24}$$

$$u_{ik}^{G} = \sum_{r} \tau_{ri} u_{rk} \tag{25}$$

4.2.2 Bare-Bone Assembly Control and Bare-Bone Stockpile Control Sub-Models

Eq. (26) indicates the cost function to be minimized of controlling bare-bone assembly system, which involves setup costs, processing costs and work-in-process carrying costs. More specifically, the total costs for the production of bare-bone *i* at assembly plant *k* per period can be specified.

$$TC_{ik}^{P} = q_k \left[\theta_{ik} \left(\frac{X_{ik}}{Q_{ik}} \right) + \Gamma_{ik} X_{ik} + \Omega_{ik} X_{ik} t_{ik} \right] \tag{26}$$

The total production lead-time (t_{ik}) is given by Eq. (27), which determines the sum of the setup time (g_{ik}), the waiting time at the workstations (l_{ik}), the processing time (h_{ik}) and the GC-module delay time (Θ_{ik}).

$$t_{ik} = g_{ik} + h_{ik} + l_{ik} + \Theta_{ik} \tag{27}$$

The processing time of a batch of bare-bone *i* at plant *k* can be calculated as Eq. (28), where r_{ik} denotes the average work rate for the processing of bare-bone *i* at plant *j*. As long as *r* >1, then bare-bone *i* utilizes more than one GC-module type, and if the manufacturer cannot begin production until all GC-modules have been received, then the lead-time or delay-time in the model is given by the maximum average realized lead-time or delay-time from suppliers. The material delay time can be then determined from Eq. (28). Additionally, the unit cost of producing bare-bone *i* at plant *k* is given by Eq. (29).

$$h_{ik} = \frac{Q_{ik}}{r_{ik}}, \quad \Theta_{ik} = \underset{r \in Y_i}{Max} \left[\Theta_{rk} \left(1 - p_{rk}^{*} \right) \right] \tag{28}$$

$$u_{ik}^{p} = \frac{TC_{ik}^{P}}{X_{ik}} \tag{29}$$

An (*s*, *Q*) inventory control policy is adopted to operate the bare-bone stockpile control system. The distribution demand shortages are assumed to be met by expedited shipment. Using standard terms, as in Cohen and Lee (1988), the total costs related to the stockpile for bare-bone *i* at plant *k* per period are given by Eq. (30), where the total cost is the sum of the stockpile holding cost, transportation holding cost from plant *k* to the configuration hubs and the expedited order setup cost.

$$TC_{ik}^{S} = q_k \left\{ \begin{array}{l} H_{ik}\left(\dfrac{Q_{ik}}{2} + n_{ik}\sigma_{ik}\right) \\ + \sum\limits_{m} x_{ikm} B_{ikm}\left[N_{ikm}P_{ik} + E_{ikm}\left(1-p_{ik}\right)\right] \\ + e_{ik}\dfrac{X_{ik}}{Q_{ik}}\left(1-p_{ik}\right) \end{array} \right\} \tag{30}$$

The relative parameters for the bare-bone stockpile are calculated similarly to those in the GC-module control sub-model. These parameters, including reorder point (s_{ik}), variance of expected demand over production lead-time ($\mathrm{var}(L_{ik})$), the expected replenishment lead-time or bare-bone *i* from plant *k* to configuration hub m (T_{ikm}) and the unit bare-bone stockpile cost (u_{ik}^{S}) are given by Eq. (31)－(35).

$$s_{ik} = L_{ik} + n_{ik}\sigma_{ik} = X_{ik}t_{ik} + \frac{1}{2}\sqrt{\frac{2}{\pi}}\ln\left(\frac{P_{ik}}{1-p_{ik}}\right)\sqrt{\mathrm{var}(L_{ik})} \tag{31}$$

$$\mathrm{var}(L_{ik}) = (X_{ik})^2\,\mathrm{var}(t_{ik}) \tag{32}$$

$$T_{ikm} = N_{ikm}P_{ik} + (t_{ik} + E_{ikm})(1-p_{ik}) \tag{33}$$

$$c_{ikm} = x_{ikm}\left[N_{ikm}P_{ik} + E_{ikm}(1-P_{ik})\right] \tag{34}$$

$$u_{ik}^{S} = \frac{TC_{ik}^{S}}{X_{ik}} \tag{35}$$

A multiple objective function that addresses cost, customer service level (fill rate), and delivery flexibility tradeoffs is proposed to find the optimal Q_{ik}, P_{ik}, T_{ikm}. The first objective function applies cost as a performance measure, and is given by Eq. (36).

$$TC_{ik} = TC_{ik}^{P} + TC_{ik}^{S} \tag{36}$$

The second objective function represents service levels (fill rates) for replenishing the configuration hubs from the bare-bone stockpile at plant *k*, and is given by Eq. (37). Finally, the delivery flexibility objective function is given by Eq. (38).

$$PS_{ik} = P_{ik} - P'_{ik} \tag{37}$$

$$PD_{ikm} = T'_{ikm} - T_{ikm} \tag{38}$$

Using the ε-constraint method, the multi-objective is formulated as Eq. (39)-Eq. (41). The values of η, ν are specified to ensure the desired minimum levels of fill rate and delivery flexibility.

$$Min \quad TC_{ik} \tag{39}$$

$$St. \quad PS_{ik} \geq \eta \quad \forall(i,k) \tag{40}$$

$$PD_{ikm} \geq \upsilon \quad \forall(i,k,m) \tag{41}$$

4.2.3 Full-Set Configuration Control Sub-Model

The full-set configuration control sub-model is formulated as the following equations. A continuous -review (*s, S*) inventory control policy is assumed, in which a replenishment quantity is made whenever the inventory position drops exactly to the reorder point *s*. The replenishment quantity is large enough to increase the inventory position to the order-up-to level *S*.

The simple sequential determination algorithm is adopted to determine the order-up-to level *S*. Demand is periodic, stochastic, and independently distributed among customer zones and over time. Additionally, the lead-time demand at each configuration hub is assumed to be normally distributed. Further, customer demand shortages are assumed to be backordered. The total cost of the full-set configuration system, which consists of holding cost, reorder, backorder cost, and configuration cost for full-set *j* at configuration hub *m* per period, is given by Eq. (42).

$$TC_{jm}^{F} = q_m \left[H_{jm} \left(\frac{Q_{jm}}{2} + n_{jm}\sigma_{jm} \right) + \theta_{jm} \frac{\sum_z D_{jz} y_{mz}}{Q_{jm}} + \pi_{jm}\sigma_{jm} + I_{jm} \left(\sum_s \Omega_{sj} B_{jkm} \right) \right] \tag{42}$$

Relevant parameters, including expected replenishment lead-time for full-set *j* at configuration hub *m* (t_{jm}), expected demand of *j* over a replenishment lead-time at *m* (L_{jm}), reorder point (s_{jm}), and order-up-to level (S_{jm}), are also calculated similarly to those in the previous sub-model, and are given by Eq. (43)-Eq. (47).

$$t_{jm} = \frac{\sum_k q_k T_{jkm}}{\sum_k q_k}, \quad T_{jkm} = \frac{\sum_i R_{ij} T_{ikm}}{\sum_i R_{ij}}, \quad B_{jkm} = \frac{\sum_i R_{ij} B_{ikm}}{\sum_i R_{ij}} \tag{43}$$

$$L_{jm} = t_{jm} \sum_z D_{jz} y_{mz} \tag{44}$$

$$\mathrm{var}(L_{jm}) = \left(\sum_z D_{jz} y_{mz} \right)^2 \mathrm{var}(t_{jm}), \quad \sigma_{jm} = \sqrt{\mathrm{var}(L_{jm})} \tag{45}$$

$$s_{jm} = L_{jm} + n_{jm}\sigma_{jm} = L_{jm} + \frac{1}{2}\sqrt{\frac{2}{\pi}} \ln\left(\frac{p_{jm}}{1-p_{jm}} \right) \sqrt{\mathrm{var}(L_{jm})} \tag{46}$$

$$S_{jm} = s_{jm} + Q_{jm} \tag{47}$$

To calculate the optimal batch size for full-set *j* at configuration hub *m*, the total cost equation is differentiated with respect to Q_{jm}, and set equal to zero (Eq. (48)). Additionally, the optimal service level for full-set *j* at configuration hub *m* is calculated by setting the derivative (with respect to P_{jm}) of the total cost equation (Eq. (49)). Unit cost of throughput for full-set *j* at

configuration hub *m* is calculated by Eq. (50).

$$Q_{jm}^{*} = \frac{\partial TC_{jm}^{F}}{\partial Q_{jm}} = \sqrt{\frac{2\theta_{jm}\left(\sum_{z} D_{jz} y_{mz}\right)}{H_{jm}}} \tag{48}$$

$$P_{jm}^{*} = \frac{\partial TC_{jm}^{F}}{\partial p_{jm}} = 1 - \frac{H_{jm}}{\pi_{jm}} \tag{49}$$

$$U_{jm} = \frac{TC_{jm}^{F}}{\sum_{k} B_{jkm}} \tag{50}$$

Figure 3 summarizes the interactive relationships between each control sub-model, according to these descriptions of operational-level planning model.

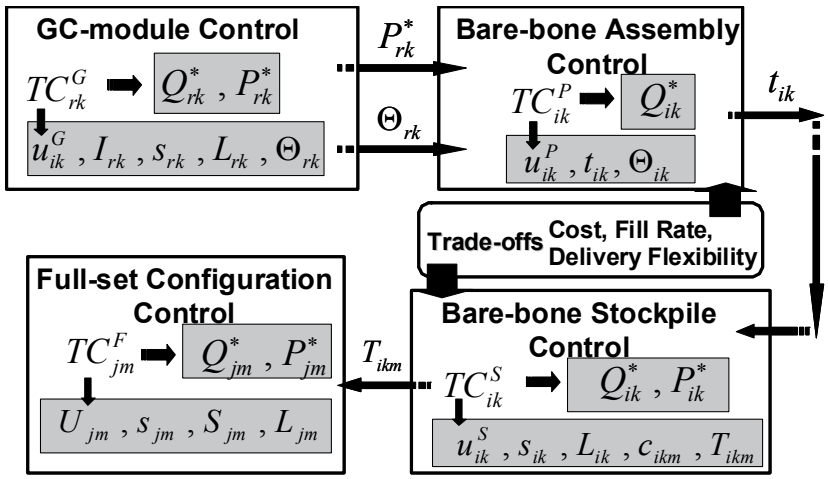

Figure 3 Interactive Relationships between Each Control Sub-Model

The GC-module control sub-model calculates the optimal values of Q_{rk}^{*}, P_{rk}^{*}, and calculates the relative parameters ($u_{ik}^{G}, I_{rk}, s_{rk}, L_{rk}, \Theta_{rk}$) by an analytical process. p_{rk}^{*} and Θ_{rk} indicate inputs in the bare-bone assembly control sub-model. In the bare-bone assembly and stockpile control sub-models, the optimal values of $Q_{ik}^{*}, p_{ik}^{*}, T_{ikm}$ are calculated from the cost, fill rate, and delivery flexibility tradeoffs. The relative parameters (u_{ik}^{p}, t_{ik}) can then be calculated, and t_{ik} is input in the bare-bone stockpile control sub-model. Parameters ($u_{ik}^{S}, s_{ik}, L_{ik}, c_{ikm}$) are calculated in the bare-bone stockpile control sub-model, and T_{ikm} is input in the full-set configuration control sub-model. Additionally, the optimal values of Q_{jm}, P_{jm} are calculated, from which the relative parameters ($U_{jm}, s_{jm}, S_{jm}, L_{jm}$) can be calculated. Now, we can summarize the actual unit variable costs ($U_{ik} = u_{ik}^{G} + u_{ik}^{P} + u_{ik}^{S}, U_{jm}, c_{ikm}$), which are adopted as inputs to the strategic-level planning model.

4.3 Solution Methodology

This section describes an iterative procedure in which the strategic-level optimization planning model is combined with the operational-level optimization planning model to calculate the optimal SC performance index. The steps of the algorithm are presented below and illustrated in Fig. 4.

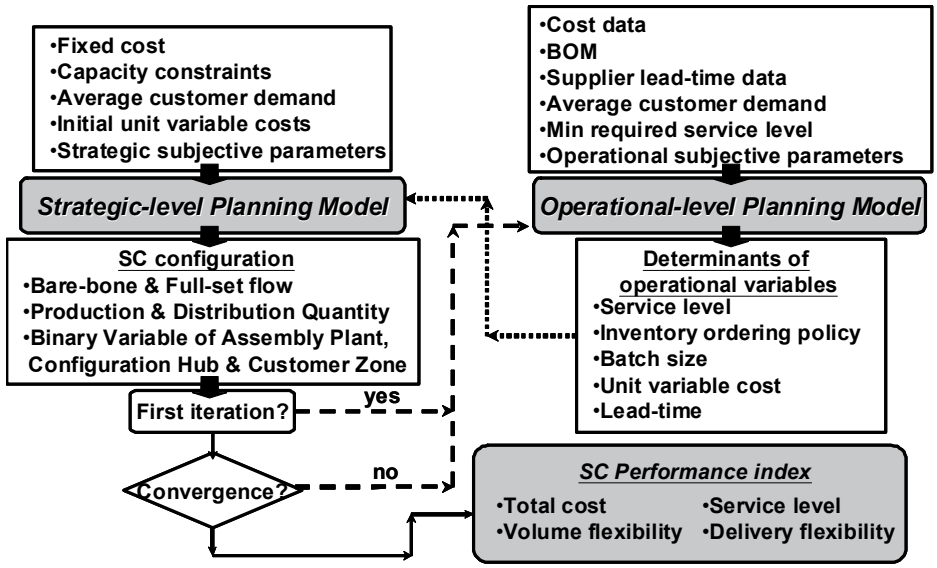

Figure 4 The Strategic-Operational Optimization Solution Algorithm

Step 1: Optimize the strategic-level planning model for an existing or proposed SC network to obtain the initial optimal configuration, using mixed integer linear programming by considering the base-case (initial) values for production, distribution, and transportation unit variable costs.

Step 2: Adopt the decision variable outputs of the strategic-level model as input data to the operational-level planning model, after dividing by the review period factor (number of operational review periods per strategic review period).

Step 3: Optimize the operational-level model based on the configuration obtained in Step 2 above.

Step 4: Optimize the strategic-level model with the new actual unit variable costs calculated in Step 3, after multiplying them by the review period factor.

Step 5: Verify whether the new unit costs have a significant influence on the optimal configuration, (i.e., check the binary decision variables for convergence). If all binary variables are equal, then go to Step 6; otherwise, go to Step 2.

Step 6: Calculate the values of the SC performance index.

Step 7: Stop.

5. Numerical Example and Model Performance

The example developed herein illustrates the algorithm presented in previous section, as well as the applicability and effectiveness of the model. The example case consists of three GC-modules with three vendors, two KC-modules with two vendors, two bare-bones, two full-sets, three assembly plants, four regional configuration hubs, and five customer zones. For this example system, five different scenarios were examined, and the performance index (total cost, volume flexibility, fill rate and expected lead-time) and final supply chain configurations were determined, as shown in Table 3.

Table 3 The Performance Index and SC Configuration for the Example Scenarios

Scenario	ε	w_k, w_m	η , υ	Performance index (Z, W, P_{ik}, T_{ikm})	SC configuration (q_k, q_m, y_{mz})
1	0	0.5, 0.5	0, 0	(16337,35,0.8,0.04)	[0,0,1],[0,1,1,0], [0,0,0,0,0 1,0,1,0, 1 0,1,0,1,0 0,0,0,0,0]
2	0	0.5, 0.5	0.15, 0.015	(16685,35,0.95,0.025)	[0,0,1],[0,1,1,0], [0,0,0,0,0 1,0,0,1, 1 0,1,1,0,0 0,0,0,0,0]
3	100	0.5, 0.5	0, 0	(16575,135,0.8,0.04)	[0,0,1],[1,1,1,0], [0,1,0,0,0 1,0,1,0, 1 0,0,0, 1,0 0,0,0,0, 0]
4	100	0.5, 0.5	0.15, 0.015	(16823,135,0.95,0.025)	[0,0,1],[1,1,1,0], [0,1,0,0,0 1,0,0,1, 1 0,0,1,1,0 0,0,0,0, 0]
5	100	0.9, 0.1	0, 0	(19649,127,0.8,0.04)	[0 ,1,1],[0,1,1,0] [0,0,0,0,0 1,0,0, 1,1 0,1,1,0,0 0,0,0,0,0]

No constraints on flexibility and customer service levels were included for the base case (scenario 1). The performance index and final SC configuration were obtained, resulting in one assembly plant and two configuration hubs. Several sensitivity analysis runs were then conducted. The volume flexibility (ε) was fixed, while the customer service level and delivery flexibility were increased simultaneously to explore the sensitivity to these performance parameters (scenario 2), leading to an increase in the total cost and a change in the customer zone-configuration hub assignments. The customer service level and delivery flexibility were increased by selecting appropriate values for the customer service index (η =0.15) and delivery flexibility index (υ =0.015). This resulted in customer service levels greater than or equal to 0.95 (the minimum required service level was 0.8 for this example), and expected lead times from assembly plants to configurations hubs less or equal to 0.025 periods (the standard delivery time was assumed to be 0.04 periods).

Scenario 3 examined the sensitivity to volume flexibility. In this scenario, the volume flexibility requirement was increased, and no service level or delivery flexibility improvements were required. However, an additional configuration hub was necessary, resulting in an additional cost to accommodate the increase in volume flexibility. In scenario 4, the flexibility (volume and

delivery) and customer service level (fill rates) were increased to test the joint effect of these performance parameters, producing the highest total cost among the first four scenarios.

Equal weight was given to the assembly plant volume flexibility and configuration hub volume flexibility in each of the first four scenarios. Scenario 5 gave more weight to the assembly plant volume flexibility, resulting in the addition of another assembly plant. Interestingly, in scenario 3, an additional configuration hub was opened (instead of a plant) when volume flexibility was increased. Scenario 5 had a higher total cost than scenario 3, since the fixed cost associated with the additional assembly plant exceeded that for an additional configuration hub.

Although the example was largely intended to test the performance of the solution algorithm, this example was used also adopted to test the effectiveness of the model formulation by measuring cost, customer service and flexibility tradeoffs among the various scenarios. Table 4 summarizes the results for the five scenarios of this example system.

Table 4 Numerical Example Summary Results (Sensitivity Analysis)

	Scenario #				
	1	2	3	4	5
# Assembly Plants	1	1	1	1	2
# Configuration Hubs	2	2	3	3	2
Volume Flexibility	35	35	135	135	127
Average Customer Service	0.93	0.983	0.93	0.983	0.93
Average Delivery Flexibility	0	0.015	0	0.015	0
Total Cost	16,337	16,685	16,575	16,823	19,649

6. Conclusion and Recommendation

The proposed model incorporates production, delivery, and demand uncertainty, and decreases complexity by reasonable simplifications. Additionally, the model provides an appropriate performance measure by adopting multi-objective analysis for the whole SC network. The model developed herein aids in the design of efficient, effective and flexible supply chains, and in the evaluation of competing SC networks for notebook-computer manufacturers. Although it may appear that this model requires the determination of a large number of input parameters, considering that this model is designed to solve a wide range of problems from the strategic-level down to the operational-level of a multi-echelon SC, the number of required parameters is relatively small. It is also important to note that in real-world applications, most of these inputs may be readily obtained from organizational databases.

The developed model (which consists of the conceptual framework, mathematical formulation, and solution algorithm) gives valuable insights into the modeling and analysis of complex SC configurations, and allows specific problems to be solved through coordinated decision-maker interaction. The model formulations described in this study specify the characteristics of the notebook-computer industry, and represent a combination of the standard and optimization methods currently adopted to analyze SC. The main innovation lies in the integration of strategic and operational levels, and the associated linkages of decisions and performance measures. This model is general at the strategic level, and can accommodate a wide variety of

different supply chain strategies. These strategies can be examined and compared by determining the performance index of each strategy. Additionally, this model is flexible for modifications and changes at the operational level. Various operational policies can be examined to identify the best policy for a given SC configuration. For instance, such policies could involve the choice between "make to order" and "make to stock", or between "periodic" and "continuous" review period. An example system, in which "make to stock" and "continuous review period" policies are considered, is described and solved in order to illustrate the applicability of the model. In the example considered, the solution algorithm was very successful in generating solutions. In addition to confirming the significance of cost, customer service and flexibility, results of this study demonstrate the requirement to integrate operational and strategic decisions in SC design.

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Environmental Policy and Growth when Utility is affected by the Stock of Resource Pollution

by

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Abstract

We consider an endogenous growth model in which a non-renewable resource gives rise to pollution. The flow of pollution progressively accumulates and deteriorates the quality of environment, that affects the utility of households. One shows that, in an unregulated decentralized economy, welfare can be increased by delaying extraction, i.e. by delaying pollution. This can be obtained by a failing ad valorem tax rate on the resource.

1. Introduction

We know that important aspects of the environmental problems that we face today are caused by the use of a particular kind of production factor : non-renewable resources. Indeed, the combustion of petroleum, coal and, to a lesser extent, natural gas is responsible for an important part of CO_2 emissions - the main greenhouse gas - and other athmosphere pollutants.

Several papers address these problems in calibrated macroeconomic models : see for instance Nordhaus and Boyer (2000), Popp (2004), or Gerlah and Lise (2005). On the other side, some authors provide analytical or numerical solutions in a partial equilibrium context : see for instance Liski and Tahvonen (2004).

However, there are few papers which provide a systematic analysis of optimum, equilibrium, and economic policies in a dynamic general equilibrium framework [1].

In recent years, some authors have introduced polluting non-renewable resources in endogenous growth models. Schou uses a model with human capital accumulation (2000), and a research-driven growth model (2002). In the first case, the flow of pollution affects productivity. In the second one, it

[1] Perhaps the main difficulty comes from the fact there are three state variables : knowledge, the natural resource, and environment.

affects utility. In the two cases, he shows that the unregulated market economy behaves optimally, so that a specific environmental policy is superfluous. Grimaud and Rougé (2005) consider a growth model with Romer horizontal differentiation. In the non-specified version of the model, they show that the rate of growth of the optimal tax can be positive or negative, depending on the strength of the psychological discount rate and the evolution of the desutility of pollution along time.

A basic common feature of these models is that utility and/or productivity are affected by the *flow* of pollution. More recently, some papers analyse models in which agents, households and/or firms, are affected by the accumulated *stock* of polluting emissions : see for instance Groth and Schou (2007) and Grimaud and Rouge (2008). These models are interesting, but they are complicated enough. That is why the main purpose of the paper is to present a dynamic general equilibrium climate change model which is as simple as possible. We consider an economy where growth is driven by a research sector, as in Romer (1990). The flow of pollution is a by-product of the utilization of the non-renewable resource. Progressively this flow accumulates and deteriorates the quality of environment, that affects the utility of households.

The main results of the paper are the following. First, in an unregulated economy, welfare can be increased by postponing extraction, i.e. by postponing pollution [2]. Second, this can be reached by a failing ad valorem tax on the use of the polluting resource. Third, a more stringent environmental policy leads the economy to postpone extraction and it enhances growth.

The paper is organized as follows. In section 2, we present the model and we characterize the optimum. In section 3, we study the economy's market equilibrium : in particular, we characterize the optimal policy. We give concluding remarks in section 4.

2. Model and welfare analysis

At each date t, the final output, Y, is produced according to

$$Y = \left(\int_0^A x_i^\alpha di \right) L_Y^\beta R^\gamma \quad , \quad \alpha + \beta + \gamma = 1, \tag{1}$$

where x_i, L_Y and R are the amounts of intermediate good i, labor, and natural resource devoted to the production of Y. A is the measure of the interval of intermediate goods. The final output is used for consumption (C) and to produce intermediate goods. Each unit of intermediate good requires one unit of output. Thus, we have

$$x_i = y_i \quad , \quad i \in [0, A] \tag{2}$$

where y_i is the quantity of final good used to produce x_i.

We assume that the supply of labor is constant, and we normalize it to one. The technology of innovation is given by the differential equation

$$\dot{A} = \delta A (1 - L_Y) \quad , \quad \delta > 0 \tag{3}$$

[2] In that respect, this result is consistent with the recommendations which are generally made (Kyoto protocol, Stern report)

where $L_A = 1 - L_Y$ is the amount of labor used in research. The resource is extracted without cost [3]. from an initial finite stock S_0, and we have the standard resource stock law of motion

$$\dot{S} = -R. \tag{4}$$

The flow of pollution is generated by the use of the resource within the production process, and is given by

$$P = hR \quad , \quad h > 0. \tag{5}$$

We denote by E a positive aggregate indicator of the environment quality. E is depleted over time by pollution, and its law of motion is

$$\dot{E} = -P = -hR \quad , \quad E_0 > 0. \tag{6}$$

Note that there is no regeneration. Integrating (6), E is given by $E = E_0 - h\int_0^t R_s ds.$

The utility function of the infinitely-lived representative agent is

$$U = \int_0^\infty \log(CE^\lambda) e^{-\rho t} dt \quad , \quad \lambda > 0, \rho > 0. \tag{7}$$

The instantaneous utility function is increasing and concave with respect to E. It would be equivalent to assume that it is a decreasing and concave function of the pollution stock $X = X_0 + h\int_0^t R_s ds,$ which gives the law of motion $\dot{X} = hR$ and the correspondance $E = E_0 + X_0 - X.$ The assumption of concavity means that, when X increases, the marginal desutility of one unit of resource increases (think to strong damages).

Finally, we have

$$Y = C + \int_0^A x_i d_i. \tag{8}$$

The programm of the social planner is to maximize the utility subject to (1)-(6) and (8). After eliminating the co-state variables, the first-order conditions reduce to the three following characteristic conditions which hold at each time t (we denote by g_z the rate of growth of any variable z) :

$$\alpha x^{\alpha-1} L_Y^\beta R^\gamma - 1 = 0, \qquad where \quad x_i = x, \forall\, i \tag{9}$$

$$g_R = -\rho - \frac{\lambda(1-\alpha)}{\gamma}\, g_E \tag{10}$$

$$g_A = \delta - \frac{\beta\rho}{1-\alpha} \tag{11}$$

Proof : see Appendix A.

[3] Extraction costs could be modelled for instance following Andre and Smulders (2004) and Grimaud and Rouge (2008)

(9) is an efficiency condition saying that, for any intermediate good i, the marginal productivity is equal to the marginal cost. (10) is the Hotelling condition giving the rythm of extraction of the resource. Finally, (11) explains how the total labor is devoted to both production and research. Let us note that if environment does not matter ($\lambda = 0$ in (7)), the economy jumps immediately to the steady-state : $g_R = -\rho,\ g_A = \delta - \beta\rho/(1-\alpha),\ g_Y = \delta - \rho.$

Now we present the main results concerning the optimal trajectories.
In Appendix A, we show that L_Y jumps immediately to its steady-state level, $\beta\rho/\delta(1-\alpha)$.

From (1), one gets $g_Y = g_A + \alpha g_x + \gamma g_R$. Since $Y = Ax/\alpha$, we have $g_x = g_Y - g_A$, that gives $g_Y = g_A + \gamma g_R/(1-\alpha)$. Using (10) and (11), one gets the rate of growth of output

$$g_Y = \delta - \rho - \lambda g_E. \qquad (12)$$

Using (6) and (10), one can show that the model has two steady-states. Focusing on the stable one, we obtain for g_R, g_E and g_Y the dynamics depicted in Figure 1 : see Appendix B for a more complete analysis using the phase diagram and analytical developments.

The rate of growth of R, g_R, progressively decreases and converges to $-\rho$. Let us observe that this limit value would be the optimal rate of growth of R at each time t, if extraction would not cause pollution, that is to say without environmental externality (indeed, in this case, $g_R = -\rho$ in (10)). Thus, when there is pollution, the optimal rate of extraction is higher than the equilibrium one (without environmental policy). This implies that, *to improve welfare, one has to postpone extraction from the present to the future* (we come back on this point later). Simultaneously, g_E progressively increases and converges to zero, while E decreases from E_0 to $E_0 - hS_0$: in fact, g_E is solution of a differential equation of Ricatti, and one gets

$$g_E = \frac{1}{e^{\rho t}\left[\frac{1}{g_{E0}} + \frac{\gamma + \lambda(1-\alpha)}{\gamma\rho}\right] - \frac{\gamma + \lambda(1-\alpha)}{\gamma\rho}}$$

Finally, (12) shows that g_Y progressively decreases and converges to $\delta - \rho$.

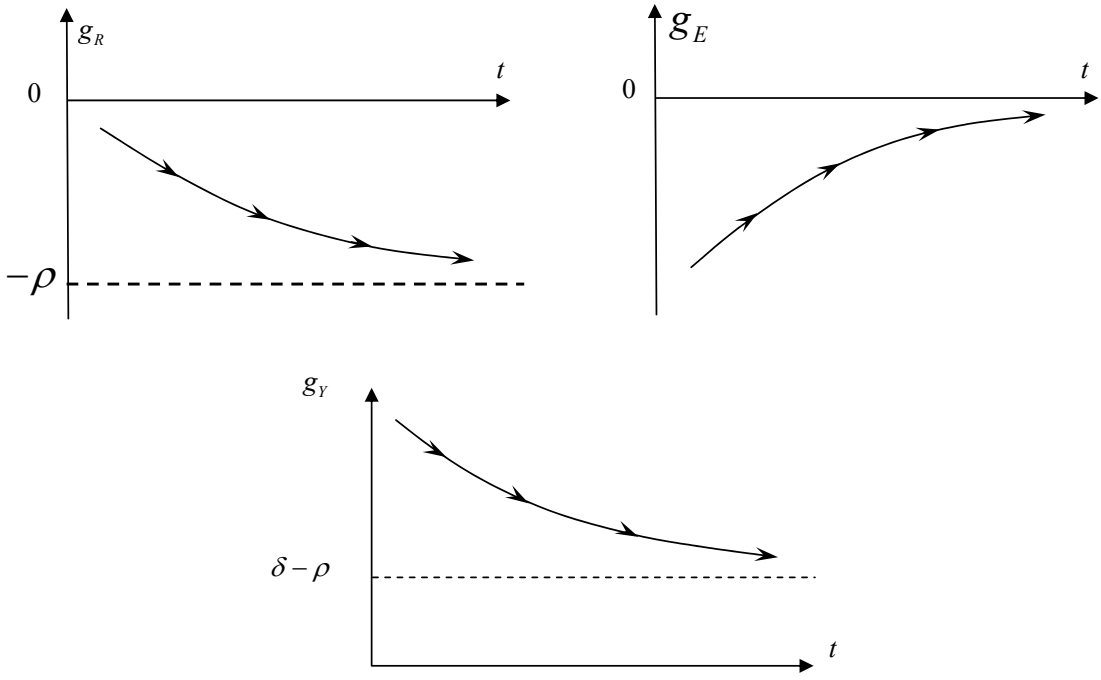

Figure 1 Dynamics of Extraction *(R)*, Environment Quality *(E)* and Output *(Y)*

3. Equilibrium and Optimal Environmental Tax

3.1 Equilibrium Solutions

The price of good Y is normalized to one, and w, p_R, r, p_i for $i \in [0, A]$ are, respectively, the wage, the resource price, the interest rate, and the price of the intermediate good i. In order to implement the optimal path, we use three tools. First, we denote by s and σ the rates of subsidy to the demand of intermediate goods and to the labor used in the research sector, in order to eliminate the two market failures arising from the monopolistic character of the intermediate-good sector and from the intertemporal spill-over in the research sector. We assume that s and σ are constant (in section 3.3, we show that is verified). Second, we denote by θ the ad valorem unit tax on the natural resource, to eliminate the distortion due to pollution.

In the final good sector, the profit is

$$\pi_Y = \left(\int_0^A x_i^\alpha di\right) L_Y^\beta R^\gamma - wL_Y - p_R(1+\theta)R - \int_0^A p(1-s)x_i di$$

where, since intermediate goods have the same productivity, we assume $p_i = p, \forall i$.

Maximizing π_Y, one gets the three following first order conditions :
$\alpha x_i^{\alpha-1} L_Y^{\beta} R^{\gamma} - p(1-s) = 0,$ that implies $x_i = x \ \forall i,$ and thus

$$x = \left(\frac{\alpha L_Y^{\beta} R^{\gamma}}{p(1-s)} \right)^{\frac{1}{1-\alpha}} \tag{13}$$

$$\beta Y / L_Y - w = 0 \tag{14}$$

$$\gamma Y / R - \tau p_R = 0 \qquad (where \ \tau = 1 + \theta) \tag{15}$$

The monopoly's profit on each intermediate good is $\pi^m = (p-1)x$. Using the demand function (13), the maximization of π^m leads to the following standard results :

$$p = \frac{1}{\alpha} \qquad \text{(constant mark-up on the marginal cost)} \tag{16}$$

$$\pi^m = \frac{1-\alpha}{\alpha} \ x \tag{17}$$

Let us consider the research sector. Let V_t be the value of an innovation which is the sum of the present values of the expected profits : $V_t = \int_t^{\infty} \pi_s^m e^{-\int_t^s r u du}$. Differentiating this equation with respect to t gives

$$r = g_V + \frac{\pi^m}{V} \tag{18}$$

The free entry condition, saying that the value of an innovation is equal to its cost, is

$$V = \frac{(1-\sigma)w}{\delta A} \tag{19}$$

In the resource sector, the maximization of the profit leads to the Hotelling rule, saying that the rate of growth of the resource price is equal to the interest rate :

$$g_{p_R} = r. \tag{20}$$

Finally, the maximization of the utility by the representative household leads to

$$\rho + g_c = r. \quad (21)$$

Our objective now is to characterize the equilibrium path by eliminating all prices (as we have eliminated the co-state variables in the first-order conditions at optimum). One gets the three following conditions :

$$\alpha x^{\alpha-1} L_Y^{\beta} R^{\gamma} - \frac{1-s}{\alpha} = 0 \quad (22)$$

$$g_R = -\rho - g_\tau \quad (23)$$

$$g_A = \frac{\alpha(1-\alpha)\delta - \beta\rho(1-\sigma)(1-s)}{\beta(1-\sigma)(1-s) + \alpha(1-\alpha)} \quad (24)$$

Proof

From (13) and (16), one gets immediately (22). This equation can be written $\alpha Y/Ax = (1-s)/\alpha$, that gives $Ax = \alpha^2 Y/(1-s)$. Since $Y = Ax + C$, we have $C = Y(1-\alpha^2/(1-s))$ and thus, if s is constant, $g_C = g_Y$.

Log-differentiating (15) with respect to time gives $g_Y - g_R = g_\tau + g_{P_R}$. Using (20) and (21), one gets $g_R = -\rho - g_\tau$, which is (23).

From (19), we have $g_V = g_w - g_A$ that, using (14), becomes $g_V = g_Y - g_{L_Y} - g_A$. Using (14), (17) and (19), the ratio π^m/V is equal to $\delta(1-\alpha)AxL_Y/\alpha\beta(1-\sigma)Y$. Then, since $Ax/\alpha Y = \alpha/(1-s)$, one gets $\pi^m/V = \delta\alpha(1-\alpha)L_Y/\beta(1-\sigma)(1-s)$.

Plugging these two results in (18) and using (21), one gets $\rho = \delta\alpha(1-\alpha)L_Y/\beta(1-\sigma)(1-s) - g_{L_Y} - g_A$, where $g_A = \delta(1-L_Y)$. As in the case of optimum, it can be shown that the transversality condition of the household program implies that $g_{L_Y} = 0$. Thus, L_Y jumps immediately to its steady-state level. Then, since $L_Y = 1 - L_A = 1 - g_A/\delta$, one gets (24).

Finally, as for optimum, one can obtain the rate of growth of output. From $g_Y = g_A + \gamma g_R/(1-\alpha)$ and (23), we have

$$g_Y = g_A - \frac{\gamma}{1-\alpha}(\rho + g_\tau) \quad (25)$$

where g_A is given by (24).

3.2 Basic externality and optimal environmental policy

In this sub-section, we focus only on the optimal tax on the natural resource. The other optimal subsidies are calculated in the next sub-section.

Comparing (10) (optimum) and (23) (equilibrium), one gets the optimal rate of growth of the environmental tax :

$$g_\tau = \frac{\lambda(1-\alpha)}{\gamma}\ g_E\ , \tag{26}$$

where g_E evolves as depicted in Figure 1.

We can make several remarks.

First, only the rate of growth of the tax matters. More precisely, the optimal tax is defined up to an homothecy : if τ is optimal, thus $k\tau$ (k is a positive constant) is also optimal since it has the same rate of growth than τ. This result has been already mentioned by Sinclair (1992), Nordhaus and Boyer (2000), Schou (2000, 2002), Grimaud-Rouge (2005, 2008) and Groth-Schou (2007). Indeed, since the stock of resource is finite, the stock of pollution is also finite. Then the question is not to choose, as in more standard problems, the quantity of pollution. It is to choose the temporal profile of emission of an exogenously given quantity. A modification of this profile is obtained by a modification of g_τ, and not by a modification of the level of τ.

Second, since g_E is negative, *without ambiguity* g_τ *is also negative.* In order to give an explanation of this result, we have to identify the externality caused by firms when they choose a profile of extraction, that is to say a profile of pollution.

Let us consider two dates, t and $t+\Delta t$, and let us assume that one transfers a little flow of extraction from t to $t+\Delta t$. More precisely, assume $\Delta C_t = -1$, corresponding to a decrease in extraction $\Delta R_t = -1/(\gamma Y_t/R_t)$ (indeed, $\gamma Y_t/R_t$ is the marginal productivity of the resource). The same quantity of resource is extracted at $t+\Delta t$: $\Delta R_{t+\Delta t} = 1/(\gamma Y_t/R_t)$ (see Figure 2).

Now, we consider the variation of utility on the two following intervals :

for all $s, s \in]t+\Delta t, +\infty[$, the quality of environment is unchanged, because the accumulated pollution is unchanged. Thus, utility is unchanged ;

for all $s, s \in [t, t+\Delta t]$, since $\Delta P_t = h\Delta R_t = -h/(\gamma Y_t/R_t)$, one gets an improvement of environment E_s, given by $\Delta E_s = h(\gamma Y_t/R_t)$. Thus, the total increase in utility on this interval is given by $hU_E\Delta t/(\gamma Y_t/R_t)$. Since $U_E = \lambda/E, Y_t = C_t/(1-\alpha)$, and $hR/E = -g_E$ (from (6)), one gets $-\lambda(1-\alpha)g_E/\gamma C$ (Δt is normalized to one).

Finally, since $U_C = 1/C$, the increase in utility expressed in terms of good is

$$\frac{-\lambda(1-\alpha)}{\gamma}\ g_E,$$

that is exactly $-g_\tau$ in (26).

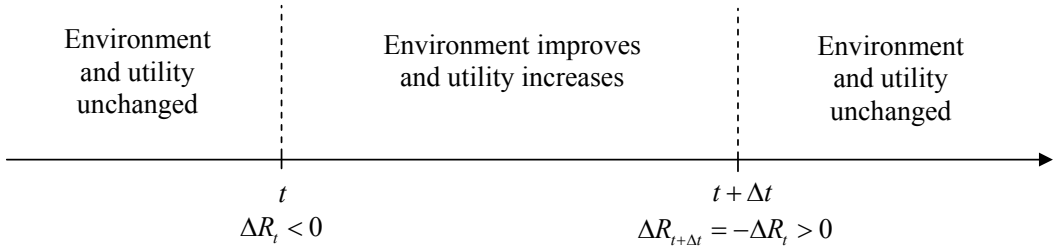

Figure 2 Basic Externality with $\Delta R_{t+\Delta t} = -\Delta R_t > 0$

In short, at each time t, the rate of growth of the tax, g_τ, is equal to the following externality : it is the social cost of the marginal temporal displacement (from $t + \Delta t$ to t) of the flow of extraction corresponding to one unit of output.

If there is no environmental policy (i.e. if $g_\tau = 0$), firms ignore the fact that they could increase the social welfare by postponing a little their consumption of resource, that is to say by postponing the flow of pollution. Their behavior leads to $g_R = -\rho$ (see (23)) : this rate of growth of the flow of extraction is too low with respect to the optimal one, $g_R = -\rho - \lambda(1-\alpha)g_E/\gamma$. By imposing a tax which decreases along time, the social planner incites firms to extract less today and more tomorrow.

3.3 Implementation of optimum and effects of economic policies

We have shown above that the optimal rate of growth of the environmental tax is $g_\tau = \lambda(1-\alpha)g_E/\gamma$, which is negative. In order to implement the optimal path described in section 2, we have to correct the other two distorsions.

Putting together (9), $\alpha x^{\alpha-1} L_Y^\beta R^\gamma = 1$, and (13), $\alpha x^{\alpha-1} L_Y^\gamma = (1-s)/\alpha$, one gets $s = 1-\alpha$, which is standard.

Similarly, from (11) and (24) (where we have now $1-s = \alpha$), one gets after some calculations

$$\sigma = \frac{\delta(1-\alpha) - \rho\beta}{\delta(1-\alpha) + \rho\gamma},$$

which is lower than one and higher than zero (from (11), where we assume $g_A > 0$). This result is standard in the Romer growth model.

Finally, from (23), (24), and (25), we can examine the impacts on equilibrium of modifications of the economic policies.

An increase in s or in σ has no effect on g_R. It stimulates g_A, and thus it stimulates g_Y. These effects are intuitive, because these two tools have a direct impact on the research sector.

A decrease in g_τ, *that is to say a more stringent environmental policy, leads to an increase in* g_R : less pollution today, more tomorrow. Thus, since g_A is unchanged, g_Y increases. We are in a case where, as conjectured for instance by Porter and Van der Linde (1995), a more stringent environmental policy enhances growth.

4. Conclusion

In this paper, we set up an endogenous growth model in which the use of a non-renewable resource within the production process generates a flow of pollution. This flow accumulates and deteriorates the quality of environment, that affects the utility of households.

The basic result is that, in the market economy, the resource is depleted too rapidly. Thus, there is too much pollution today. In fact, firms do not take into account the fact that they could increase the social welfare by postponing a little the flow of pollution. This goal can be reached by a failing ad valorem tax rate on the use of the resource. Thus environmental policy incites firms to use less resource today and more tomorrow.

These results are obtained in a very simple model, and several extensions are open for future research. First, as in Schou (2000), one could assume that the quality of environment affects also productivity. Second, it is possible to introduce a cost of extraction, as for instance in André and Smulders (2004). Third, one could assume that the environmental quality progressively regenerates, as for instance in Aghion and Howitt (1998). Finally, in the line of Acemoglu (2002), one can introduce several specific research sectors. In this case, a basic question is to study the effects of an environmental policy on the bias of technical progress [4].

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[4] See for instance Grimaud-Rouge (2008).

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About the Author

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Appendix A: Optimum

The Hamiltonian is

$$H = (\log C + \lambda \log E)e^{-\rho t} + \zeta\left(\left(\int_0^A x_i^{\alpha} di\right) L_Y^{\beta} R^{\gamma} - C - \int_0^A x_i di\right) + \mu\delta A(1 - L_Y) - \nu R - \phi h R.$$

The conditions $\frac{\partial H}{\partial C} = 0, \frac{\partial H}{\partial x_i} = 0, \frac{\partial H}{\partial L_Y} = 0,$ and $\frac{\partial H}{\partial R} = 0$ lead to

$$\frac{e^{-\rho t}}{C} - \zeta = 0 \qquad \text{(A.1)}$$

$$\alpha x_i^{\alpha-1} L_Y^{\beta} R^{\gamma} - 1 = 0 \quad \text{(efficiency condition)} \quad \text{that implies } x_i = x, \text{forall } i \qquad \text{(A.2)}$$

$$\frac{\zeta \beta Y}{L_Y} - \mu\delta A = 0 \qquad \text{(A.3)}$$

$$\frac{\zeta \gamma Y}{R} - \nu - \phi h = 0 \qquad \text{(A.4)}$$

Moreover, $\frac{\partial H}{\partial A} = -\dot{\mu}, \frac{\partial H}{\partial S} = -\dot{\nu},$ and $\frac{\partial H}{\partial E} = -\dot{\phi}$ lead to

$$\zeta(x^{\alpha} L_Y^{\beta} R^{\gamma} - x) + \mu\delta(1 - L_Y) = -\dot{\mu} \qquad \text{(A.5)}$$

$$\dot{\nu} = 0 \qquad \text{(A.6)}$$

$$\frac{\lambda e^{-\rho t}}{E} = -\dot{\phi} \qquad \text{(A.7)}$$

(A.2) can be written $Y = Ax/\alpha.$ Since $Y = C + Ax,$ we have $C = (1-\alpha)Y.$

Using this result and eliminating ζ between (A.1) and (A.4), one has $\gamma e^{-\rho t}/(1-\alpha)R = \nu + \phi h.$ Differentiating this equation with respect to time and using (A.6) and (A.7) gives $\frac{d}{d_t}(\gamma e^{-\rho t}/(1-\alpha)R) = \frac{-h\lambda e^{-\rho t}}{E}.$ Dividing both sides by $\gamma e^{-\rho t}/(1-\alpha)R$ gives $-\rho - g_R = h\lambda(1-\alpha)R/\gamma E.$ From (6), one has $g_E = -hR/E,$ that gives finally

$$g_R = -\rho - \frac{\lambda(1-\alpha)}{\gamma} g_E,$$

which is the Hotelling condition (10).

From (A.3), we have $\zeta/\mu = \delta A L_Y/\beta Y.$ Moreover, eliminating ζ between (A.1) and (A.3) gives $e^{-\rho t}\beta Y/CL_Y = \mu\delta A.$ Log-differentiating with respect to time, one gets (note that $g_Y = g_C$) $-\rho - g_{LY} = g_\mu + g_A.$ Plugging this result in (A.5) and using (A.3), we have

$\rho + g_{LY} + g_A = \delta A L_Y (x^\alpha L_Y^\beta R^\gamma - x)/\beta Y + g_A$. From (A.2), one has $x^\alpha L_Y^\beta R^\gamma - x = x/\alpha - x = x(1-\alpha)/\alpha$.

Since $Y = Ax/\alpha$, the previous equation becomes $g_{LY} = -\rho + \delta(1-\alpha)L_Y/\beta$.

Now, using the transversality condition $\lim_{t\to\infty}\mu_t A_t = 0$, we show that L_Y jumps immediately to its steady-state. The equation $g_{L_Y} = -\rho + \delta(1-\alpha)L_Y/\beta$ can be written $\dot{L}_Y = -\rho L_Y + \delta(1-\alpha)L_Y^2/\beta$. This is a Ricatti's differential equation which can be integrated as following. Let be $y = 1/L_Y$, that gives $\dot{y} = -\dot{L}_Y/L_Y^2$. Then the differential equation becomes $\dot{y} = \rho y - \delta(1-\alpha)/\beta$, and its solution is $y = e^{\rho t}(y_0 - \delta(1-\alpha)/\beta\rho) + \delta(1-\alpha)/\beta\rho$. Finally, one gets

$$L_Y = \frac{1}{e^{\rho t}\left[\frac{1}{L_{Y_0}} - \frac{\delta(1-\alpha)}{\beta\rho}\right] + \frac{\delta(1-\alpha)}{\beta\rho}}$$

From (A.1) and (A.3), and using the fact that $Y/C = 1/(1-\alpha)$, we have $\mu A = \beta e^{-\rho t}/\delta(1-\alpha)L_Y$, that gives

$$\mu A = \frac{\beta}{\delta(1-\alpha)}\left(\frac{1}{L_{Y_0}} - \frac{\delta(1-\alpha)}{\beta\rho}\right) + \frac{e^{-\rho t}}{\rho}$$

The transversality condition, $\lim_{t\to\infty}\mu_t A_t = 0$, is satisfied only if $L_{Y_0} = \beta\rho/\delta(1-\alpha)$, that is the steady-state. Since $L_A = 1 - L_Y = 1 - \beta\rho/\delta(1-\alpha)$ and $g_A = \delta L_A$, one gets

$$g_A = \delta - \frac{\beta\rho}{1-\alpha},$$

which is condition (11).

Appendix B: Optimal Dynamics

At each date t, the Hotelling condition (10), $g_R = -\rho - \lambda(1-\alpha)g_E/\gamma$, has to be verified : see the line AD in the phase diagram. Differentiating with respect to time, it implies $\dot{g}_R = -\lambda(1-\alpha)\dot{g}_E/\gamma$.

Moreover, from (6), $\dot{E} = -hR$, we have $g_E = \dot{E}/E = -hR/E$, which is negative. Log-differentiating with respect to time gives $\dot{g}_E = g_E(g_R - g_E)$. Thus, if $g_R > g_E$ (resp. $g_R < g_E$), we have $\dot{g}_E < 0$ (resp. $\dot{g}_E > 0$) and $\dot{g}_R > 0$ (resp. $\dot{g}_R < 0$). If $g_E = g_R$, then $\dot{g}_E = \dot{g}_R = 0$.

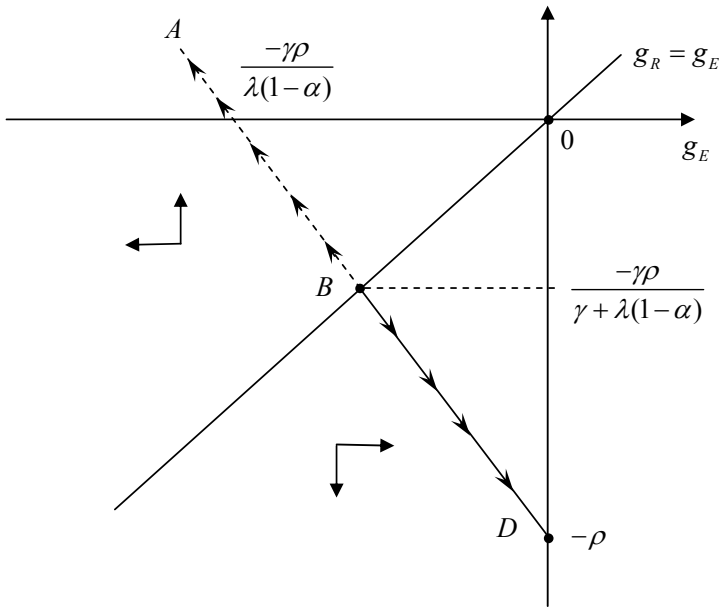

Figure 3: Phase diagram

Let us note that we can eliminate the path BA. Indeed, since g_R is alternatively negative and positive along this path, the stock of resource is fully exhausted in finite time. Thus it exists a date T from which $g_E = 0$ and production is nil (from (1)). That contredicts equation (12) where we can assume $\delta \neq \rho$.

There are two steady-states in the phase diagram. The first one (point B) is unstable and it is such that $g_R = g_E = -\gamma\rho/(\gamma + \lambda(1-\alpha))$.

The second one (point D) is stable, and it is such that $g_E = 0$ and $g_R = -\rho$. The economy converges to it if, at $t = 0$, we have $g_E > -\gamma\rho/(\gamma + \lambda(1-\alpha))$ (or, equivalently, $g_R < -\gamma\rho/(\gamma + \lambda(1-\alpha))$. In the text of the paper (section 2), we focus on this case.

The above results can be found by analytical methods.

From $g_R = -\rho - \lambda(1-\alpha)g_E/\gamma$ and $\dot{g}_E = g_E(g_R - g_E)$, one gets the following differential equation of Ricatti :

$$\dot{g}_E = -\left(1 + \frac{\lambda(1-\alpha)}{\gamma}\right)g_E^2 - \rho g_E.$$

Let be $y = 1/g_E$, that implies $\dot{y} = -\dot{g}_E/g_E^2$. Then, one gets the linear differential equation $\dot{y} = \rho y + 1 + \lambda(1-\alpha)/\gamma$, whose solution is $y = e^{\rho t}[y_0 + (\gamma + \lambda(1-\alpha))/\gamma\rho] - (\gamma + \lambda(1-\alpha))/\gamma\rho$. Thus, g_E is given by

$$g_E = \frac{1}{e^{\rho t}\left(\frac{1}{g_{E_0}} + \frac{\gamma + \lambda(1-\alpha)}{\gamma\rho}\right) - \frac{\gamma + \lambda(1-\alpha)}{\gamma\rho}}$$

If $g_{E_0} = -\gamma\rho/(\gamma + \lambda(1-\alpha))$, we have $g_{R_0} = -\rho - \lambda(1-\alpha)g_{E_0}/\gamma = g_{E_0}$, that correspond to the point B, in the phase diagram.

If $g_{E_0} > -\gamma\rho/(\gamma + \lambda(1-\alpha))$, g_E progressively increases and tends to zero. Simultaneously, g_R decreases and tends to $-\rho$. The economy converges to the point D.

A Study on a Competitive Position and Readiness of Thai Logistics Service Providers for Services Liberalisation

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Abstract

Nowadays, the global logistics services industry is increasingly playing an important role to international trade and investment. Effective logistics systems can reduce total costs and also improve service levels, so products can sell at competitive prices in global markets. Logistics services involve a complex web of activities designed to ensure the efficient movement of materials, intermediate inputs, finished goods and reversed products between exporters and importers. Countries (e.g. Japan, Chile, South Korea, Hong Kong, and Australia) have now requested that the Thai government open itself to logistics service liberalisation. However, literature reveals interesting issues related to international logistics service liberalisation and logistics service providers (LSPs). For example, countries can have different definitions of the terms and scope of logistics, as well as different understandings of "major industry players," the readiness and adaptability of LSPs that are in the small-to-mid-sized enterprise (SME) category, and international non-tariff barriers. To prepare and facilitate Thai stakeholders (LSPs, logistics users, and regulators) to assess their capabilities for logistics service liberalisation, Thailand needs to assess the current capabilities of its LSPs, including examining their readiness for logistics liberalisation. The main objective of this study is to examine the current capacities of Thai LSPs, including an assessment of their readiness and adaptability to services liberalisation with international trade partners. This study also examines issues related to the benefits and costs of logistics services liberalisation in Thailand. In the literature review for this study, a problematic issue was discovered. Countries now maintain varying definitions of the terms (and scope of) "logistics" and "supply chain." Therefore, this study applied the World Trade Organisation (WTO) definitions for scope and meaning. Under the WTO definition of scope, logistics services cover activities in seven sectors: 1. transportation; 2. storage and warehousing services; 3. express mails/parcels; 4. packaging; 5. custom [broker] clearances; 6. information technology for logistics, and; 7. freight forwarding companies. To examine these sectors among Thai LSPs, survey research and in-depth interviews were conducted via 558 and 105 respondents respectively. Research processes were designed to ensure that validity and reliability were carefully maintained. Data collected was systematically edited and coded before processing and analysis by SPSS version 11.0.5. The results show that within each sector, Thai LSPs have varying, (but relatively low), degrees of readiness and adaptability to service liberalisation. Most of them still lack understanding of logistics service liberalisation and its effects. Within each logistics sector, competitive capabilities were found to be at medium to low levels. Outdated national laws and regulations, as well as unstable political and economic situations, were found to be impeding the growth of the national logistics service industry. This study also assesses the benefits and costs of liberalisation, and shows that LSPs in the small-to-mid-sized enterprise (SME) category have the most potential for adverse effects. On the other hand, liberalisation can offer logistics users (importers and exporters) greater capabilities for achieving better market responsiveness and cost

reductions. The study points out problematic issues to growth within Thai logistics sectors, issues that are impeding international trade flow. It also provides recommendations on how to facilitate Thai LSPs to adapt and respond to the rapid changes of international logistics liberalisation.

Keywords: Liberalization, Free Trade, services, Logistics services provider, Logistics, Thailand

1. Introduction

In recent years, Thailand's government has placed a high priority on the logistics services industry, identifying it as a driving force for improving service levels and reducing the costs of international trade. This priority has come about due to the current atmosphere of intense competition among Thai and foreign logistics services providers (LSPs) within Thai markets. Countries have asked and tried to pressure the Thai government to open trade via services liberalisation, especially by logistics services liberalisation. However, there is no current data to support critical decision-making, especially in regards to capacity levels or the competitive position of Thai LSPs as compared to foreign LSPs. The objective of this study is to explore the current capabilities of Thai LSPs, including an assessment of their readiness and adaptability to services liberalisation with international trade partners. This study also examines issues related to the benefits and costs of logistics services liberalisation in Thailand.

In the literature review for this study, a problematic issue was discovered. Countries now maintain varying definitions of the terms (and scope of) "logistics" and "supply chain." This, of course, causes confusion and impedes the growth of logistics services liberalisation. This study applied the World Trade Organisation (WTO) definitions for scope and meaning. Under the WTO definition of scope, logistics services cover seven logistics activities: 1. transportation; 2. storage and warehousing services; 3. express mails/parcels; 4. packaging; 5. custom [broker] clearances; 6. information technology for logistics, and; 7. freight forwarding companies. Under mentioned activities, it explores strengths and weakness of each logistics activities, including examining opportunities and threats contributing to opening logistics services liberalization between Thailand and partners.

2. Literature Review

The global logistics service industry is increasingly playing an important role to international trade and investment (5). Effective logistics systems can reduce total costs and improve service levels so that products can be sold with lower prices and higher responsiveness to global markets (8, 9). Logistics services involve a complex web of activities designed to ensure the efficient movement of materials, intermediate inputs, finished goods and reversed products between exporters and importers (1).

Countries (e.g. Japan, Chile, South Korea, Hong Kong, and Australia) have now requested that the Thai government open itself to logistics service liberalisation. However, literature (8, 9, 10) reveals interesting issues related to international logistics service liberalisation and logistics service providers (LSPs). For example, countries can have different definitions of the terms and scope of logistics, as well as different understandings of "major industry players," the readiness and adaptability of LSPs that are in the small-to-mid-sized enterprise (SME) category, and international non-tariff barriers (11). To prepare and facilitate Thai stakeholders (LSPs, logistics users, and

regulators) to assess their capabilities for logistics service liberalisation, Thailand needs to assess the current capabilities of its LSPs, including examining their readiness for logistics liberalisation.

This literature review searched the various international definitions (by terminology and scope) of logistics. The results showed that countries defines different definitions and scopes of logistics activities. Even though countries may have different definitions and perspectives (9, 11), their basic logistics concepts are similar and consistent in that they focus on the two major trade flow activities of physical goods and information flow, including focusing on cost effectiveness and responsiveness (8, 9,10, 11). This issue of common definitions of terms and scope as it relates to logistics liberalisation is becoming a challenging issue for negotiators and governments. Countries (9, 10, 11) assessed the capabilities of their logistics players before negotiating free trade agreements or establishing service liberalisation. Most of them examined readiness and adaptability within their service sectors before opening logistics services liberalisation.

The literature review pointed out trade benefits and cost reductions attributable to logistics services liberalisation. However, it also identified problematic issues. For example, how does one assess readiness for logistics liberalisation within the categories of LSP size (i.e., small to large) and sector (i.e., transport or freight-forwarding companies)? What is the role of government to LSPs: facilitator or regulator? To avoid confusion, this study applies the World Trade Organisation (WTO) scope of logistics activities (9,10) within seven major sectors: transportation; storage and distribution; express mails and parcels; packaging; custom broker; information technology for logistics; and freight forwarding companies (11).

The literature pointed to the conclusion that a preparatory evaluation of the readiness of stakeholders within the logistics industry is essential before considering or negotiating the establishment of logistics liberalisation. The potential success of logistics liberalisation is based on a win-win approach to negotiations that always takes into consideration the readiness and adaptability of stakeholders. The literature also pointed out that there is a relationship between capacity level and readiness to activating logistics liberalisation, as well as to its success. It also pointed to the unique characteristics of each sector. Within Thai LSPs, there were varying low degrees of readiness and adaptability to logistics service liberalisation. Most of them still lack understanding and effects of opening logistics service liberalisation. Each sector showed a competitive capability at medium to low levels.

3. Research Methodology

To achieve the research objective, this study developed its research data through two sources. First, a literature review was conducted. The literature reviewed was related to logistics management, trade services, logistics businesses in Thai firms, and services liberalisation. This data source provided a broad view about the benefits and costs that occur from opening free trade agreements and other forms of trade services liberalisation.

Secondly, relevant data was collected by questionnaire surveys and in-depth interviews. This part of the research focused on exploring the current status and capacity level of Thai LSPs. In-depth-interviews were used specifically to obtain deeper insight into the relevant opinions and concerns of executives and managers at Thai LSPs.

To obtain the full scope of data, the research analysis covered seven LSP sectors (as defined by the WTO): transportation; storage and warehousing services; express courier and parcels;

packaging; custom clearance; information technology for logistics; and freight forwarding companies. As shown in Table 1, a number of samplings were taken from each sector.

Table 1 Numbers of Sampling Sizes

No	Type of LSPs	Targeting sampling	Actual Sampling	Rate of Response
1	Transportation	150	140	0.93
2	Storage and warehousing services	145	128	0.88
3	Express courier and parcels	50	47	0.94
4	Packaging	50	42	0.84
5	Custom clearance	95	70	0.74
6	Information technology for logistics	50	30	0.60
7	Freight forwarding companies	200	128	0.64
	Total	**740**	**585**	**0.79**

Table 1 shows numbers of targets and sampling sizes. After having developed sampling sizes for each logistics sector, this study gathered data by questionnaire survey. The 740 questionnaires were distributed by various methods, e.g., face-to-face, postal and e-mail. The rate of response generated was very good with 585 respondents or 79.0 percent in total. The data collection period took four months.

The study also conducted in-depth interview with 105 respondents, covering all sectors of Thai LSPs. All interviews were conducted in Thai language, using a tape-recorder, in one to three hour sessions. Notes were also taken at each interview to supplement the recordings and instill an air of professionalism and importance at each interview. The semi-structured questions were developed based on research questions and these same questions were repeatedly asked of all respondents. After all data from the in-depth interviews was transcribed and tabulated in appropriate formats, content analysis (2) was performed.

Research processes were structured to ensure that validity and reliability were carefully maintained. The research tools, i.e., questionnaires and interview questions, were designed to fit properly with targeting groups. The questionnaires used perceptual Likert scales (1), where targeted samples were asked to rate each item on a five-point scale, ranging from strongly disagree to strongly agree. If a variable was related to a complex concept (2), it was covered by multiple queries and its value corresponded to the mean value of the scale. In determining the measurement properties of the constructs used in the statistical analysis, reliability and validity were assessed respectively (1, 2) using Cronbach's alpha. The alpha value of overall questionnaire was 0.82. The authors (7) suggested that a value of reliability of 0.70 is acceptable, while over 0.80 is considered good (2).

After questionnaires were returned, they were classified by sources (type of LSP) and coded and edited to make them ready for data entry (7). The SPSS was used to analyse the data. The survey results were incorporated with information from the in-depth interviews.

4. Results and Discussion

This study offers results covering four major issues. First, the demographic data of respondents was utilized to identify targeted groups and their characteristics. Secondly, there was an examination of the capacity levels and readiness of major players in Thai logistics industry as compared with foreign LSPs. Thirdly, there was an examination of other issues related to negotiation and establishment of logistics liberalisation between Thailand and countries. Finally, this study analysed the benefits and costs to Thai LSPs and other stakeholders (logistics users and regulators) when activating logistics liberalisation.

Table 2 Types of Respondents

Kind of Business	No. of Respondent	Percent
1. Freight forwarding	130	23.0
2. Warehousing and storage facilities	128	21.0
3. Information technology for logistics	30	5.0
4. Transportation	141	24.0
5. Express and courier parcels	45	8.0
6. Customs broker	70	12.0
7. Packaging	41	7.0
Total:	**585**	**100.0**

Table 2 shows types of respondents. The greatest number of respondents (by sector) came from transporting companies in all modes at 23.0 percent, followed by freight forwarding, and warehousing and storage companies at 23.0 and 21.0 percent respectively. These results reflect a reality within the Thai logistics industry, indicating that transports (land, water, and air) are playing a major role.

Table 3 Numbers of Employees

Number of Employees	Percent
Less than 50 persons	49
51-200 persons	35
201-500 persons	10
More than 501 persons	6
Total	100

Table 3 presents number of companies' employees. This study identified companies by size. It revealed that most Thai LSP companies (84 percent) have less than 200 employees. It also shows that most are small companies (at 49 percent; with medium-sized enterprises at 35 percent). These results also identified the real major players of Thai LSP.

Table 4 Value of Fixed Assets

Value of Assets	Percent
Less than 50 Million baht	70
51-200 Million baht	13
101-200 Million baht	7
More than 201 Million baht	10
Total	100

Table 4 shows value of fixed assets of surveyed companies. When considering size of business firms by value of fixed assets, this study referred to the definitions of Ministry of Industry, Thailand. Firms with fixed assets of less than 50 million baht or 50 employees or less are considered small-sized companies. Firms with fixed assets between 50-200 million baht are defined as medium-sized companies. The results in this area of the study are consistent with the result in Table 4-3, revealing that most Thai LSP companies have a value of fixed assets at less than 200 million baht. An overarching conclusion is that most Thai logistics companies are SMEs.

Table 5 Management and Shareholders' Structure

Shareholders' Structure	Percent
Thai 100%	93
Thai > Foreigner e.g. Thai 51%, Foreigner 49%	6
Foreigner > Thai e.g. Foreigner 51%, Thai 49%	1
Total	100

Table 5 presents shareholders' structure of respondents. In considering the shareholder (ownership) structure of respondents, the result revealed that most companies, 93 percent, were Thai-owned companies. This was followed by joint ventures between Thai and foreign companies, at just 6 percent. The low percentage of joint ventures reflects a major problematic issue: foreign logistics service providers have impeded entry into Thai logistics markets because of current Thai laws.

Table 6 Capability Levels of Thai LSPs as Compared to Foreign LSPs

Capability Levels	Mean
Providing excellent service quality	2.85
Achieving higher performance through logistics staff	2.72
Ability to effectively access local target markets	2.71
Maintaining vision in dynamic business environments	2.70
Effectively managing operating costs	2.68
Providing services via one-stop service centre	2.51
An organisational culture that responds well in a dynamic business environment	2.49
Excellent logistics knowledge and understanding	2.28
Ready access to resources and capital	2.25
Strong management	2.20
Sufficient resources of information technology (hardware, software and "people-ware")	2.03
Having a strong global business network	1.92

Table 6 reveals capability levels of Thai LSPs as compared to foreign LSPs. The results reveal that most of Thai LSPs rated their performance and capacities of conducting businesses at lower than the standard level (3.0). They identified that they had higher service quality than foreign competitors (2.85), maintained strong, competent staff to handle customer problems (2.72), and had the capability of local access to target markets (2.71).

However, the results also showed that some issues were becoming weak points. Those issues included: lack of resources and capitals (2.25); weak management talents and competencies (2.20), and; low availability of IT for logistics (2.03). Particularly telling was the lack of global business networks (1.92).

Table 7 Problems and Opportunities Contributing when Establishing Logistics Services Liberalization

Problems and Opportunities Occurring	Mean
Having intense competition in logistics industry	3.91
Having increasingly cut the prices in logistics industry	3.78
Foreign LSPs increasingly expand the market to Thailand	3.68
The LSP compete to improve higher service quality	3.64
Having higher integration and effectively allocating resources	3.49
Importers and exporters have more alternatives for the LSPs	3.45
Improving higher potential for importing and exporting to foreign markets.	3.43
Thai exporter can increasing expand business to foreign markets	3.18
Thai LSPs can expand their business to foreign market	2.90

Table 7 shows problems and opportunities contributing when establishing logistics services liberalization. This study identified problems and opportunities for Thai LSPs in establishing logistics services liberalisation. Targeted respondents were asked about problems or opportunities which could be expected to occur if Thailand established logistics services liberalisation. Most of them strongly agreed that the Thai logistics industry is experiencing intense competition (3.91). They believed Thai LSPs would have to increasingly use price strategies (3.78). They saw foreign LSPs expanding more and more into Thailand markets (3.68).

Table 8 Benefits Occurring to Thai LSPs, if Establishing Logistics Services Liberalization

Benefits Occurs	Percent
None and having a negative effect	54
Yes, but it might have both positive and negative effects	25
Yes and having a positive effect	21
Total	100

Table 8 shows benefits occurring to Thai LSPs, if establishing logistics services liberalization. As far as benefits for Thai LSPs from logistics services liberalisation, the results reveal that most of the respondents (54 percent) believed that if Thailand established logistics services liberalisation it would not negatively affect Thai LSPs in any way. Some of them (25 percent) pointed that it might affect Thai LSPs to a small degree, but without major affect, since foreign LSPs were already operating logistics businesses in Thailand in the form of agencies or nominees (e.g. TNT, Linfox, Fedex and NYK Logistics).

Table 9 Supports or Incentives to Entry Foreign Market by Thai government if Establishing Logistics Services Liberalization

Supports or Incentives Providing by Thai Government	Percent
Yes, Thai government support to entry foreign market	44.0
Not sure	34.0
No, Thai government does not support	22.0
Total	100.0

Table 9 examines the attitudes of respondents to Thai governmental supports and incentives to entry into foreign markets through logistics services liberalisation. The result showed that a large percentage of respondents (44.0 percent) agreed that the Thai government should actively support Thai LSPs' entry into foreign markets. Some of them (34 percent) were not sure that the Thai government would support Thai LSPs investing in foreign markets, because of high risks and uncertainties. Unfortunately, the results also revealed that LSPs think the Thai government currently provides insufficient support in policy, resources or capital for effective entry into foreign markets.

Table 10 Evaluation of Positive Effects to Business Operations

Evaluation of Positive Effects to LSPs	Percent
Strong positive	29
Rather positive	27
Neutral	21
Rather negative	14
Strong negative	9
Total	100

Table 10 shows an evaluation of positive affects for Thai LSPs through logistics service liberalisation between Thailand and partners, the study asked respondents to identify such affects. Most respondents (56 percent) identified that liberalisation did provide positive effects to Thai logistics industry. These benefits included better utilization of resources and capital, plus the transfer of valuable technology and know-how from developed countries. As the result, liberalisation would enhance Thai LSP business development, increase trade capabilities, and improve competitive positions over foreign LSPs.

On the other hand, some of the respondents (23 percent) were concerned about negative affects to their operations. They worried that activating logistics liberalisation could increase competition and eventually destroy their business.

Table 11 Costs and Benefits Occur if Opening Logistics Services Liberalization

Costs and Benefits Occur	Percent
Thailand received benefits less than costs	67
Thailand received benefits more than costs	21
No different between costs and benefits gain	12
Total	100

Table 11 shows costs and benefits of activating logistics service liberalisation, the study revealed that most respondents (67 percent) identified that Thailand would not reap benefits sufficient to the costs. They indicated that they believed foreign LSPs have high competencies, strong financial support, and wide global networks.

Some respondents (12 percent) pointed out that liberalisation would not be any different for them, in term of operations, since foreign LSPs (e.g. TNT, and Linfox) have already established businesses in Thailand. They indicated it might change some business practices. However, a larger percentage (21 percent) thought that activating logistics liberalisation in Thailand would reap more benefits than costs. They think liberalisation would facilitate importers and exporters to sell more products in global markets with lower costs and higher service levels.

Table 12 Attitudes and Support of Thai LSPs to Opening Logistics Services Liberalization between Thai and Partners

Support and Agreement of Thai LSPs to Opening Trade in Services Liberalization	Percent
Strong support	29.0
Rather support	27.0
Neutral	22.0
Not rather support	10.0
Not strong support	12.0
Total	100.0

Table 12 shows an attitude and support of Thai LSPs to opening logistics services liberalization between Thai and partners. Thai LSPs were asked if they agreed with and supported logistics liberalisation negotiations by the Thai government with foreign partners. The result revealed that most respondents (56 percent) do support such negotiations, but qualified that by indicating that the government should negotiate carefully by considering and analysing the benefits and costs involved. Further, the government should formulate policies and strategies to develop capacity among Thai LSPs, especially the SMEs.

Some respondents (22 percent) felt that there would be no difference if Thailand negotiated logistics services liberalisation, since even without such negotiations, there were already many foreign LSPs investing in Thailand. Lastly, 22 percent of respondents indicated that they did not agree with nor support negotiations.

5. Discussion and Implications

As indicated by this study, Thai logistics players come from various sectors. The literature revealed that countries define logistics and its scope differently. Thailand, for example defines logistics as transport and warehouse activities. On the other hand, Australia defines logistics as activities related to core or non-core logistics. This is a problematic issue when a country wants to negotiate to open logistics services liberalisation with another country. In essence, they will be speaking different languages. Therefore, the Thai government should develop certain definitions of logistics and its scope for negotiating in international forums. The definitions and scope of logistics would be handled consistently within an international context.

Further, the Thai government should define the scope of logistics activities and size of logistics businesses. This definition should be different than other industries due to the unique nature and operations of LSP businesses. The Ministry of Industry, Thailand, defines firms with fixed assets of less than 50 million baht, or 50 employees or less, as so-called small-sized companies. A company with 50-200 million baht in fixed assets is considered a medium-sized company. But, look at TNT, for example. TNT is a world class company operating in Thailand with only 80 employees. The company effectively operates a wide network across many countries. This shows how business size within the logistics industry is unique and needs to be defined more in relation to business management and operations.

This study pointed out that most of Thai LSPs were small-to-mid-sized enterprises (SMEs). It identified that their strengths as commitments to: higher service quality than foreign competitors; strong and competent staffs for handling customer problems, and; a capacity to access local target

markets. It also identified the Thai LSP weak points within the global logistics industry. Those weak points included: availability of resources and capital; strong management talents and competencies; availability of IT for logistics, and especially; a lack of global business networks. These weaknesses indicated that the Thai government should assist Thai LSPs by helping eliminate, or at least, reduce these shortcomings and increase their competitive advantage.

Most Thai LSPs in each sector had a low degree of readiness and adaptability to logistics service liberalisation. This was particularly true within SME sectors. They needed capital, technology and know-how to improve their competitiveness. Accordingly, larger Thai logistics companies had a higher capacity level and readiness for activation of logistics liberalisation than the SMEs. Most of them still lacked understanding regarding the affects of logistics service liberalisation. The competitive capabilities within all sectors were at relatively medium to low levels. There were other mitigating factors, e.g., outdated national laws and regulations, and unstable political and economic climates, impeding the growth of the Thai logistics service industry. In relation to Thai government agencies and their role in facilitating logistics operations, it was indicated they lacked understanding and knowledge on how to effectively encourage, facilitate and offer incentives to Thai LSPs so that they can better contribute and compete in the global logistics markets.

After analysing the benefits and costs to liberalisation, LSPs in SME sectors have the most potential for adverse affects. On the other hand, logistics users (Thai importers and exporters) can reap the greatest benefits through higher responsiveness and lower costs. The study points out problematic issues to growth within Thai logistics sectors, issues that are impeding international trade flow. It also provides recommendations on how to facilitate Thai LSPs to adapt and respond to the rapid changes of international logistics liberalisation.

In summary, the results show that:

- Countries lack concise and clear definitions and scopes of logistics activities.
- It found that most of Thai LSPs (more than 95 percent) are SMEs and they have less degree of readiness for logistics service liberalization.
- Thai LSPs lack a competitive advantage to entry to market in other countries.
- Many logistics sectors (i.e. warehouse, freight forwarding, custom broker and IT for logistics) are being acquired by foreign companies.
- Factors (i.e. laws and regulations, incapability of LSPs, culture, and lack of logistics knowledge and best practices) impede to development of logistics industry in Thailand.
- A role of Thai government agencies is unclear and lack of readiness. They also act as a regulator, even they would be a facilitator to assist and support to Thai LSPs.
- Logistics users consider for using LSPs in issues of prices, services quality and services minded respectively, as a decisive factor.

6. Conclusion

The study examined the capability levels of Thai logistics service providers (LSPs), including an assessment of their readiness and adaptability to international trade services liberalisation between Thailand and outside trade partners. It concluded that Thai LSPs, in particular SMEs, had a lesser degree of capacity to compete with foreign LSPs. They also lacked readiness to contribute to the establishment of logistics liberalisation. A timeframe for developing LSP readiness before activating logistics liberalisation would be unique to each sector, depending on types and sizes of logistics activities, but should range between 3-8 years.

The study examined issues related to the benefits and costs of logistics services liberalisation in Thailand. It concluded that by opening logistics liberalisation between Thailand and outside partners, Thai LSPs would be at a disadvantage to foreign LSPs. However, liberalisation would benefit Thai importers and exporters in trading their products into global markets through lower costs and higher responsiveness. Confusion over definitions of logistics terminology and scope were found to be problematic to negotiations within international forums. This study pointed out that the Thai logistics industry should define the terms and scope of logistics, consistent to an international context. Another issue was governmental support and facilitation of Thai LSPs. In particular, SMEs should be focused on to enhance their sustainable competitive capabilities and encourage the overall growth of the Thai logistics industry.

The study led to a conclusion that most of today's Thai logistics players effectively lacked critical capacity levels for logistics liberalisation. They have also been negatively impacted by the lack of definition of the terms and conditions required for effective logistics liberalisation negotiation. In the final analysis of the benefits and costs to activating logistics liberalisation, growth of international trade within Thailand would certainly expand. The SMEs in the Thai logistics industry would be adversely affected in term of operations, resource utilization, and capital. Finally, Thai logistics users (importers and exporters) would reap the highest benefits through higher responsiveness and lower costs.

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Public Services, the Keynesian Multiplier, and Growth

by

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Abstract

This research study investigated an endogenous growth model with elastic labour supply, monopolistic competition in the product market, productive public services, and "keeping up with the Joneses" effects in order to analyse the nature of the Keynesian multiplier and its relation to a "supply side multiplier". The main finding is that the (reduced-form) balanced-budget multiplier is hump-shaped (against government size) and envelopes the "supply-side multiplier" of Barro (1990). Further, the growth- and welfare-maximising government size is that of Barro (1990). We also find that an increase in the "Joneses" effect and a decrease in monopoly power increase labour supply and growth.[1]

Keywords: Fiscal Policy, Public Services, Monopolistic Competition, Keynesian Multiplier, Optimal Size of Government, Growth, Keeping up with the Joneses

1. Introduction

In recent years, fiscal policy has been analysed by (among others) three, rather distinct, strands of macroeconomic literature. One, essentially static, variety of models (Mankiw, 1988; Starz, 1989; Dixon, 1987; Dixon and Lawler, 1996; Heijdra, 1998, Heijdra, Ligthart and van der Ploeg, 1998; Sylvestre, 1993;) seeks to re-discover and analyse the Keynesian multiplier in static monopolistic setups with optimising households. The balanced-budget multiplier emerges in the short run because of the virtuous circle of higher spending generating higher company profits, which then feed on to higher spending through consumption; the multiplier vanishes in the long run, though, because free entry eliminates all profits and breaks the virtuous circle. Coto-Martinez, and Dixon (2003) provide an open-economy extension in this vein. Apart from their static nature, these models maybe criticised for the specific functional form it uses for production, with a constant marginal product of labour (but see Dixon and Lawler, 1996, for generalisations on this and other dimensions); and for building the multiplier entirely on capital's share (as the real wage is constant due to the specific production function employed), whereas it might be expected that the marginal propensity to consume out of labour's share is greater (Galor and Zeira, 1993; see also Mankiw, 2000). But a better understanding of the multiplier remains essential for a number of reasons,

[1] An early version of this paper was presented at the November 2002 meeting of the International Economics and Finance Association - UK Chapter (IEFS-UK); thanks are due to participants for helpful comments.

including understanding the effects of discretionary fiscal policy, and because the multiplier affects the efficacy of automatic stabilisers (see Blanchard, 2000).

A second strand, builds on intertemporal optimisation by households (as well as firms), and analyses the effects of fiscal policy in this context (Aschauer, 1985, 1988; Barro, 1989; Aiyagari *et al*., 1990; Christiano and Eichenbaum, 1992; Baxter and King, 1993; Gali, Lopez-Salido and Valles, 2002). The interesting features of these models include the response of consumption to intertemporal resources, and the effect on the latter of changing interest rates, which accompany the changing consumption; above all, they make a methodological contribution by integrating fiscal policy into the mainstream of dynamical macroeconomics. But due to their diversity (they are with or without endogenous labour supply, capital, endogenous growth, and market imperfections), they fail to reach uniform conclusions; e.g., a point of contention is the relative magnitudes of short- relative to long-run multipliers, the size of either (above or below unity, hence the issue of whether or not private consumption is crowded out or in, etc.). More fundamentally, they share with the static monopolistic approach the weakness that fiscal policy is entirely wasteful; this feature is rectified in the next approach.

Another, dynamic but perfect competition-based, strand of literature begins with Barro's (1990) seminal contribution. Here, government spending sustains productive public services and complements private capital in generating constant returns to scale and in giving rise to endogenous growth. In his steady-state analysis, Barro derives the seminal result that, for growth maximisation (and utility maximisation in a decentralised economy under Cobb-Douglas preferences) the share of productive government expenditures in GDP should equal the elasticity of public services in production. The robustness of this result has been checked in several directions: e.g. in open economies by Mourmouras and Ghosh (2000), and Ghosh and Mourmouras (2002); in economies with public capital by Futagami, Morita and Shibata (1993), Miller and Tsoukis (2003), and Ghosh and Roy (2004), among others. Though deviations from the Barro (1990) rule emerge, in particular where utility maximisation is concerned, that rule remains an important and intuitive benchmark. These analyses lack a demand side, and are mostly without dynamics; but the greatest contribution of this strand may be that it offers a basis for considering the optimal size of government.

So, the effects of fiscal policy on aggregate economic activity have been approached from a variety of angles, with sometimes little convergence in results within each approach, let along synthesis between approaches. This theoretical "embarrassment of riches" is reflected on empirical work which fails to settle conclusively any of the big issues (e.g., in addition to the references given above, see Blanchard and Perotti, 2002, the simulation study by Gali *et al*., 2002; see more references in Tsoukis, 2006). Thus, the quest for a clearer understanding of the effects of fiscal policy is far from over. At the same time, this understanding of fiscal policy is more important than ever. Socially and politically, fiscal policy is charged with a multiplicity of tasks, including (among others) stabilisation, maintenance of public services, and contribution to growth. The first role is being strengthened as the counterpart role of monetary policy is being weakened, because of a combination of developments, including Central Bank independence with a mandate to stabilise inflation above all, and monetary union (relevant not only to Europe but potentially to other parts of the world, too); the other roles of fiscal policy have always been important. In this light, the disparity of available theoretical and empirical results must be seen as less than ideal, necessitating further refinement.

This paper sets out to synthesise the three hitherto distinct theoretical strands of analysis of fiscal policy mentioned above. This synthesis is important for the dual reason that an expansion due to the Keynesian multiplier increases the return to private capital and the rate of growth, in parallel

with the supply-side effect through productive public services; two are balanced by endogenous labour supply. Thus, the essentially demand-side analysis of the Keynesian multiplier and the supply-side analysis of public services-based endogenous growth are brought to bear together, in a mutually enhancing way. Our setup is quite rich, yet analytically manageable, encompassing monopolistic competition and a multiplier-like structure in the short run, variable labour supply and endogenous growth. The more specific questions which shall be asking the nature of the Keynesian multiplier with variable labour supply and its relation to the "supply multiplier" of Barro (1990) and related literature; and the effect of monopoly power and rivalry in consumption ("keeping up with the Joneses") on the demand multiplier, equilibrium labour supply and growth.

The paper builds on such antecedents as Heijdra (1998), which combines elements of the first two approaches, particularly monopolistic competition giving rise to a Keynesian type of multiplier with intertemporal optimisation, but no endogenous growth; Turnovsky (2000), which has endogenous growth with intertemporal optimisation model but not monopolistic competition and Keynesian effects; and Devereux *et al*. (1996), who have monopolistic competition and growth but no productive public spending. The paper is structured as follows: Section 2 describes the model, while Section 3 presents the steady-state solution and the main results. Section 4 considers the optimality of the Barro (1990) rule for welfare in decentralised equilibrium. Section 5 concludes, while an Appendix considers the dynamic properties of the model. Finally, it is worth pointing out at the outset that all our results are analytical, but plausible parameter values are occasionally consider in order to sign some coefficients in an empirically relevant manner.

2. The Model

2.1 Consumers

Individual i maximises intertemporal utility by appropriate choice of consumption and leisure-labour,

$$\text{Max} \quad \overline{U}_{it} \equiv \int_t^{\infty} e^{-\rho s} \frac{U_{is}^{1-1/\eta}}{1-1/\eta} ds\,, \tag{1}$$

with period subutility defined as,

$$U_{is} \equiv \left(C_{is} - \delta C_s\right)(1-L_{is})^{\beta}, \quad \beta>0, \quad 0<\delta<1. \tag{2}$$

Households derive income from the rental of their factor endowments to firms: capital receives the real rate of interest (r) - asset markets are assumed competitive, labour receives the real wage (W/P), while there are also "super-normal" profits due to the firm's monopolistic position in the goods market; all are taxed uniformly at rate τ. Thus, the households' budget constraint, equating the uses and sources of funds, is:

$$\dot{K}_{it} + Q_t \dot{E}_{it} = (1-\tau)\left(r_t K_{it} + L_{it} W_t + \Pi_{it}^{M}\right) - C_{it} \tag{3}$$

The following variables pertain to a specific individual i and time t:

C_{it}: Consumption of the composite consumption basket (in real terms);[2]

[2] It is assumed that there is a unit-mass of firms, each producing a monopolistically differentiated good, as described below in Subsection 2.2. The individual goods are aggregated to a composite consumption bundle by the familiar Dixit-Stiglitz aggregator; two-stage budgeting then applies, with the household deciding on the total value of the consumption bundle and, at a second stage, allocating the consumption spending to individual goods. The second stage of this problem is both familiar and unimportant for our purposes, hence its description is omitted.

L_{it}: Labour, and with an endowment of time equal to one, 1-L_s being leisure;
K_{it}, E_{it}: Holdings of physical capital and financial capital (number of shares) respectively by agent i. It is assumed (see also under firms) that the firm's value derives entirely from monopoly profits, since physical capital belongs directly to households;
Π^M_{it}: Remittance of real monopolistic ("supernormal") profits, i.e. that share of capital over the competitive market real interest rate (see below under firms) – it is assumed that all such profits are remitted directly to households.

The following variables are common across agents:
W_t,: The (nominal=real) wage, with the aggregate price level being the numeraire, $P_t \equiv 1$;
Q_t: The price of equity in real terms;
r_t: The real rate of interest – market efficiency equates the real rate of return obtainable from direct ownership of equity to that obtainable through the financial market;
C_t: Mean consumption (note the absence of subscript i). Its presence there signifies the "keeping up with the Joneses" effect (as in Gali, 1994; Ljungqvist and Uhlig, 1999; see also Tsoukis, 2005) whereby the utility obtainable from consumption is adjusted by the comparison with mean consumption (as a result, marginal utility increases, as any additional unit of consumption confers additional utility because of "status"). This effect is studied here because it affects the multiplier and equilibrium labour supply.

The relevant parameters are:
τ: The flat (across time periods, income brackets, and sources of income) rate of tax and spending – see below;

$0<\delta<1$: The coefficient of comparison with the "Joneses";

β: The elasticity of leisure relative to that of consumption in utility;

ρ, η: instantaneous rate of time preference and the inverse of the intertemporal elasticity of substitution in consumption, respectively.

Adding $\dot{Q}_t E_{it}$ to both sides of (3), indicating by $V_{it} \equiv Q_t E_{it}$ the total value of individual i's equity holdings, and equating the rate of return on equity with the rental rate of capital r by the assumption of efficient markets,

$$\dot{Q}_t / Q_t + \Pi^M_{it} / V_{it} = r_t ,$$

we finally have:

$$\dot{A}_{it} = (1-\tau)\left(r_t A_{it} + L_{it} W_t\right) - C_{it} \qquad (3')$$

A_{is} $\equiv K_{it}+V_{it} \equiv K_{it}+Q_t E_{it}$: Total value of individual i's assets.

Maximisation of (1) with instantaneous utility (2) with respect to C_{it}, L_{it}, subject to (3'), and imposing symmetry across households (C_i=C, L_i=L), yields the following well-known optimality conditions:

$$U_t^{-1/\eta} / (1-\delta) C_t = \lambda_t \qquad (4)$$

$$\beta U_t^{-1/\eta} / (1-L_t) = \lambda_t \omega_t , \qquad (5)$$

with $\omega_t \equiv (1-\tau) W_t$ being the net-of-tax real wage,

$$\dot{\lambda}_t = \lambda_t (\rho - (1-\tau) r_t) \qquad (6)$$

λ_t: The dynamic (current-value) Lagrange multiplier associated with (4) in the Hamiltonian. Furthermore, we impose the transversality condition:

$$\lim_{t\to\infty} \lambda_t A_t = 0 \quad (7)$$

Combining the first two optimality conditions, we also find an intratemporal relation between consumption and leisure:

$$\omega_t(1-L_t) = \beta(1-\delta)C_t \quad (8)$$

We gain here a first understanding of the "keeping up with the Joneses" effects (captured by δ). Given the after-tax real wage ω, those effects reduce leisure; this is because of the externality involved (each agent's consumption inadvertently reduces everybody else's utility), whose only effect in symmetric equilibrium is to induce more work effort.

2.2 Firms, government and National Income Accounting

We now turn to firms, starting again with explicit heterogeneity (introduced by the firm-specific subscript j). The mass of firms is again unity, and is fixed.[3] Their production possibilities are described by a uniform Cobb-Douglas production function:

$$Y_{jt} = K_{jt}^{\phi} G_t^{1-\phi} L_{jt}^{1-\phi} \quad (9)$$

Y_{jt} is real output of firm j at t. Constant returns to scale apply to the two privately employed factors (capital-labour), and we follow Barro (1990) and others in assuming that (labour augmenting) productivity is equal to non-rivalrous public services.[4] A multiplicative technological parameter has for simplicity been suppressed. The Cobb-Douglas specification (like other parameterisations followed in this paper) is naturally restrictive, but because of its tractability, has been widely followed in the literature with few exceptions.

We assume that the only expenditure government incurs is in order to support public services G;[5, 6] furthermore, the government runs a balanced budget financed by a flat rate of tax τ:

$$G_t = \tau Y_t \quad (10)$$

Firms are Dixit-Stiglitz monopolists who face individual demand curves as follows:

$$Y_{jt} = Y_t P_{jt}^{-\theta} \quad (11)$$

θ >1: Elasticity of substitution between the individual products;
Y_t: Mean output demand (equal to aggregate because of the unit mass of firms);
P_{jt}: Real (in terms of the aggregate consumption basket) price of good j.

Gross (pre-tax and inclusive of the normal return to capital) real profits are given as:

$$\Pi_{jt} \equiv P_{jt} Y_{jt} - W_t L_{jt} \quad (12)$$

[3] The mass of firms is fixed, so entry and exit is not allowed. At the same time, firms make profits because of their (Dixit-Stiglitz-style) monopolistic power. Following the macroeconomic literature, we call this setup monopolistic competition; Heijdra (1998) calls it "restricted monopolistic competition", because of the no-entry condition. In industrial economics contexts, the term symmetric oligopoly is used; but it should be clear that there are no strategic interactions between firms. Allowing entry and a growing number of goods varieties would be unnecessary complication, as growth comes from public services.

[4] That constant returns should apply to the two cumulative factors (private capital and productivity) is a well-known requirement for endogenous growth to emerge. The returns applicable to capital and labour could be set more freely (as in Turnovsky, 2000), but the insights gained would be limited. Hence, constant returns apply here between private capital and labour.

[5] These services are supported by current expenditures only and do not result from accumulated public capital. For an analysis of fiscal policy and growth along those lines, see Miller and Tsoukis (2003). Moreover, it is assumed that there is no congestion (the public services are a pure public good), so that each producer benefits equally from the level of the public service.

[6] In order not to further clatter the paper with equations, there are no utility-enhancing public services here; see Turnovsky (2000) for a recent analysis incorporating such services. Obviously, in terms of the analysis that follows, such services would induce only a negative supply multiplier (through the effect of taxation).

where W_t is the economy-wide wage – labour being entirely homogeneous.

Firms rent capital and labour from households. The firm's objective is to maximise its value V, the present value of profits net of the reward to capital:

$$\max_{L,K} V_{jt} \equiv \int_t^{\infty} e^{-\int_t^s (1-\tau) r_v dv} (1-\tau)\left(\Pi_{js} - r_s K_{js}\right) ds, \tag{13}$$

where Π_s is real profits gross of rental payments to owners of capital. It should be emphasised that interest income and direct income from profits are symmetrically taxed.

Maximisation of the above with respect to employment L_I and capital K_i subject to the demand curve (11) yields two well known optimality conditions: Firstly, a static pricing rule which may be written as follows to facilitate further progress:

$$P_{jt} Y_{jt} = (1+\mu)(1-\phi)^{-1} W_t L_{jt} \tag{14}$$

The markup μ is defined by:

$$\mu \equiv \frac{\theta}{\theta - 1} - 1 \geq 0 \tag{15}$$

The markup is an indicator of monopoly power, with the lower bound of 0 being the limiting case of perfect competition. Inserting the price rule (14) into the gross profit expression (12), we have,

$$\Pi_{jt} = m P_{jt} Y_{jt}, \tag{12'}$$

where $m \equiv (\mu + \phi)/(1+\mu)$, with $\phi \leq m < 1$,[7] is the share of capital in gross-of-tax output; this share increases with the degree of monopoly power μ from the limiting case of ϕ (perfect competition). It also follows that the wage bill is:

$$W_t L_{jt} = \frac{1-\phi}{1+\mu} Y_{jt} P_{jt} = \frac{1-\phi}{\mu+\phi} \Pi_{jt} \tag{12''}$$

Secondly, capital is employed up to the point where its marginal product equals the rental rate (the economy-wide real rate of interest r):

$$r_t = \phi P_{jt} Y_{jt} / K_{jt} \tag{16}$$

Thus, monopolistic profits are:

$$\Pi_{jt}^M / P_{jt} = m Y_{jt} - r K_{jt} = (m - \phi) Y_{jt} \tag{17}$$

We now revert to symmetric equilibrium, indicated by dropping the firm-specific subscript, in which case $P_{jt} = P_t = 1$, $Y_{jt} = Y_t$. Thus, tax-adjusted real aggregate profits inclusive of rental to capital are given by:

$$\pi_t \equiv (1-\tau)\Pi_t = (1-\tau) m Y_t \tag{17'}$$

Therefore the tax-adjusted wage bill is:

$$\omega_t L_t \equiv (1-\tau)(1-m) Y_t \tag{17''}$$

The model is closed with National Income Accounting, which takes the form:

$$Y_t = C_t + I_t + \gamma_t Y_t \tag{18}$$

γ: The percentage in GDP of government spending (on productive public services).

[7] We can see this inequality by re-writing the definition of m as $m - \phi = \mu(1-m)$.

3. Steady state

3.1 The setup

The first observation is that the instantaneous utility satisfies the requirement that the substitution and income effects of the real wage on leisure cancel out (see King, Plosser and Rebelo, 1988), so that labour is constant in the steady state. With labour income a constant share of output, this implies that the real wage (W) grows in the balanced growth path at the same rate g as all other variables – more on the balanced growth path below. In view of this, integrating the budget constraint (3') forward, imposing the transversality condition (7), we obtain steady-state consumption,

$$C = R\left(A + \omega L / R\right) \quad , \qquad R \equiv (1-\tau)r - g \tag{19}$$

where: $\omega \equiv (1-\tau)W$ is the after-tax real wage and $R \equiv (1-\tau)r - g$ is the growth-adjusted discount rate. Variables without subscripts indicate steady-state values. Adding ω(1-L) to both sides, and exploiting the proportionality condition (8), we finally have:

$$C = \mathrm{B}\left(RA + \omega\right), \qquad 0 < \mathrm{B} \equiv 1/(1 + \beta(1-\delta)) < 1 \tag{19'}$$

It is useful to note that the "marginal propensity to consume" B is inversely affected by the share in utility of leisure (β) and positively by the "Joneses effect" (δ).[8]

With a constant capital growth rate in the steady state and a constant share of public expenditure in GDP, National Income Accounting (see below) readily shows that the steady state involves also a constant consumption-capital ratio. Hence, consumption, capital, output (with zero population growth) and the real wage, all grow at rate g along the balanced-growth path. The key equations are the steady-state production function (9 with 10), the consumption Euler equation (6 with 4 and constant employment), value of assets (3' solved forward, with 17'), human (as opposed to financial) capital (ω/R), and National Income Accounting (18). In the steady-state, they take the form, respectively:

$$Y = K(L\gamma)^{\Phi} \quad , \qquad \Phi \equiv (1-\phi)/\phi \tag{20}$$

$$g = \eta\left((1-\tau)r - \rho\right) \tag{21}$$

$$\frac{A}{K} = 1 + \frac{(1-\tau)(mY/K - r)}{R} = 1 + \frac{(1-\tau)(m-\phi)Y/K}{R} \tag{22}$$

From (21), we also see that the growth-adjusted discount rate equals:

$$R \equiv (1-\tau)r - g = (1-\eta)(1-\tau)r + \eta\rho \tag{23}$$

National Income Accounting:

$$Y = C + I + \gamma Y \tag{24}$$

Because of the requirement of fiscal solvency, we shall evaluate at γ=τ (balanced budget) in the steady-state analysis below.[9] Using human capital (17''), assets (22) and the growth rate (21), consumption (16) may finally be re-written as:

[8] This is, of course, a marginal propensity to spend out of lifetime income.

[9] The standard requirement for fiscal solvency is that the budget deficit, inclusive of interest payments, be constant (or, more generally, stationary) (Ahmed and Rogers, 1995; Trehan and Walsh, 1991). If we allow a primary budget imbalance (γ≠τ) in the steady state, this will imply a steady accumulation of government assets or liabilities, therefore interest payments will steadily rise, violating the solvency condition. Thus, a balanced budget is the only admissible assumption in the steady state.

$$C = \mathrm{B}\left((1-\tau)(1-m)YL^{-1} + (1-\tau)mY - I\right) \tag{25}$$

The second equality follows from replacing (R-r)K=gK via (21).[10]

In the steady state of a closed economy, consumption is a fraction of GDP. To ensure that this is the case, we must assume the following for employment:

$$L \in \left[\underline{L} \quad 1\right], \qquad \underline{L} \equiv \frac{1}{1+(1-\mathrm{B})\mathrm{B}^{-1}(1-\tau)^{-1}(1-m)^{-1}} < 1 \tag{26}$$

We readily have $\frac{\partial \underline{L}}{\partial m} < 0$.

3.2 The Spending ("Keynesian") Multiplier

At this stage, we turn attention to the Keynesian multiplier. It is instructive to begin with the New Keynesian multiplier as derived in the earlier static literature mentioned above. This can be obtained with a number of simplifications to our framework. Let government spending G be fixed, financed by lump-sum taxes, so that τ=0; let there be no investment (I=0); and, crucially, let the production technology be linear in labour, so that the marginal product of labour and real wage be fixed (as in this literature). Then, use the National Income Accounting Equation (18) to replace C in (25):

$$Y = cons\tan t + \mathrm{B}(mY - G) + G$$

The multiplier is readily given by:

$$0 < dY/dG = (1-\mathrm{B})/(1-\mathrm{B}m) < 1$$

It increases with the profit share (m) and the propensity to spend out of income (B). The less-than-unity size of this multiplier implies that private consumption falls in response to the fiscal expansion, a rather un-Keynesian proposition (Dixon, 1987). The multiplier in our case is derived shortly below; but it should be clear from the assumptions made to derive the standard multiplier, that the latter is given as a special case of our framework – with some important differences spelt out below.

To derive the multiplier in our case, let us keep productive services temporarily constant, so that variations in the output/capital ratio y are delivered solely from variations in labour. Substituting consumption out of (26) via National Income Accounting (25), dividing the resulting equation by K, and letting y≡Y/K, we obtain:

$$y(1-\gamma) = \mathrm{B}(1-\tau)y\left((1-m)L^{-1} + m\right) + g(1-\mathrm{B}) \tag{28}$$

Intertemporal optimisation allows us to endogenise investment, which depends on market size, g=η(ϕy-ρ). The multiplier is, evaluating at γ=τ:

$$\left.\frac{\partial y/y}{\partial \gamma}\right|_{Demand-side,\,\tau=\bar{\tau}} = \frac{1}{(1-\tau)\left(1-\mathrm{B}\left((1-m)L^{-1}+m\right)-\eta\phi(1-\mathrm{B})\right)} \tag{29}$$

The striking result that emerges here is that the denominator is negative (this is easy to check considering 28 and growth 21), implying that the multiplier does not converge. Intuitively, this result emerges since consumption is a fixed proportion of income, but the "marginal propensity to invest" out of a given market size (η(1-τ)ϕ) is higher than the "average propensity" to invest, (η(1-τ)ϕy-ρ)/y; hence, while the latter is just enough to bring about goods market equilibrium, the former

[10] (1-τ)mY-I would also be the net profit remitted to households from the alternative structure whereby capital belongs to firms; hence, this and our structure (where capital belongs to households) are equivalent.

results in a divergent spiral of demand and output expansion.[11] Naturally, output *will* converge after a fiscal expansion; the mechanism that ensures this is the adjustment of labour. For reference, the balanced-budget multiplier is,

$$\left.\frac{\partial y / y}{\partial \gamma}\right|_{Demand-side,\tau=\gamma} = \frac{1}{1-\tau}, \tag{29'}$$

implying that net private resources $\breve{y} \equiv (1-\gamma)y$ are left intact after the fiscal expansion; this represents a restoration of the textbook balanced-budget multiplier. Thus, endogenising investment through intertemporal optimisation strengthens the New Keynesian multiplier quite drastically. But the divergence of this multiplier highlights the need to consider a "reduced-form" multiplier, incorporating the supply side, too; we turn to this next. .

3.3 The supply-Side Multiplier

This multiplier describes the effects on output supply of an expansion in spending on productive public services. Defining net private resources again as $\breve{y} \equiv (1-\tau)y$, we can write the production function (20) as,

$$\breve{y} = (1-\tau)(\tau L)^{\Phi}, \tag{20'}$$

therefore we have the Barro (1990) *supply side multiplier (keeping labour constant)*:

$$\left.\frac{\partial \breve{y}}{\partial \tau}\right|_{Supply-side,\,fixedL} = -y + (1-\tau)\frac{\partial y}{\partial \tau} = -y + (1-\tau)y\Phi/\tau \tag{30}$$

Whereas (29') is uniformly positive, (30) exhibits the balance of two effects mentioned in the Introduction: A positive productivity effect and a negative incentive effect from taxation; it changes sign at $\tau^* \equiv 1-\phi$, from which point onwards the disincentive effect dominates the productivity effect of public services and the "supply multiplier" becomes negative. Thus, the plot of $(1-\tau)y$ against τ is Barro's (1990) hump-shaped curve. What reconciles (29) with (30) is, of course, endogenous labour supply: It is easy to see that demand (the RHS of 28) decreases in L, whereas supply depends positively on L, hence endogenous labour moves to equilibrate the two. This argument underpins the discussion below. We also expect that if $\tau<\tau^* \equiv 1-\phi$ and we are on the rising section of the hump mentioned above, a rise in government spending on public services will increase supply (see 30), and demand (see 29'), hence the movement of labour will depend on the relative size of the demand and supply multipliers. These arguments are made more precise below.

3.4 Model Solution

Introducing the production function (20) and the "Keynes-Ramsey" growth (21) into National Income Accounting (28), and collecting the $Y(1-\tau)$-C terms on the LHS, we get (making no distinction between γ and τ from now on):

$$LHS(L;\tau,m) \equiv \breve{y}\left\{1-\mathrm{B}\left((1-m)L^{-1}+m\right)\right\} \tag{28L}$$

$$RHS(L;\tau,m) \equiv \eta\left(\breve{y}\phi-\rho\right)(1-\mathrm{B}) \tag{28R}$$

[11] It is easily checked that the divergence may or may not emerge with more general functional forms for production. E.g., with CES production , $Y=((\phi K^{\psi})+(\phi(\tau Y)^{\psi})+((1-\phi)L)^{\psi})^{1/\psi}$, then growth is $g=\eta((1-\tau)\varphi\psi y^{1-\psi}-\rho)$, and the "marginal propensity" is $=\eta(1-\tau)\varphi\psi(1-\psi)y^{-\psi}$; the demand-output spiral converges if the latter is less than the former. But more general results are not available for our model with CES production functions.

Then, (28) can also be cast in terms of an excess supply function:

$$G(L;\tau,m) \equiv LHS(L;.) - RHS(L;.) =$$

$$= \breve{y}\left\{1 - \mathrm{B}\left((1-m)L^{-1} + m\right)\right\} - \eta(\breve{y}\phi - \rho)(1-\mathrm{B}) \qquad (28')$$

Net resources (the tax-adjusted output-capital ratio) is given from production function (20) as $\breve{y} \equiv (1-\tau)y = (1-\tau)(\tau L)^{\Phi}$. LHS(L;.) and RHS(L;.) are depicted in Figure 1 – with L^{Φ} on the horizontal axis. While RHS is obviously a straight line, it is readily seen that LHS is a convex function of L^{Φ}. Intuitively, the convexity is given by the fact that since the total wage bill is a fixed share of GDP depending on monopoly power (i.e., ωL=constantxY), the after-tax real wage that determines the value of the unit time endowment of each individual then depends on the hours of work (i.e., ω =constant x Y/L); [12] consumption therefore falls with L and excess supply rises. We are now in a position to state:

Proposition 1 - *Existence and uniqueness of equilibrium:*

(a) (28) admits a non-degenerate equilibrium, with L belonging to the interval in (27).
(b) The equilibrium is unique.
(c) The equilibrium is globally stable and unique.

Proof:

(a) Let the excess supply function G(L;.) be as in (28'). Obviously, G(L) is real-valued and continuous on $[\underline{L} \quad 1]$, which is compact. Using the production function (20) and the growth equation (21), it is also obvious that G(L) is bounded by:

Lower: $G(\underline{L}) = -y\tau - g < 0,$ (31L)

Upper: $G(1) \equiv (1-\eta\phi)(1-\tau)\tau^{\Phi}(1-\mathrm{B}) + \eta\rho(1-\mathrm{B})$ (>0) (31U)

By the intermediate value theorem (see e.g. Apostol, 1974, p. 85), existence is guaranteed if the condition $1>\eta\phi$ is satisfied; this would guarantee that the sign in parenthesis for the upper bound holds. The elasticity of intertemporal substitution η is commonly thought to be around unity, if not lower (Hall, 1988; King and Rebelo, 1999); the elasticity of capital in production ϕ must be bounded above by the profit share (as the latter also incorporates monopolistic profits), which is of the order of 0.35 (se e.g. Blanchard, 1997). Therefore, the condition is likely to be met in practice and the sign in parenthesis is the empirically plausible one.

(b) Given the signs of the bounds for G(.) and the monotonicity and slopes of LHS(.) and RHS(.) given above, a single geometric argument suggest uniqueness (refer to Figure 1).

(c) See the Appendix in the longer version, Tsoukis (2006).

[12] In Barro (1990), growth is entirely supply-side determined, with labour exogenous at L=1. In terms of Figure 1, the LHS is missing and growth is given by the RHS at L=1.

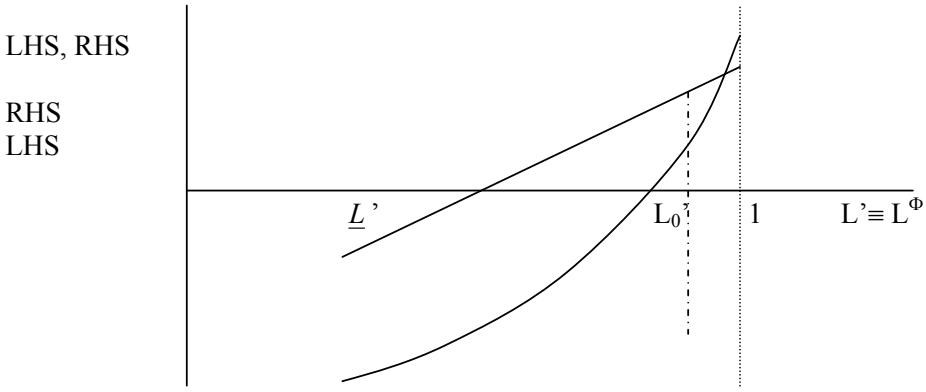

Figure 1 Single Geometric Argument

2.5 Comparative statics and the "reduced-form" multiplier

We next turn to determining how the steady state(s) respond (locally) to changes in the parameters of interest, the long-term tax/government spending rate τ, and the degree of monopoly power as proxied by m (monotonically connected to μ, as shown above). Since the conditions of the implicit function theorem are satisfied (in particular, since $\partial L_0/\partial L \neq 0$), we differentiate $G(L_0;\tau,m)=0$ with respect to L_0, τ and m and rearrange appropriately, to obtain:

To establish comparative statics, we find the following signs for the derivatives of G(.):

$$\frac{dG(L,y;\tau,m)}{dL} = (\breve{y}/L)\left\{\Phi(1-\eta\phi)(1-B)-(1-m)B\left(L^{-1}(\Phi-1)-\Phi\right)\right\}(>0) \qquad (32)$$

The equality follows from the production function (20'). It is easy to check that the above has the same sign as the following quantity:

$(\breve{y}/L)B(1-m)/\Phi-\eta\rho(1-B)$ (>0)

With a capital-output ratio of the order of 2.5 (Romer, 1989; King and Rebelo, 1999), Φ≥2, the size of government τ about 0.4, the intertemporal elasticity of substitution η≤1, labour of the order of 1/3, 1-m about 0.65 as mentioned above, and relative importance of leisure β a fraction (of that of consumption; note that (1-B)/B=β+(1-δ)), then the sign in parenthesis is the empirically relevant one.

The derivatives of G(.) wrt to the long-term tax /spending rate τ and the degree of monopoly power m are:

$$\frac{\partial G(.;.,m)}{\partial m} = \breve{y}B(L^{-1}-1) > 0 \qquad (33a)$$

$$\frac{\partial G(.;.,m)}{\partial B} = -\breve{y}\left(1+(L^{-1}-1)(1-m)\right)+g < 0 \qquad (33b)$$

The sign follows from the fact that $\breve{y}-g = C/K > 0$.

$$\frac{\partial G(.;\tau,.)}{\partial \tau} = \left[1-B\left((1-m)L^{-1}+m\right)-\eta\phi)(1-B)\right]\partial\breve{y}/\partial\tau \qquad (34)$$

Using (29) and (30), this may be expressed as:

$$\frac{\partial G(.;\tau,.)}{\partial \tau} = SM / DM \qquad (34')$$

$$SM \equiv -y + (1-\tau)y\Phi / \tau$$

$$DM \equiv 1 - B\left((1-m)L^{-1} + m\right) - \eta\phi)(1-B) < 0$$

In other words, SM is the "supply multiplier" (30), and DM the inverse of the (divergent) multiplier (29), ignoring the 1-τ multiplicative constant, which is negative.

Proposition 2 – *Effects on equilibrium labour supply:*

(a) $$\frac{dL_0}{dm} = -\frac{\partial G(L_0;m,\tau)}{\partial m} / \frac{\partial G(L_0;m,\tau)}{\partial L} \quad (<0)$$

(b) $$\frac{dL_0}{dB} = -\frac{\partial G(L_0;m,\tau)}{\partial B} / \frac{\partial G(L_0;m,\tau)}{\partial L} \quad (>0)$$

(c) $sgn\{dL_0/d\tau\} = sgn\{SM\} > (<) 0$, for $\tau < (>) \tau^*$

Proof:

(a) The sign follows readily from (32) and (33a); it is the empirically relevant one.

(b) Again, see (32) and (33b).

(c) From (33) and (34), we have,

$$\frac{dL_0}{d\tau} = -\frac{\partial G(L_0;m,\tau)}{\partial \tau} / \frac{\partial G(L_0;m,\tau)}{\partial L}. \qquad (35)$$

Furthermore, from (32) we have the empirically relevant sign $\frac{\partial G(L_0)}{\partial L} > 0$ and from (34') we have $\frac{\partial G}{\partial \tau} = \frac{SM}{DM}$. The result follows noting that DM<0, whereas SM > (<) 0 for $\tau < (>) \tau^*$ - see (30). □

The effects of monopoly power on the multiplier have been discussed fairly extensively in the New Keynesian literature mentioned in the Introduction. In that literature, monopoly power raises consumption because it enhances profits and dividends, while the real wage is equalised to a constant marginal cost. Here, monopoly power raises the profit share in output, but reduces the real wage (a declining labour share, divided by labour). The latter effect dominates (since $\omega L=(1-m)Y$, and L is a fraction), so that a rise in m generates an excess supply (locally around L_0), which induces a fall in employment. We also have that the marginal propensity to consume (B) affects positively employment, for a reason that is the flip side of the above. As a corollary, we also have that the "Joneses effect" (δ) also increases labour supply: the attempt to keep up with the others increases the marginal utility of consumption and therefore labour supply.

We also see that the effect of government size/tax rate on labour mirrors the Barro (1990) hump-shaped curve: When the size of government is below the critical value τ*, any rise in spending and public services generates an increase in labour; beyond that level, further increases in the tax and spending rate decrease labour. This is because, at any $\tau<\tau^*$, the productivity effect on the real/wage opportunity cost is stronger than the effect via the tax disincentive, so that an increase in productive public spending increases the net-of-tax real wage, prompting a decline in leisure.

The supply-side multiplier (30) above was derived under the assumption of fixed labour (specifically at L=1, as in Barro, 1990). We can now relax this, and allow labour to change in order to balance the demand and supply sides. We thus obtain a *reduced-form multiplier*:

$$\left.\frac{d\breve{y}}{d\tau}\right|_{Reduced-form} = \left.\frac{\partial\breve{y}}{\partial\tau}\right|_{Supply-side,\,fixedL} + \frac{\partial\breve{y}}{\partial L_0}\frac{dL_0}{d\tau} \qquad (36)$$

(36) may be thought of as a synthetic multiplier in the sense that it combines both supply-side and demand-side (via L) effects of government spending/taxation. But Proposition (2b) establishes that equilibrium L and τ are inversely related, and that $dL_0/d\tau|_{\tau=\tau^*}$; specifically, using (34'), (35), and the production function, we have:

$$\left.\frac{d\breve{y}}{d\tau}\right|_{Reduced-form} = \left.\frac{\partial\breve{y}}{\partial\tau}\right|_{Supply-side,\,fixedL}\left(1-\Phi\breve{y}L^{-1}DM^{-1}/(\partial G/\partial L)\right)$$

By the sign of DM (<0) and with the derivative in (32) (plausibly positive), we have that:

$$\left.\frac{d\breve{y}}{d\tau}\right|_{Reduced-form} \geq \left.\frac{\partial\breve{y}}{\partial\tau}\right|_{Supply-side,\,fixedL},$$

$$\operatorname{sgn}\left.\frac{d\breve{y}}{d\tau}\right|_{Reduced-form} = \operatorname{sgn}\left.\frac{\partial\breve{y}}{\partial\tau}\right|_{Supply-side,\,fixedL}$$

with equality at $\tau=\tau^*$. These further suggest a simple relation between the associated two frontiers, as follows:

Proposition 3: *Relation between the reduced-form and the supply-side, fixed L multipliers:*
There exists a simple envelope relation between the net resources frontiers arising out of the supply side ($\breve{y}(\tau;Lfixed)$, see Barro, 1990), and the demand and supply sides combined ($\breve{y}(\tau;L)$): the latter envelopes the former, with equality at $\tau=\tau^*$.

Proposition 3 is depicted in the following graph:

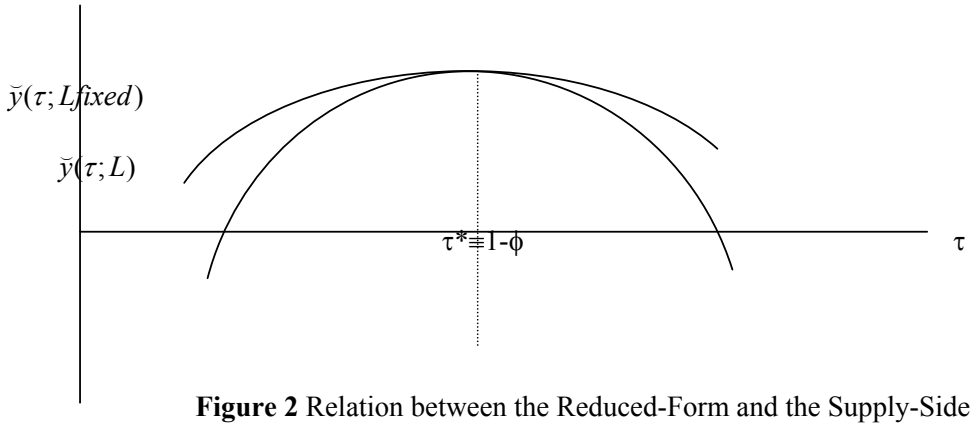

Figure 2 Relation between the Reduced-Form and the Supply-Side

Intuitively, at $\tau<\tau^*$, we have an improvement in production with increases in τ; this is reflected on a more-than-proportion rise in demand, and an increase in labour to meet it. The sign of this effect changes at $\tau>\tau^*$, from which point onwards further rises decrease the demand. In other words, the overall shape of Barro's (1990) hump-shaped curve of net-of-tax output against the size of government is qualitatively unaltered; the size of government $\tau^*\equiv 1-\phi$ is shown to be critical for demand expansions as well, and may be called the *efficient* size of government. Quantitatively, the effect of a rise in τ is stronger (if $\tau<\tau^*$) with endogenous labour because of the faster rise in demand than supply; signs change the other side of τ^* but the effect is numerically stronger again. This

result must be added to the toolkit of "Barro (1990)-related results" reviewed in Miller and Tsoukis (2003); it suggests that there are potentially non-linear effects of fiscal expansions, the effects depending on whether the size of government is below or above the efficient level. This non-linearity may be able to explain some apparently dissonant results, like the negative results of Alesina *et al*. (2000) versus the general consensus of expansionary effects of fiscal policy; some results on expansionary fiscal contractions; and the general disparity between empirical estimates. Our results suggest that the size, and even sign, of any multiplier critically depends on the size of government in relation to the efficient size. Hence, the synthesis of demand and supply sides that this paper introduces arguably yields valuable new insights.

Finally, since the growth rate is $g = \eta(\breve{y}\phi - \rho)$, Proposition 4 immediately implies:

Proposition 4: *The growth rate in the decentralised equilibrium is maximised at the Barro (1990) benchmark of* $\tau=\phi$.

3. Welfare

Finally, we are in a position to evaluate changes on societal welfare (under the maintained framework of decentralised equilibrium), generated by the share of productive public services in GDP. We continue to assume a balanced budget, so that γ=τ, and we utilise the utilitarian welfare criterion. Evaluating at the steady state, and because of symmetry and unit mass of consumers, welfare may be written as:

$$\overline{U}_0 \equiv \int_0^{\infty} e^{-\rho s} \frac{U^{1-1/\eta}}{1-1/\eta} ds = \frac{\left((1-\delta)K_0(C/K)(1-L)^{\beta}\right)^{1-1/\eta}}{(\rho - g(1-1/\eta))(1-1/\eta)}$$

The strategy here is to index consumption on the predetermined (therefore, historically given) initial capital, which is to normalised to unity, K_0=1. Therefore, letting x indicate any parameter of interest,

$$\frac{\partial \overline{U}_0 / \overline{U}_0}{\partial x} \frac{1}{1-1/\eta} = \frac{\partial (C/K)/\partial x}{C/K} - \frac{\beta \partial L/\partial x}{1-L} + \frac{\partial g/\partial x}{(\rho - g(1-1/\eta))}$$

From NIA, Y(1-τ)=C+I, therefore, $C/K = \breve{y} - g = \breve{y}(1-\eta\phi) + \eta\rho$, and it is reminded that $g = \eta\phi\breve{y} - \eta\rho \equiv (1-\tau)\eta\phi(\tau L)^{\Phi} - \eta\rho$, hence $\breve{y}$ and g are positively related. Thus, the previous expression is written as:

$$\frac{\partial \overline{U}_0 / \overline{U}_0}{\partial x} \frac{1}{1-1/\eta} = \frac{(1-\eta\phi)\partial \breve{y}/\partial x}{C/K} - \frac{\beta \partial L/\partial x}{1-L} + \frac{\eta\phi \partial \breve{y}/\partial x}{(\rho - g(1-1/\eta))}$$

It is furthermore reminded that monopoly power m decreases employment ($d\breve{y}/dm < 0$, see Proposition 2a) and the growth rate, while the effect of the share of productive public spending on employment is given by Proposition 2b. The total effect on welfare is not clear, because the conflicting effects of both parameters on leisure, employment, growth and the C/K ratio. We proceed to evaluate the derivative with respect to τ at τ=τ*. It is reminded that $\breve{y} \equiv (1-\tau)(\tau L)^{\Phi}$, therefore $\left.\frac{d\breve{y}}{d\tau}\right|_{\tau=\tau^*} = \frac{\partial \breve{y}}{\partial L}\frac{\partial L}{\partial \tau} = \Phi \frac{\breve{y}}{L}\frac{\partial L}{\partial \tau}$, as SM=0 at this point, and $d\breve{y}/dm = (\partial \breve{y}/\partial L)(\partial L/\partial m)$. Also, $C/K = \breve{y} - g = \breve{y}(1-\eta\phi) + \eta\rho$. Inserting all this information above, we have:

$$\frac{\partial \overline{U}_0 / \overline{U}_0}{\partial x}\frac{1}{1-1/\eta} = \left(\Phi \frac{(1-\eta\phi)\breve{y}/L}{(1-\eta\phi)\breve{y}+\eta\rho} - \frac{\beta}{1-L} + \Phi \frac{\eta\phi\breve{y}/L}{(\rho - g(1-1/\eta))} \right) \partial L/\partial x$$
$$x=m,\tau|\tau=\tau^*$$

Thus, the sign of the expression in brackets will be clearly positive at least if $\Phi \frac{(1-\eta\phi)\breve{y}}{(1-\eta\phi)\breve{y}+\eta\rho} - \frac{\beta L}{1-L} > 0$. Given empirically plausible values of (in decreasing order of importance for the argument):

- The elasticity of capital in production $\phi < 0.5$, so that $\Phi \equiv (1-\phi)/\phi > 1$;
- An output-to-capital ratio of about 2.5 to 3 (Romer, 1989) and a government spending/tax rate of about 0.40 (Tanzi and Schuknecht, 1997);
- A share of capital of about m=1/3;
- Labour of the order of 1/3 of the total time endowment, so that the labour-to-leisure ratio being of the order of 1/2;
- A rate of time preference of $\rho=0.01$ (in continuous time); the maintained hypothesis of the elasticity of interetemporal substitution of $\eta \leq 1$; and less importantly: the elasticity of consumption in utility of $\beta=1$ (for want of any better estimate, but the argument that follows is not particularly sensitive to this hypothesis).

Under these empirically plausible conditions, we have:

$$\text{sgn}\{\partial \overline{U}_0 / \partial x\} = \text{sgn}\{\partial L / \partial x\} \quad (37)$$

It is worth pointing out that the effects of a rise in the "Joneses" effect are ambiguous: it will increase output and consumption, but it will also decrease leisure, and it will decrease utility out of any given consumption level. We can summarise:

Proposition 5: *Effects of monopoly power and of the tax/productive government spending rate evaluated at the Barro (1990) benchmark:*

(a) Increasing monopoly power (m) harms welfare; this follows from (37) and Proposition 2a;
(b) The effect of a rise in the tax/productive government spending rate on welfare is qualitatively the same as the effect on labour supply; see (37) and Proposition 2b.

This

Furthermore, we also have a corollary:

Corollary: *On the optimality of the Barro (1990) tax/public spending rate ($\tau^* \equiv 1-\phi$) for welfare in decentralised equilibrium in the steady state:*

The tax/spending rate $\tau \equiv 1-\phi$ also maximises welfare in a model of endogenous labour supply and monopolistic competition, when the steady state of decentralised equilibrium is considered. This is so as the effect on labour also vanishes at this point; see Proposition 2b.

5. Conclusion

This paper provides a synthesis between the static, imperfect competition-related analysis of the fiscal multiplier associated with the New Keynesian literature, the intertemporal optimisation approach to fiscal policy, and the analysis of optimal productive public spending in relation to growth. Notable features of our model are monopolistic competition in the product market, "keeping up with the Joneses" behaviour by households, endogenous labour supply, and endogenous growth generated by productive public services supplementing private capital in production. Our main aim, and result, is to develop the Keynesian multiplier in this setup; in particular, to introduce two extensions to the static literature and study their effects: profits that affect investment as well as consumption, and a variable real wage that affects the virtuous circle of income-demand-income, as in the standard textbook case. Thus, the model provides an integrated demand-and-supply analysis of both the multiplier and growth, a task not attempted so far in the literature.

We show that the reduced-form multiplier, the labour supply, and the growth rate present the same (but steeper) hump-shaped curve against the government size (rate of productive public services in GDP and flat income tax rate) as the one identified by Barro (1990). In particular, the graph of the multiplier against the tax/spending rate is enveloped by the graph of the growth rate. The rate of growth and welfare (under Cobb-Douglas preferences) are maximised at the tax/spending rate that equals the elasticity of public services in production. We also show that the "keeping up with the Joneses" effect increases employment and growth (though its effects on welfare are ambiguous), while monopoly power harms employment, growth and welfare.

In conclusion, the main result remains the derivation of the (hump-shaped) multiplier and growth rate when the demand and supply sides are integrated. The significance of these findings is dual: the Barro (1990) tax/spending rate continues to be an important benchmark for the optimal size of government; and the Keynesian multiplier is non-linear and changes sign at this point. Thus, fiscal expansion may be contractionary if the size of government is greater than optimal. This may be important in understanding such empirical findings as some documented adverse effects of fiscal expansions (e.g. in Alesina *et al*., 2000) and "expansionary fiscal contractions" (see e.g. Giavazzi and Pagano, 1990; Giavazzi, Jappelli and Pagano, 2000) and further suggest introducing the size of government as a control in such empirical work.

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Appendix A: Dynamics under Symmetry

We now turn to the dynamics. The dual aim is first, to establish its dynamic properties; and second, to compare the short- to the long-run responses of variables to various types of shock. For tractability, we confine attention to the case of symmetry (so that C_i=C for all i). We continue to adhere to the convention that lower-case letters indicate logs; and that hats indicate deviations from the steady state (it should be clear from the context and the narrative whether the deviations are in logs or levels). The key equations are now the following:

Optimality conditions (4), and (6) combined with (2) yield:

$$(1+1/\eta)\dot{c}+(\beta/\eta)d\log(1-L)/dt=(1-\tau)r-\rho \quad (38)$$

(5), (6) with (2) also yield:

$$\dot{c}/\eta+(1+\beta/\eta)d\log(1-L)/dt=(1-\tau)r-\rho-\dot{\omega} \quad (39)$$

From the production function, $y=(\tau L)^{\Phi}$, $\Phi\equiv(1-\phi)/\phi$, we get after log-differentiating:

$$\Phi\hat{L}=\hat{y} \quad (20'')$$

Labour's share is given by,

$\omega L=(1-m)Y$,

and upon time-differentiation and using the production function (20'') - remembering $y\equiv Y/K$:

$$d\log\omega/dt=-\dot{l}+\dot{y}+\hat{g}=(1-1/\Phi)\dot{y}+\hat{g} \quad (40)$$

For reference, the proportionality between leisure and labour is,

$\omega\beta(1-L)=C$,

therefore we have,

$\log(1-L)=\log(CL/Y)-\log(\beta(1-m))$. (41)

Furthermore, from National Income Accounting, we have that $Y_t(1-\gamma_t)=I_t+C_t$, where γ_t is the share of government expenditures in GDP. As mentioned, such expenditures are assumed to be equal to total tax revenue in the long run, so that government remains solvent. We now introduce the possibility of (counter-) cyclical primary budget deficits;[13] such deficits average out over the cycle, so that any effect they may have on public debt is assumed to grow at a rate which is less than the tax-adjusted real interest rate. Hence, the relevant transversality condition is satisfied and public debt is sustainable. For concreteness, let a simple fiscal rule be followed, whereby the primary deficit (γ-τ) is linked inversely to the output gap $(\hat{Y}/Y)$, with the variation arising only from the expenditures side, so that:

$$\gamma_t=\tau+\hat{\gamma}_t\equiv\tau-\Gamma(\hat{y}_t+\hat{k}_t)\ ,\quad \Gamma>0$$

while $\bar{\gamma}_t=\tau$. $\Gamma>0$ is an index of the degree of activism in fiscal policy for stabilisation purposes. In the sequel, our aim it establish the effects of a higher Γ (more fiscal activism) on the properties of the system. Since investment and government expenditures together do not typically account for more than 40% of GDP, dividing through by K, we can reasonably well approximate the NIA equation by taking log deviations as:

$$(1+\Gamma)\hat{y}=\hat{c}-(1+\Gamma)\hat{k}+\overline{(K/C)}\hat{g}$$

[13] While the long-term component of public expenditure (τ% of GDP) is assumed to be entirely productivity-enhancing, we are also assuming for simplicity that the cyclical (deficit-financed) component γ_t-τ is entirely wasteful – neither productivity, nor utility-enhancing. Hence, it is a pure aggregate demand policy.

Time-differentiating, we get the NIA equation in differential form:

$$\dot{c} = (1+\Gamma)(\dot{y}+\hat{g}) - \overline{(K/C)}\dot{g} \qquad (42)$$

$\overline{K/C}$ is the steady-state capital-consumption ratio. System (38) to (42) involves 5 variables, y, L, w, c and g. To reduce the dimensions to an analytically manageable 2 x 2, we proceed as follows:

Insert the production function (20"), the interest rate rule r=ϕY/K and NIA in differential form (42) into (38) to get in deviations form:

$$(1+1/\eta)\left((1+\Gamma)(\dot{y}+\hat{g}) - \overline{(K/C)}\dot{g}\right) + \left(\overline{L}\beta/\eta\Phi(1-\overline{L})\right)\dot{y} = \eta\phi\bar{y}\hat{y} \qquad (43)$$

Moreover, essentially the same procedure applied to (39) with the addition of the labour share (40), yields:

$$\eta^{-1}\left((1+\Gamma)(\dot{y}+\hat{g}) - \overline{(K/C)}\dot{g}\right) + \left((1+\beta/\eta)(\overline{L}/\Phi(1-\overline{L})\right)\dot{y} = -(1-1/\Phi)\dot{y} - \hat{g} + \eta\phi\bar{y}\hat{y} \qquad (44)$$

Subtracting (44) from (43), we get:

$$(1+\Gamma)(\dot{y}+\hat{g}) - \overline{(K/C)}\dot{g} - \lambda\dot{y} = (1-1/\Phi)\dot{y} + \hat{g} \qquad (45)$$

$$\lambda \equiv \overline{L}\Phi^{-1}(1-\overline{L})^{-1}$$

(This is nothing but (41) in differential form.) We now have a 2x2 system ((43) and (45) - in that order) in y and g. We consolidate the system in matrix form as follows:

$$\begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix}\begin{bmatrix} \dot{g} \\ \dot{y} \end{bmatrix} = \begin{bmatrix} b_{11} & b_{12} \\ b_{21} & 0 \end{bmatrix}\begin{bmatrix} g \\ y \end{bmatrix} \qquad (46)$$

$$a_{11} \equiv -(1+1/\eta)\overline{(K/C)} < 0$$

$$a_{12} \equiv (1+1/\eta)(1+\Gamma) + \left(\overline{L}\beta/\eta\Phi(1-\overline{L})\right) > 0$$

$$a_{21} \equiv -\overline{(K/C)} < 0$$

$$a_{22} \equiv -\lambda + \Gamma + 1/\Phi = +\Gamma(1-2\overline{L})(1-\overline{L})^{-1}\Phi^{-1}(<)0$$

The sign in parenthesis follows from the empirically relevant case of the elasticity of capital in production being no more than 1/3, in which case Φ>1, for labour of the order of 1/3 so that 1-2L>0, and for sufficiently weak stabilisation (in the vicinity of the benchmark of Γ=0).

$$b_{11} \equiv -(1+1/\eta)(1+\Gamma) < 0, \qquad b_{12} \equiv \eta\phi\bar{y} > 0, \qquad b_{21} \equiv -\Gamma < 0$$

We now proceed to characterise the comparative dynamics. Rearranging the system above we have:

$$\begin{bmatrix} \dot{g} \\ \dot{y} \end{bmatrix} = d^{-1}\begin{bmatrix} b_{11}a_{22} - b_{21}a_{12} & b_{12}a_{22} \\ -b_{11}a_{21} + b_{21}a_{11} & -b_{12}a_{21} \end{bmatrix}\begin{bmatrix} g \\ y \end{bmatrix} \qquad (46')$$

where

. $d \equiv a_{11}a_{22} - a_{21}a_{12} > 0$

The sign of the above determinant is unambiguous. The determinant of the matrix on the RHS is:

$$D \equiv b_{21}b_{12}(a_{12}a_{21} - a_{11}a_{22})/d = -b_{21}b_{12} > 0$$

The positive sign implies two roots of the same sign; to ascertain their sign, we write the formula for the eigenvalues as,

$$2\psi = T \pm \left(T^2 - 4D\right)^{1/2},$$

where T is the trace of the matrix on the RHS of (46'); it can easily be checked that T>0; D is as above. Under the assumption of $T^2>4D$, ruling out oscillations, it follows unambiguously that $T_{1,2}>0$. Since both g (a rate of growth - of capital) and labour are "jump" variables (non-predetermined), the requirements of Blanchard and Khan (1980) are fulfilled for determinacy and uniqueness of the dynamic path. In fact, there is no adjustment at all, and the system attains its new equilibrium value instantaneously. The role of countercyclical fiscal policy should be noted in this respect: The signs derived above depend critically on $\Gamma>0$ and $b_{21}<0$.

The Effectiveness of Managers' Leadership Styles: A Case Study from Retail Tyre Companies in Thailand

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Abstract

This paper examines leadership styles and organisational effectiveness, and discusses which styles of leadership are supportive to business. The research sampled 140 managers by survey questionnaire; in analysing the data, the statistical technique of hierarchical multiple regression was applied. Results show that leadership styles do have an influence on organisational effectiveness.

1. Introduction

Competition in the global economy is complex. Business requires managers who can make an impact by competing successfully in the context of globalisation (Hagen and Lodha, 2004). Scholars have proposed the concept of organisational learning to enhance organisational effectiveness (Neuendorf, 2002; Szarka et al., 2004), in which managers encourage a learning environment within their organisations; knowledge needs to be shared at every level of the organisation. In addition, in small firms, managers are the key persons in making day-to-day decisions, and they are found to be the most important drivers of success in enabling firms to achieve their oranisational goals (Arnold et al., 2008; Coffey and Atkinson, 1996; Miguel et al., 2004; Netemeyer and Maxham, 2007; Payne et al., 2005; Pelham and Lieb, 2004). It appears that the decisiveness of the manager is an essential contribution towards organisational success (Elbanna and Child, 2007).

In particular, managers are instrumental in creating an organisational ethos of learning for each member of the organisation (Martin et al., 1998, cited in Mabey, 2004). Furthermore,

establishing and sharing a company ethos and culture is seen as a desirable outcome for organisational success. One reason for this is that attempting to secure the best from employees through direct supervision is at best costly and often simply unattainable (Michie and Oughton, 2003). Several researchers have emphasised that leadership is most significant in organisations seeking to transform themselves through organisational learning (Daft, 2000). Handy (1995) supposed that managers play an important role in conveying knowledge and encouraging a learning environment in the organisation. Similarly, Senge (2006) said that the sort of changes needed in the creation of organisational learning are extremely challenging and would need "real leadership".

More specifically, scholars have indicated that leadership and performance are two important and interrelated variables contributing to organisational effectiveness and thus there is a critical need to examine this relationship (Hadikin and O'Driscoll, 2000; Tepper, 2000, cited in Harris et al., 2007). As such, leadership may be seen as part of a learning process that takes place through carrying out day-to-day responsibilities and in turn influences organisational effectiveness. Hence, applying appropriate Leadership Styles may help to transfer and encourage learning in the organisation and this would lead to improving employees' skills, which in turn could improve organisational effectiveness overall.

The aim of this research was to investigate which types of management leadership style are supportive to the company. Retail tyre firms in north east Thailand were used as a case study. The paper is organised as follows: a discussion of related work is followed by an explanation of the research methodology. The results are given and discussed in the two next sections, supported by statistical evidence in the appendix. The conclusion addresses the limitations of the research, and suggests future directions.

2. Related Work

2.1 Organisational Effectiveness

Organisational learning plays a vital role in sustaining the company and achieving its organisational goals, which in turn leads to superior organisational effectiveness. Thus, many authors consider learning to be a fundamental aspect of competitiveness and link it with knowledge acquisition and organisational effectiveness (Lopez et al., 2005). Scholars seek to show how knowledge can improve organisational effectiveness, and they believe that the organisation should create a learning environment to encourage members to continue to learn. In pursuit of the development of learning in the organisation, Clarke (1999, cited in Mabey, 2002) proposed that the capability of the manager to support members of the organisation should not be underestimated, including encouragement of appropriate learning in a way which is productive corporately and individually (Mabey, 2002).

Correspondingly, Beaver and Jennings (2001) suggested that the manager in the small firm is in the best position to make the learning environment happen. In each small firm, the manager may have varied perspectives, so the goals will be at different levels. Grunburg (2004) and Wall et al. (2004) suggested that subjective and objective measures are important factors in measuring organisational effectiveness, dependent on the goals of each organisation. Objective measures can be considered in different categories, such as profit, sale volume, market share, and return on investment, while subjective measurement depends on the perceptions of managers.

De Hoogh et al. (2004) studied small and medium sized enterprises in the Netherlands, examining the relationship between leadership and organisational effectiveness; they focused on the

objective measure of financial performance, comprising profitability, liquidity and solvency. They found that leadership is positively related to profitability but unrelated to liquidity and solvency.

Swinney et al. (2006) considered the association between managers' levels of education, gender and organisational effectiveness and focused on subjective measures obtained from managers' perception. Results indicated that level of education and the gender of the managers interact to have an impact on organisational effectiveness. Wang and Ang (2004) applied subjective or self-reported measures in three dimensions: growth in market share, growth in cash flow, and growth in sales, to investigate how to develop firms' performance. Questionnaires were distributed to local firms in Singapore. They found that there is a significant correlation between environment, resource-based capabilities, strategy, and venture capital in a firm's involvement and performance.

Ardichvili (2001) studied the relationship between leadership styles of entrepreneurs and managers in three large manufacturing companies in Russia. Three subjective measures were used: satisfaction (satisfaction with the managers' leadership styles), extra effort (the extent to which managers were able to elevate employees' motivation beyond their initial expectations), and effectiveness (effectiveness in meeting employees' needs). Results indicated that there is a significant difference between entrepreneurs and managers in all three leadership styles (Transformational, Transactional, and Laissez-faire leadership) and subjective measures.

Similarly, Wall et al. (2004) suggest that it is valid to use different aspects of subjective data; however, researchers need to take care in data collection. Generally, financial records are confidential and most firms are unwilling to provide these kind of data, so some researchers have asked respondents to rate the performance of their organisation by using a rating scale which compares them with other competitors in their business sector (Love et al., 2002; Pett and Wolff, 2007; Wiklund and Shepherd, 2005). In support of the previous concept, Oliver (1997, cited in Eskilden and Kristensen, 2006) suggests that organisational effectiveness can be typically evaluated on a rating scale whereas importance can be either rated by the respondents or estimated on the basis of performance. Similarly, research to date has used both objective and subjective indicators, the results showing that both approaches have been highly correlated or equal (see, for example, Dess and Robinson, 1984, cited in Pelham and Lieb, 2004; Garg et al., 2003, cited in Ghobadian and O'Regan, 2006; Guest et al., 2003; Jennings and Young, 1990; Wall et al., 2004).

However, one may question whether the self-reported measures may be biased for measuring organisational effectiveness. Yeung and Berman highlighted that 'a weak measure on the right issue is better than a strong measure on the wrong issue' (Yeung and Berman, 1997, cited in Mabey and Ramirez, 2005). Nevertheless, the literature suggests that responses on performance achievements are reliable (Nayyar, 1992; Tan and Litschert, 1994, cited in Ghobadian and O'Regan, 2006). Hence, it appears that to understand the organisational effectiveness of each firm, gathering data using a rating scale from the manager is also an effective form of measurement.

In conclusion, organisational effectiveness can be measured on a variety of dimensions and no single measurement completely describes all aspects of effectiveness. In line with Walton and Aerts (2006), financial performance is an appropriate way to measure the basic overall performance of each firm against others within the same business area. Due to the nature of small business, the manager plays a vital role in determining the creation and development of the organisation (Bellas, 2004). Also, as suggested by Oliver (1997, cited in Eskilden and Kristensen, 2006) organisational effectiveness can be typically evaluated on a rating scale whereas importance can be either rated by the respondents or estimated on the basis of performance. It appears that to understand the organisational effectiveness of each firm, gathering data by using a rating scale from the manager

can be an effective form of measurement. Therefore, in this study, the managers of each firm were asked to evaluate their financial performance compared with other firms in their sector.

2.2 Leadership Styles

It is widely accepted that the manager, as leader, plays a key part in ensuring organisational learning takes place. Highlighting this key role, Senge (2006, p. 321) asserted that "the neglected leadership role is that of the designer of the ship; no one has a more sweeping influence on the ship than the designer". Leaders also face the task of developing and sustaining fundamental change in order to encourage learning in the organisation. Daft (2000) suggests that the leader's role in the process of organisational learning can be divided into three distinct roles: to create and share vision; to design an appropriate horizontal structure to help to achieve this vision; and to act as "servant leaders"; servant leadership facilitates the growth, goals, and empowerment of followers. Additionally, research has suggested that transformational forms of leadership are particularly important in promoting organisational learning (Bass 1985b; Bass and Avolio, 1989, cited in Gleue, 2002).

It has been suggested that the *transformational leadership* approach is more effective than others in creating change in an organisation compared with *transactional leadership*. In recent literature, Bass and Avolio are widely acknowledged for developing these new leadership concepts. According to (Bryman, 1999, p. 31), their basic ideas are heavily influenced by Burn's (1978) work. Burn believed that transactional leadership is more common place than is transformational leadership, if less dramatic in its consequences. Bass (1985) however, further developed the concepts of transactional and transformational leadership. He established them as two separate theories and distinguished the different features for transformational and transactional leadership (Judge and Piccolo, 2004).

Bass (1985b) proposed that transformational leaders are likely to make their employees trust, respect, and admire them by focusing on idealised influence, individualised consideration and inspirational motivation, which in turn, implies serving as a charismatic role model and expressing a vision that could be created. It also suggests a need for intellectual stimulation, defined as questioning old assumptions and the status quo (Avolio and Bass, 1995, cited in Hetland and Sandal, 2003). This leadership style describes the managers who tend to focus on higher motivation development and motivate the subordinate's motivation by inspiring vision of the future (Bass, 1997, cited in Jens and Kathrin, 2007).

Elaborating further, transformational leadership theory could be considered a form of behavioural theory. It is based on the premise that leadership could be learned (Bass, 1998, cited in Hetland and Sandal, 2003). More importantly, there is substantial evidence indicating that transformational leadership helps to increase higher levels of individual performance (Avolio and Yamamario, 2002; Bass, 1985b, 1990, cited in Dionne et al., 2004a). For example, Hater and Bass, (1988, cited in Judge and Piccolo, 2004) found that managers at Federal Express who were rated as transformational received higher performance evaluation. However, Yukl (1999) argued that Bass and Avolio's leadership theory would be stronger if the essential influence processes were identified more clearly and used to explain how each type of behaviour affects each type of mediating variable and outcome.

Compared to transformational leadership approach, transactional leadership is recognised as the traditional management function of leading (Bass, 1985a, cited in Daft, 2000). There are three key dimensions making up transactional leadership namely contingent rewards, management by

exception-active and management by exception-passive. Contingent rewards refer to the degree to which the leader sets up constructive transactions or exchanges with subordinates. Transactional leadership clarifies expectations and establishes the rewards for meeting these expectations. On the other hand, management by exception-active refers to managers who monitor subordinates' behaviour, anticipate problems and take corrective actions before the behaviour creates serious difficulties. In contrast, management by exception-passive means that the managers will take action when the behaviours of their subordinates have already produced problems (Judge and Piccolo, 2004).

Managers who have this leadership style are less likely to support their employees in terms of developing their skills. Instead they prefer to provide appropriate rewards and focus on clarifying the role and task requirements of employees and initiate structure (Kuhert, 1994). These attributes of transactional leadership could lead to an increase in organisational effectiveness as researchers have also suggested that managers with this leadership style are likely to be diligent and broadminded. They are more concerned with the efficiency of the tasks than building members' abilities. They often stress the impersonal aspects of performance such as plans, schedules and budgets. They also tend to follow the organisational norms and values (Daft, 2000). Nonetheless, some studies have found both positive and negative correlations between transactional leadership and performance (Geyer and Steyrer, 1998; Howell et al., 2005, cited in Jens and Kathrin, 2007).

In comparison to transformational and transactional leadership, *laissez-faire* or non-leadership describes managers who are neither task oriented nor people oriented. They let their subordinates work on their own. They avoid making decisions, often hesitating to take action and are more likely to be absent when needed. Laissez-faire leadership is also related to management by exception-passive leadership (Judge and Piccolo, 2004). It appears that they are not highly motivated, their power only comes from their position in the organisation but they are less likely to carry out their responsibilities. Almost inevitably, laissez-faire leadership is likely to result in damaging consequences for the working environment, health and well-being of employees (Corrigan et al., 2000, cited in Hetland and Sandal, 2003).

To conclude, Bass and Avolio's approach to leadership is arguably one of the most prominent theories in contemporary research. It provides much insight into how to create change and sustain organisational learning for the entire organisation (Avolio, 1999, cited in Brown and Keeping, 2005; Judge and Bono, 2000, cited in Shin and Jing, 2007; Bass 1985b; Bass and Avolio, 1989, cited in Gleue, 2002). Although a number of scholars have claimed that leadership is positively related to organisational effectiveness, the interplay between leadership and diversity remains largely unexplored (Jackson et al., 2003, cited in Shin and Jing, 2007, p. 812). Kristy et al. (2007) have suggested that the demographics of managers also need to be studied in relation to leadership. To a large extent, the leadership style which is supportive to this particular business is in need of further investigation. Taking into account the various strengths and limitations of previous research into leadership styles, this study attempts to incorporate Bass and Avolio's leadership theory specifically and study its relationship to organisational effectiveness.

3. Research Methodology

"The majority of managers are familiar with the deductive approach so that those managers or policy-makers tend to put faith in the conclusions emanating from this approach" (Saunders et al., 2003). Data collection methods used in this study included survey questionnaires; the data were subjected to multiple regression analysis.

The purpose of this study is to explore the effective attributes of managers in terms of leadership styles which may impact organisational effectiveness. Tyre firms in Thailand were selected as the unit of study. A quantitative approach was applied to study the relationship of the variables in the context of this business.

3.1 Sample and Data Collection

The research sample consisted of 140 service retail managers in Thailand. The data were collected by survey questionnaire. Prior to conducting the questionnaire, telephone calls were made to arrange the time and to ascertain that these managers were willing to participate in this survey. Respondents were assured of the confidentiality of their answers.

Questionnaires were distributed to managers of tyre firms in north east Thailand. This area was chosen to study because it is the most densely populated region with approximately 21,386,000 people (Thai Ministry of Transportation, 2008). A total of one hundred and forty completed questionnaires were received, representing a response rate of 63.6%. As Cole et al. (1997, cited in Ames, 2003) suggest that mail surveys are expected to have response rates of 11 to 15%, this was considered more than satisfactory. To ensure reliability and validity, a pilot study was tested before conducting the actual questionnaire.

The questionnaire was composed of three sections, to collect data on demographics, leadership style and organisational effectiveness. The first section comprised questions relating to gender, age, education, experience; the second section used a 0-4 Likert scale where 0 was "Never" and 4 "Always". In the third section, managers were asked to evaluate their company's financial performance by providing a percentage score against other firms in their sector.

3.2 Reliability and Validity

The most frequently used method for calculating internal consistency is Cronbach's coefficient alpha (Saunders et al., 2003, p. 310), which was applied to ensure the level of reliability (see appendix, Tables 1 to 6). The results indicated that Transformational Leadership is equivalent to 0.851, Transactional to 0.864, and Laissez-faire to 0.836. Therefore, we found that the levels of Cronbach's coefficient alpha for both learning and leadership styles are acceptable for an attitude scale.

Balnaves and Caputi (2001) propose three main kinds of validity: construct, internal and external validity. Construct validity determines whether the construct of the research is successfully operationalised and represents the phenomena relating to the research objective. In this study, the unit of analysis is the manager of the firm, qualified to provide accurate data based on their knowledge.

Internal validity refers to the extent to which the research design really allows the researcher to draw conclusions about the relationships among variables. In this research, using the quantitative approach, statistical techniques have been applied to test the relationships among variables; in support, Burns (2000) suggests that the standardised test is helpful in forming an important part of the body of necessary information. Hair et al. (2006) recommended that the most common test for normality is the Kolmogorov-Smirnov test, which determines the level of significance of the differences from a normal distribution. The most commonly used significance level is 0.05. Hence, the organisational effectiveness was tested for normality by using this test (see appendix, Table 7). The results indicated that a significant level of the sample are greater than 0.05. So, we can conclude

that the sample has a normal distribution. This implies that the sample conforms to acceptable formats.

In contrast to the other types, external validity reflects the degree to which the samples are actually representative of the population from which they were drawn. In this study, the respondents have been stratified based on the location of their firms to ensure that each sample from the different locations had an equal chance of being selected. A probability or random sample technique was then applied to select samples. This means that the samples were randomly selected, contributing further to the generalisability of the data gathered.

In addition, the questionnaire was sent to professional proof readers based in the UK and Thailand in order to check translation from English to Thai and from Thai to English. This was necessary to ensure that the respondents shared the same understanding of the phrases applied in every single question. All respondents were also assured of the highest level of confidentiality of data, which will be used for academic purposes only. Respondents were also notified that a copy of the results would be provided, although no individual companies would be identifiable from the published information.

3.3 Data Analysis

The data were analysed by applying hierarchical multiple regression (Statistics Package for Social Science). The independent variables are gender, age, experience, education, and leadership styles; the dependent variable is organisational effectiveness.

3.3.1 Multiple Regression Analysis

Multiple regression is one of the most widely used methods in quantitative studies (Hardy, 1993). A typical regression model attempts to explain variation as a quantitative dependent variable, Y, by mapping the relationship of Y to a specified set of independent variables as an additive, linear function. Observing the least squares estimation techniques could help in understanding a prediction equation and allows us to estimate conditional means on the dependent variable-expected values of Y. Special combinations of values are assessable as quantitative variables for which we can suppose equal intervals relative to an arbitrary zero point; the number of feasible predicted values for Y is unlimited (Hair et al., 2006). When both dependent and independent variables are quantitative, the set of relationships can be captured geometrically.

Raudenbush and Bryk (2002) stated that hierarchical multiple regression is an extension of linear regression used when one is interested in the linear relationship between a set of independent variables and one dependent variable. The independent variables are referred to as predictor variables and the dependent variable as the criterion variable. The method has traditionally been identified as appropriate for interval or ratio scales (Saunders, 1956; Cohen et al., 2003) and is the preferred statistical method for identifying interaction effects. Most applications engage random-effects designs in field settings where surveys are utilised to determine individual and organisational characteristics of interest. Accordingly, the independent and dependent variables in this study are ratio scale. Linderman et al. (1980) suggest that it is necessary to have at least 100 samples in order to apply multiple regression effectively, and a majority of authors recommend at least 5 to 20 times as many observations (cases, respondents) as one has variables, if the estimates of the regression line are to be stable (Cohen, 1990; Hair et al., 2006, p. 196; Steven, 1986). Accordingly, in this research there are 140 cases.

A sequential or hierarchical analysis of a set of independent variables may produce the coefficients necessary to answer the scientific questions at hand. In the hierarchical form, the set of independent variables are entered cumulatively in the R square and partial regression and correlation coefficients are determined when each independent variable joins the others (Todman and Dugard, 2006). A full hierarchical procedure for a set of independent variables consists of a series of regression analyses, each with one more variable than its predecessor. The choice of a particular cumulative sequence of independent variables is made in advance, as stated by the purpose of the research. Moreover, the researcher should be guided by the theoretical foundation that originally led to the research question (Kerr et al., 2002). The higher the correlation between the independent and dependent variable, the better the prediction equation (Auamnoy, 2002). This research framework has two main groups of independent variables: respondents' demographics, and leadership styles. As a result, the relationship between independent and dependent variables have been tested to attain the results precisely.

3.3.2 Multicollinearity

To detect problems of multicollinearity, the coefficient correlation of each pair of independent variables was observed (see appendix, Table 8 Coefficient Correlation). We find that the coefficient correlation of the set of independent variables did not exceed 0.80. Furthermore, tolerance and VIF were tested for the multicollinearity problem (see appendix, Table 9 Collinearity Statistics); we found that the tolerance of each predictor was not lower than 0.100 and the VIF did not exceed 3.16 (the limit suggested by Hair et al. 2006). This suggests that the set of independent variables would not cause the multicollinearity problem.

3.3.3 Dummy Variables

The coding of categorical data requires the development of mutually exclusive and exhaustive categories (Tabachnick and Fidell, 2007). Categorical variables can be dichotomous, using binary (0, 1) coding; dummy variables are always dichotomous variables. All respondents who are members of a particular category are assigned a code of 1, otherwise 0. Following this coding convention, we construct a set of dummy variables for a given categorisation so that any particular respondent is coded 1 on one and only one dummy variable in the set. In this research, the gender of respondents is the categorical variable; therefore, it is recoded. Male is recoded as 0 and Female as 1.

4. Results

Rather than looking for a statistical solution, the researcher should be guided by the theoretical foundations that originally led to the research question (Kerr A. et. al., 2002). This suggests that the researcher select the most appropriate independent variables to predict a dependent variable. Therefore, in this section, hierarchical regression analysis is performed to examine the direct effects of respondents' demographics and leadership style on the dependent variable known as organisational effectiveness. In proportion to the theoretical framework of this research, a set of respondents' demographics was initially entered, followed by leadership styles (transformational, transactional and laissez-faire leadership). Two hierarchical regression analyses were required to test for organisational effectiveness.

The results suggest that Model 1, composed of gender, age, education, and experience as independent variables, has $R^2 = 0.032$ (see appendix, Table 10 Model Summary). This means that those independent variables could explain the dependent variable, organisational effectiveness,

approximately 3.2%. After another independent variable has been added to Model 2, the R square increased to 0.565 (see appendix, Table 10 Model Summary). It can be concluded that the set of independent variables in Model 2 is the most valuable in predicting the dependent variable.

Hypothesis: Respondents' demographics and leadership styles have an impact on organisational effectiveness.

H_0: $\beta_{1,} = \beta_2 \ldots = \beta_k = 0$, there is no significant linear relationship among the set of predictors composed of respondents' demographics, leadership styles, and organisational effectiveness.

H_1: At least there is $\beta_i \neq 0$, i = 1, 2… k, significant linear relationship among the set of predictors composed of respondents' demographics, leadership styles, and organisational effectiveness.

To test the hypothesis, Model 2 has been considered because it has the highest value of R square, 0.565, i.e. approximately 56.5% that the independent variables in this model could explain the dependent variable. The results of ANOVA suggest that P value is equal to 0.00 (see appendix, Table 11 ANOVA) which is less than 0.05; therefore, the null hypothesis is rejected, and it is concluded that respondents' demographics and leadership styles have an impact on organisational effectiveness. Once a set of independent variables affects a dependent variable, the prediction equation could be ascertained.

4.1 Beta Coefficient

$Y = \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7$

Where:

Y = Organizational Effectiveness
β_i = Beta Coefficient of each predictor
X_1 = Gender
X_2 = Age
X_3 = Education
X_4 = Experience
X_5 = Transformational Leadership
X_6 = Transactional Leadership
X_7 = Laissez-faire Leadership

The prediction equation is shown in appendix, Table 12 Beta Coefficient.

Organisational Effectiveness = - 0.067 (Gender) + 0.043 (Age) + 0.071 (Education) + 0.003 (Experience) + 0.700 (Transformational Leadership) + 0.068 (Transactional Leadership) - 0.118 (Laissez-faire)

The coefficient beta assists in determining whether the averaging process used in calculating coefficient alpha is masking any inconsistent item (Malhotra & Birks , 2003). Beta Coefficient (β) is the standardised unit of each independent variable which explains the significance value of each predictor in the equation (Auamnoy, 2002). From the prediction equation above, we see that the beta coefficients have indicated that once all independent variables have been standardised in the same unit, they can be ranked as follows:

The most powerful predictor in the Standardised Coefficient Equation is Transformational leadership (0.700), indicating that Transformational Leadership is positively correlated with organisational effectiveness. Hence, it could be supposed that managers with a high level of Transformational leadership are supportive to the organisation. This is followed by Laissez-faire leadership (- 0.118), which is negatively correlated with organisational effectiveness, suggesting that managers with a high level of Laissez-faire leadership are not supportive to the organisation. Transactional leadership (0.068) is positively correlated with organisational effectiveness. Thus, it could be supposed that managers who have a high level of Transactional leadership are likely to be helpful to the organisation. However, it should be noted that the Beta Coefficient of Transactional leadership is lower than Transformational leadership's approximately ten times. This implies that Transformational leadership has a stronger positive correlation with organisational effectiveness.

Next, the Beta Coefficient of Education is 0.071, positively correlated with organisational effectiveness. Thus, it could be supposed that managers who have high levels of education are likely to be helpful to the organisation. Both age and experience are positively correlated with organisational effectiveness; it can be supposed that the older the manager, the better he or she can perform. Similarly, Experience has a positive correlation with Organisational Effectiveness, implying that the more experienced the managers are, the better they perform. Last, results showed that gender is a largely irrelevant variable vis-à-vis organisational effectiveness.

5. Discussion

The results show that Transformational leadership had a markedly positive beta weight, implying that managers who are able to successfully create vision and a learning environment in the firm are also likely to increase their employees' skill levels which in turn would lead to improving Organisational Effectiveness. There is substantial evidence indicating that Transformational leadership helps to increase levels of individual performance (Avolio and Yamamario, 2002; Bass, 1985b, 1990, cited in Dionne et al., 2004). In addition, Transformational leadership is positively related to organisational effectiveness (Colbert et al., 2008; Howell et al, 2005; Weichun at al., 2005).

Transactional Leadership also has a positive correlation with Organisational Effectiveness, so it can be supposed that the manager who has a high level of Transactional leadership is likely to be supportive to the firm. Kuhert (1994) proposed that the Transactional leadership manager is likely to provide appropriate rewards to employees, but to be less likely to support employees in terms of developing their skills. Such managers may need to consider playing a more active role in encouraging employees to develop skills, and provide rewards when needed.

Education has a positive correlation with Organisational Effectiveness, implying that the higher the level of education, the better the manager is likely to perform. Likewise, Age has a positive correlation with Organisational Effectiveness. It can be supposed that the older the manager, the better he or she can perform. Similarly, Experience has a positive correlation with Organisational Effectiveness, implying that the more experienced the managers are, the better they perform. Furthermore, compared to other variables, the statistical tests also indicated that gender is a largely irrelevant variable vis-à-vis organisational effectiveness. Nonetheless, this study did not explore the correlation between gender and organisational effectiveness specifically.

Finally, managers who recognise knowledge as a critical resource have a positive attitude towards organisatoinal learning (Pham and Swierczek, 2006). However, Seng (1990, cited in

Torrington et al., 2005) said that without the appropriate leadership, organisational learning could not take place. In this study, we found that leadership styles have a positive correlation with Organisational Effectiveness, so it would be helpful for managers to apply the effective leadership styles, Transformational and Transactional, to encourage learning in the organisation by developing employees' skills through creating new ways of solving problems. For example, managers may support their employees by boosting their confidence when they set out to accomplish their assigned tasks, and giving them feedback on how best to improve their performance. Also, it may be useful for managers to create vision among employees and challenge them to think critically about their work. For further encouragement, managers may need to show appreciation and support for employees when they have successfully completed the assigned tasks, for instance indicating that they are pleased and satisfied to have such valuable employees in the organisation. Studies have also shown it is necessary to provide appropriate rewards to employees when they accomplish assigned tasks (John and Makoto, 2000; Michie and Sheehan-Quinn, 2001).

6. Conclusion

In this study, we investigated the relationship between leadership styles and organisational effectiveness. A quantitative approach was used to analyse the data. The results suggested that leadership styles have a positive correlation with organisational effectiveness, and that the most effective leadership styles are Transformational and Transactional. This research has thus indicated how managers might contribute to creating a conducive learning environment, and in turn improve organisational effectiveness.

It should be noted that we considered only respondents' demographics and leadership styles. Apparently, these variables are not comprehensive factors, as there are critical dimensions underlying effective components of being managers that our study does not integrate. So, those variables are potentially correlated with organisatoinal effectiveness such as human resource management (see, for example, Dionne et al., 2004; Michie and Sheehan-Quinn, 2001). Additionally, this study is new in the Thai context, but the replication of this research may be beneficial to help understand the overall picture of this industry. Additionally, the researcher may consider applying a longitudinal study to assess and confirm the relationships between independent and dependent variables in the results of this study.

Regarding future research, Mason (2002) asserted that the qualitative method offers an advantage in studying "how things work in particular contexts", and Burns (2000) suggested that it confers a sense of reality, describing accurately what the informants feel, perceive and how they behave. Hence, it would be useful to apply the qualitative method to clarify how managers encourage and transfer knowledge to their employees. The study could also be extended to different geographical regions to develop broader views (Hetland and Sandal, 2003), classifying the different approaches that each manager contributes to their organisation in order to identify particular techniques for transferring and encouraging knowledge to employees.

Last but not least, in this study the respondents, i.e. the managers, were not willing to provide detailed financial data because of the highly competitive nature of their business; instead, they were asked to evaluate the financial performance of their firms. Wall et al. (2004) proposed that although it is clear that subjective and objective measures of financial performance have much in common, one cannot assume that either is error-free. Therefore, to make this study more generalisable it would be helpful for future research to look at objective measures such as return on assets, productivity or profit (see, for example, Davis and Daley, 2008; Ellinger et al., 2002; Michie and Sheehan, 2003).

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About the Author

Vissanu Zumitzavan is a PhD candidate in the department of Industrial Labour Economics, at the Birmingham Business School, University of Birmingham, Birmingham, United Kingdom. He is currently researching the relationship between managers' learning and leadership styles and sustaining learning in the organisation and consequently increasing organisational effectiveness. His research interests are in the areas of sustaining the organisational effectiveness, organisational learning, learning styles and leadership styles. In addition, he is a lecturer in the areas of Management in the faculty of Accountancy and Management at Mahasarakham University, Mahasarakham, Thailand.

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Ian is currently researching the effects of Shareholder Value approaches to corporate strategy on HRM and the role of private equity firms in the market for corporate control and is a member of the panel of experts on the Treasury Select Committee on Private Equity. In addition to this Ian was commissioned by the GMB trade union to help devise the submission that the union made to the committee. In February 2007, Ian was invited to submit formal written evidence to the Financial Services Authority discussion document on the regulation of private equity. Ian has published in the journal of management studies, organization studies, the European journal of industrial relations, the industrial relations journal and personnel review and contribute several chapters to Beardwell and Holden, the UK's bestselling HRM text book.

Appendix A: Leadership Style

Table 1 Transformational Leadership Item-Total Statistics

Question	Scale mean if item deleted	Scale variance if item deleted	Corrected item-total correlation	Alpha if item deleted
21	25.150	80.200	0.548	0.838
22	25.093	85.740	0.346	0.851
23	25.250	80.333	0.531	0.839
24	25.107	82.931	0.463	0.844
28	25.143	80.080	0.530	0.839
29	25.043	81.912	0.506	0.841
30	25.293	78.971	0.546	0.838
31	25.221	80.418	0.501	0.842
35	25.286	78.666	0.577	0.836
36	25.157	80.709	0.493	0.842
37	25.279	77.440	0.601	0.834
38	25.007	79.475	0.603	0.834

Table 2 Reliability Coefficients N of Cases = 140, N of Items = 12

	Transformational leadership
Cronbach's coefficient alpha	0.851

Table 3 Transactional Leadership Item-Total Statistics

Question	Scale mean if item deleted	Scale variance if item deleted	Corrected item-total correlation	Alpha if item deleted
25	10.864	29.413	0.519	0.864
26	11.014	27.108	0.628	0.847
32	10.921	26.994	0.698	0.834
33	10.929	25.722	0.742	0.825
39	10.843	27.299	0.625	0.847
40	10.821	25.615	0.738	0.826

Table 4 Reliability Coefficients N of Cases = 140, N of Items = 6

	Transactional leadership
Cronbach's coefficient alpha	0.864

Table 5 Laissez-faire Leadership Item-Total Statistics

Question	Scale mean if item deleted	Scale variance if item deleted	Corrected item-total correlation	Alpha if item deleted
27	2.579	1.627	0.724	0.749
34	2.550	1.530	0.747	0.723
41	2.586	1.568	0.629	0.845

Table 6 Reliability Coefficients N of Cases = 140, N of Items = 3

	Laissez-faire leadership
Cronbach's coefficient alpha	0.836

Organisational Effectiveness

Table 7 Test of Normality

	Kolmogorov-Smirnov	
	df	Sig.
Organisational Effectiveness	140	0.200

H_0: the sample is normal distribution.

H_1: the sample is not normal distribution.

The result indicates that P-value is 0.200 which is greater than 0.050. Therefore, we do not reject the null hypothesis. This means that the sample is normal distribution.

Multiple Regression

Table 8 Coefficient Correlations

Independent Variables	Experience	Gender	Education	Age	Transformational Leadership	Transactional Leadership
Experience	1.000					
Gender	0.188	1.000				
Education	0.310	-0.155	1.000			
Age	-0.345	0.061	0.037	1.000		
Transformational Leadership	-0.092	0.047	-0.077	0.027	1.000	
Transactional Leadership	-0.032	-0.113	0.000	0.125	0.069	1.000
Laissez-faire Leadership	-0.087	-0.126	0.012	-0.006	0.241	0.021

Dependent Variable: Organisational Effectiveness

Table 9 Collinearity Statistics

Independent Variables	Collinearity Statistics	
	Tolerance	VIF
Gender	0.853	1.172
Age	0.812	1.232
Education	0.819	1.221
Experience	0.698	1.433
Transformational Leadership	0.922	1.085
Transactional Leadership	0.961	1.041
Non Leadership	0.920	1.087

Dependent Variable: Organisational Effectiveness

Table 10 Model Summary

Model predictors	R^2
Model 1. Gender, Age, Education, and Experience	0.032
Model 2. + Transformational, Transactional, and Laissez-faire leadership	0.565

Dependent Variable: Organisational Effectiveness

Table 11 ANOVA

Predictors	Sig.
Gender, Age, Education and Experience	0.351
Gender, Age, Education, Experience, Transformational, Transactional, and Laissez-faire leadership	0.000

Dependent Variable: Organisational Effectiveness

Table 12 Beta Coefficient

Predictors	Standardised Confidents
	Beta
Gender	- 0.067
Age	0.043
Education	0.071
Experience	0.003
Transformational leadership	0.700
Transactional leadership	0.068
Laissez-faire leadership	- 0.118

Dependent Variable: Organisational Effectiveness

Guide for Authors

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เรามุ่งมั่นที่เป็นมหาวิทยาลัยแห่งแรกที่ได้รับการรับรอง

มหาวิทยาลัยหอการค้าไทย
University of the Thai Chamber of Commerce
Business-experienced University

University of the Thai Chamber of Commerce, Thailand

In 1940, the Thai Chamber of Commerce founded a non-profit education institution called the College of Commerce to produce graduates in the business field. After the outbreak of World War II in 1941, this institution was closed. In 1963, the College was reopened, and the two-year curriculum was developed into a standard four-year in 1964. In 1970, it was officially accredited under the Private College Act. In 1984, this institution was accredited as a university and the name was changed to the University of the Thai Chamber of Commerce. At present, the University of the Thai Chamber of Commerce provides 39 undergraduate program. The School of Graduate Studies is responsible for 9 graduate programs and 1 graduate diploma program, and the School of Business Administration is responsible for 1 certification programs. All programs are approved by the Ministry of University Affairs.

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