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BANK OF THAILAND

การเปลี่ยนแปลงเชิงโครงสร้างครั้งใหม่: เตรียมความพร้อมให้กับเศรษฐกิจไทย

Dealing with Structural Changes: a Diagnosis of the Thai Economy

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สายนโยบายการเงิน และสายกำกับสถาบันการเงิน
ธนาคารแห่งประเทศไทย

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บทคัดย่อ

โลกภายใต้บริบทใหม่จะเพิ่มทั้งโอกาสและความท้าทายให้กับภาคธุรกิจไทย บทวิจัยนี้ต้องการตอบคำถามสำคัญ 2 ประการ คือ (1) โลกที่จะมีจีนเป็นแรงขับเคลื่อนสำคัญ ขณะที่กำแพงภาษีในภูมิภาคจะลดลงจากการรวมตัวทางเศรษฐกิจของกลุ่มประเทศอาเซียน จะส่งผลต่อโครงสร้างของเศรษฐกิจไทยอย่างไรในช่วง 5-10 ปีข้างหน้า และ (2) เศรษฐกิจไทยพร้อมรับมือกับการเปลี่ยนแปลงที่จะเกิดขึ้นหรือไม่

จากการวิเคราะห์โดยใช้แบบจำลอง Computable General Equilibrium (CGE) พบว่า มีความเป็นไปได้สูงที่โครงสร้างภาคอุตสาหกรรมของไทยจะถูกกดดันให้ต้องปรับเปลี่ยนโฉมไปมากจากปัจจุบัน อีกทั้งลักษณะและขนาดของการเปลี่ยนแปลงมีความเป็นไปได้หลายรูปแบบ เศรษฐกิจที่จะอยู่รอดได้ดีต้องสามารถปรับตัวสนองตอบการเปลี่ยนแปลงของสภาพแวดล้อมโลกได้อย่างยืดหยุ่น ซึ่งเศรษฐกิจที่มีลักษณะดังกล่าวจะต้องมีความคล่องตัวในการโยกย้ายปัจจัยการผลิต และผู้ประกอบการมีความสามารถในการปรับตัวสูง

บทวิจัยนี้พบว่า เศรษฐกิจไทยมีความพร้อมที่จะรองรับการเคลื่อนย้ายปัจจัยการผลิตในระดับที่ยอมรับได้ตามมาตรฐานสากล โดยการแข่งขันเป็นปัจจัยสำคัญที่ส่งเสริมให้การจัดสรรทรัพยากรระหว่างภาคอุตสาหกรรมเป็นไปได้อย่างมีประสิทธิภาพที่สุด ในขณะเดียวกัน ผู้ประกอบการไทยในภาพรวมมีความสามารถที่จะรับมือกับความผันผวนที่อาจเกิดขึ้นในระดับที่น่าพอใจ โดยระดับความทนทานของภาคธุรกิจไทยปรับตัวดีขึ้นในช่วง 5 ปีที่ผ่านมา อย่างไรก็ตาม ยังพบว่ามีความแตกต่างในระดับความทนทานของแต่ละภาคอุตสาหกรรมอยู่ ประเด็นสำคัญ คือ ผู้ประกอบการซึ่งเป็นหัวใจของระบบเศรษฐกิจไม่สามารถนิ่งเฉยได้ เนื่องจากเศรษฐกิจโลกในระยะต่อไปจะมีความผันผวนเพิ่มมากขึ้นกว่าที่ผ่านมา จึงจำเป็นที่จะต้องมีการพัฒนาและปรับตัวอย่างต่อเนื่อง โดยผู้ประกอบการควรยินดีเปิดรับระดับการแข่งขันทางธุรกิจที่เพิ่มมากขึ้น และต้องพัฒนาตนเองอยู่เสมอ เพื่อเป็นการสร้างภูมิคุ้มกันที่ดีที่สุดในระยะยาว

BOT Symposium 2011

Dealing with Structural Change: A Diagnosis of the Thai Economy

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Abstract

The entry of China into the global economy and regional economic integration is ushering in a new global production structure. Thailand will have to find her place in this new global order by embracing internal structural change. The paper finds that Thailand will have to confront sizeable structural change due to global developments. And depending on how global and domestic developments play out, there are wide-ranging possibilities on how Thailand may transform structurally. Nevertheless, no matter what possibility materializes, the Thai economy's smooth transformation rests on its adaptability and resiliency. We focus on adaptability in terms of physical mobility and resiliency in terms of firm resiliency to shocks. Thailand's physical capital mobility is adequate by international standards, but rigidities exist in sectors that lack competition or financial access. At the firm level, the overall picture is that of resiliency to shocks, but there are firms in non-competitive sectors that appear particularly vulnerable. On overall, the Thai economy is adaptable and resilient but will be challenged by imminent and substantial structural change; the Thai economy must build adaptability and resiliency from within. For example, policymakers can facilitate resource allocation by fostering competition and sustaining financial sector liberalization. Firms should enhance productivity, seek out opportunities in new markets, prepare for regional competition and manage financial risk more carefully.

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Executive Summary

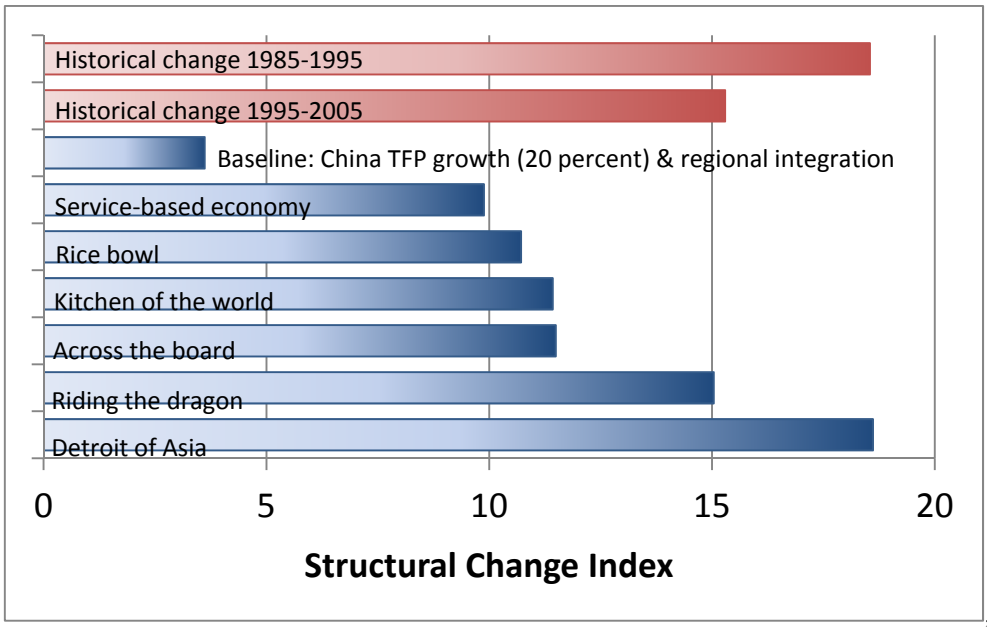
The global economy is on the cusp of change. The entry of China into the global economy and ASEAN regional economic integration will usher in a new global production structure. As a small open economy, Thailand will have to find her place in this new global order by embracing internal structural change—the large flow of labor and physical capital between sectors and the corresponding shift in output across sectors. Certain sectors will rise. Some will contract. The success of Thailand in meeting the challenges of structural change hinges on the flexibility of the market economy in reallocating resources optimally and the adaptability of Thai firms in weathering the pain of transition.

This paper poses three research questions: (1) What do various plausible global economic developments, such as the rise of China and regional integration, mean for both the magnitude and direction of Thailand's structural change? (2) Is physical capital sufficiently mobile to reallocate from sunset to sunrise sectors? (3) Are firms flexible enough to weather shocks associated with the pain of structural transition?

Thailand will have to redefine its role in the new global economy by confronting sizeable structural change that can potentially take many forms.

- A global computable generable equilibrium (CGE) model shows that plausible scenarios suggest impending structural change may approach the scale of Thailand's economic transformation during the 1990s with respect to change along the industrial ladder.

  Figure 1 illustrates that in many plausible scenarios, structural change will be large (i.e. average sectoral share change in each scenario ranges from 7 to 15 percentage points).[2] The direction of sectoral change differs widely depending on how productivity growth is assumed to evolve.



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- While there are many possibilities on how Thailand may evolve, smooth transformation under any circumstance requires **adaptability and resiliency**.

[2] **Structural Change Index (SCI)** is defined as $SCI = \frac{1}{2}\sum_{i=1}^{n}\left|s_i^1 - s_i^0\right|$, where s_i^1 and s_i^0 are shares of sector *i* in the economy at years 0 and 1, respectively. The SCI reflects the average change in sectoral share for 56 sectors.

Thailand's capital mobility, a key element of systemic adaptability, is adequate by international standards, but rigidities exist in non-competitive sectors.

- Thailand's physical capital mobility (proxied by the dispersion in marginal revenue product of capital) outperforms that of developing countries but underperforms that of advanced economies. Room for improvement exists.
- This paper finds that a lack of competition hinders capital mobility and may obstruct structural change.[3]
    - For example, relatively low competition in the rubber-plastics and automobile sectors contribute to high marginal return to capital, or under-investment, as firms obtain excess profit by producing below the optimal amount.
- Lack of access to domestic finance also hinders capital mobility but is weakly significant.

At the firm level, the overall picture is that of resiliency to shocks, but there are firms in non-competitive sectors that appear particularly vulnerable.

- The average Thai firm can withstand shocks to its sales revenue up to a threshold of 39 percent, a large but infrequent shock that occurs once a decade.
- In the tradables sector, the most resilient sectors in terms of shock-absorbing buffers are electronics and vehicles, followed by those in the heavy and light manufacturing sectors. The food and beverage sector shows the greatest within-sector variation in terms of the difference between resilient vs. vulnerable firms.
- Vulnerable sectors include transport, storage and communications sector, wood products and furniture, leather products as well as hotels and restaurants.
- A substantial proportion of firms (bottom 10 percent) are vulnerable, incapable of withstanding sales revenue shocks higher than 7 percent.
- Although resiliency has improved over time, Thai firms cannot afford complacency as the coming structural change will bring more frequent and forceful shocks.

The Thai economy is, on overall, adaptable and resilient but will be challenged by imminent structural change; reform must build adaptability and resiliency from within.

- **System adaptability.**
    - Policymakers should facilitate resource allocation by fostering competition through, for example, streamlining licensing to facilitate entry and exit, liberalizing price controls to allow the market mechanism to function, and encouraging foreign participation.
    - Financial sector liberalization should continue at least as envisioned, if not accelerated.
- **Firm resiliency.**
    - The average firm in a contracting sector may see sales drop by 7-15 percent over the medium term and, as a result, may have to close or move sectors.
    - Firms should continuously enhance product value-added, seek out opportunities in new markets (e.g. Sub-Saharan Africa and the Middle East), prepare for not only local but also regional competitors (e.g. ASEAN, China), and manage financial risk more carefully. Firms must prepare by asking themselves "what-if" scenarios to gauge how various changes in the market can cause stress.

[3] Consistent with Ariyapruchya et al (2006) and Udomkerdmongkol et al (2011) which found that competition fosters productivity and investment, respectively.

1 Introduction

"One day Alice came to a fork in the road and saw a Cheshire cat in a tree. Which road do I take? she asked. Where do you want to go? was his response. I don't know, Alice answered. Then, said the cat, it doesn't matter."

~ Lewis Carroll, *Alice in Wonderland (1865)*

The global economy is on the cusp of change. The entry of China into the global economy amid regional economic integration is ushering in a new global production structure. While the precise shape and form of the new global production structure will be difficult to ascertain, it is almost a certainty that the magnitude of change will be large given the size and dynamism of economic leviathans China and ASEAN. As the world recovers from the global financial crisis, structural change will rise to the fore as a major challenge facing the world, Asia, and the Thai economy.

Thailand will have to find her place in this new global order by embracing internal structural change. There will be both challenges and opportunities. As a small open economy, Thailand will have to reorient its production structure to take advantage of new trade opportunities while avoiding competition from abroad. Some sectors will rise; others will contract or fall. The success of Thailand in meeting the challenges of structural change hinges on the flexibility of the market economy in reallocating resources optimally and the adaptability of Thai firms in weathering the pain of transition.

If Thailand is to successfully weather structural change, factors of production—labor and capital—must flow from sunset to sunrise sectors. The market will have to play its role as the basic mechanism for effective resource re-allocation. However, in practice, market frictions, both structural and self-imposed, exist and may hinder or even prevent necessary adjustment.

Structural change, almost by definition, implies shocks to firms. Historically, transition from one stage to another has not been smooth. Transition will be challenging if the scale of the upcoming structural is large and the pace rapid. As prices for goods and factors of production change in response to the new global production structure, capital and labor will be uprooted and reallocated across sectors. However, no matter how efficient the system is in allocating resources, no economy can function without firms that are able to adjust to shocks. It is therefore essential to gain an insight of the Thai firms' ability to face these challenges since shocks and volatility in the future are expected to be more frequent and forceful as structural change gains momentum. Firm-level analysis is critical to answer how Thailand can prepare for such challenges.

This paper therefore poses three research questions: (1) What do various plausible global economic developments mean for Thailand's potential sunrise and sunset sectors? (2) Is physical capital sufficiently mobile to reallocate from sunrise to sunset sectors? (3) Are firms flexible enough to weather shocks associated with the pain of structural transition?

This paper's findings follow: (1) Thailand will have to redefine its role in the new global economy by confronting sizeable structural change but numerous possibilities exist regarding the precise shape and form of the impending change; (2) Thailand's capital mobility, a key element of systemic adaptability, is adequate by international standards, but rigidities exist in non-competitive sectors; (3) At the firm level, the overall picture is that of resiliency to shocks, but there are firms in non-competitive sectors that appear particularly vulnerable. The Thai economy is, on overall, adaptable and resilient but will be challenged by imminent structural change; reform must build adaptability and resiliency from within.

The paper is divided into seven sections: (i) introduction which includes literature review and stylized facts on Thailand's experience with structural change, (ii) data (iii) methodology, (iv) results, (v) conclusion, (vi) references, and (vii) appendix.

1.1 Structural Change in Thailand: Stylized Facts

Thailand has experienced significant structural change – the large movement of resources across sectors – in recent history. Indeed, for Thailand, as well as other countries, economic growth has entailed structural change. In the mid-1980s, Thailand embarked on a high growth path on the back of economic liberalization, prompting labor to reallocate from agriculture to more productive sectors—mostly manufacturing and, to some extent, services. At the same time, Thailand became more integrated into the global economy. The figures below shows the manufacturing sector's share of total GDP output and labor rising rapidly in the 1980s-1990s.

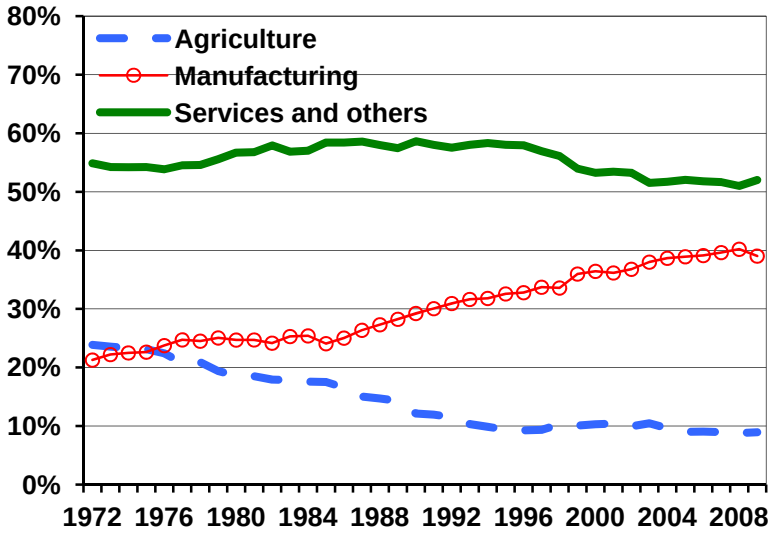

Figure 1. Sectoral Share of GDP

Source: NESDB

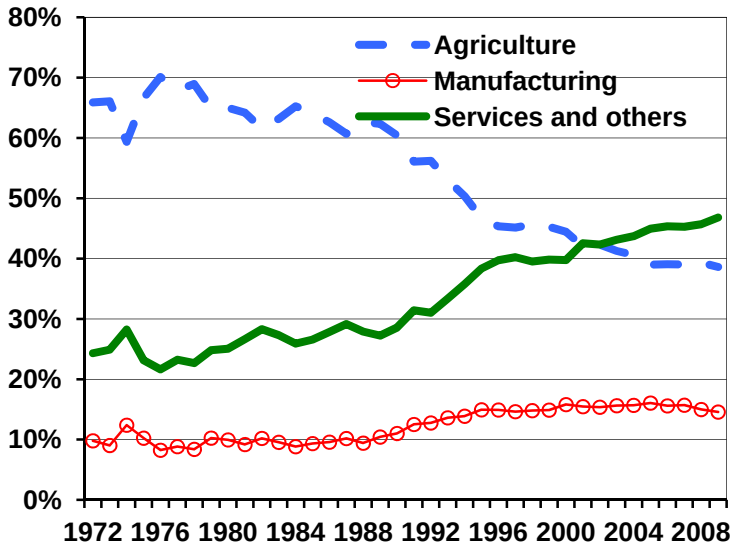

Figure 2. Labor Share by Sector

Source: NESDB

However, while capital income saw a large reallocation, labor income remained relatively unchanged suggesting that obstacles to efficient resource allocation may exist.

While Thailand has successfully weathered structural change in the past, the current challenge of structural change is arguably different from past structural changes which were spurred by reform from within. This time, the winds of structural change are external in origin; they will be strong and will occur at a pace not of Thailand's choosing.

1.2 Literature Review

The literature on structural change has a long history. Adam Smith (1776) saw structural features as strongly related to the level of economic development while David Ricardo (1817) saw changing composition of the productive system as a prerequisite for economic growth. Modern first-generation literature sought to describe the patterns of development experienced by most countries. Fisher (1939), Clark (1940), Kuznets (1966) and Chenery and Syrquin (1975) conjectured that economic growth entailed production shifts from the primary (agriculture, fishing, forestry, mining) to the secondary (manufacturing and construction) to the tertiary sector (services). Rostow (1960) argued that the economy passes through various stages of development from the traditional stage to the take-off stage to the mass consumption stage. This literature is mostly descriptive, trying to provide a bird-eye's view of the development process, with the emphasis on the multifaceted nature of structural change. In contrast, recent literature tends to be more analytical, using formal models designed to focus on a few specific aspects of structural change.

Recent literature has focused on understanding how macro-micro linkages drive macroeconomic phenomenon. Caselli and Feyrer (2005) found that marginal product of capital (MPK) in developing countries exceeded that of developed countries after correcting for natural capital and price effects of capital. They argue that lack of MPK equalization between countries is due to market frictions. Hsieh and Klenow (2009) find inefficient allocation of physical capital in China and India. Wei and Dollar (2009) find that MPK dispersion in China exist due to discriminatory government policy on lending.

2 Data

2.1 Global Trade Analysis Project Database

In order to analyze the impact of the global production structure on Thailand, we utilize the Global Trade Analysis Project (GTAP) which is composed of a computable general equilibrium (CGE) model and a database. The centerpiece of the Global Trade Analysis Project (GTAP) is a global data base describing bilateral trade patterns, production, consumption and intermediate use of commodities and services. Underlying the database are national input-output tables, trade, macroeconomic, and protection data from several sources. The underlying input-output tables are heterogeneous in sources, base years, and sectoral detail; thus for achieving consistency, substantial efforts are made to make the disparate sources comparable. The database is a fully documented, publicly available global database which contains complete bilateral trade information, transport and protection linkages among 113 regions for all 57 GTAP commodities for a single year (2004 in the case of the GTAP 7 Data Base). The reference year corresponds to

the global economy in 2004. For the case of Thailand, we use the latest input-output table from year 2005 as a basis for the GTAP coverage of 57 sectors in Thailand.[4]

2.2 The Productivity Investment Climate Survey

The Productivity Investment Climate Survey 2007 (PICS 2007) is a survey conducted by the National Economic and Social Development Board (NESDB), the Thailand Productivity Institute and the World Bank. It is a survey of 1043 manufacturing firms, consisting of four modules: CEO, Finance Manger, Personnel Manager and Workers Survey. The PICS 2007 provides rich data on perceived business climate such as firms' balance sheet, firm's investment condition as well as firms' characteristics. However, its coverage is limited only to manufacturing. While only manufacturing firms are sampled, sub-sectoral variation may illuminate structural rigidities present in the system.

The survey covers seven regions: North, Upper Northeast, Lower Northeast, Central, Bangkok and Vicinity, East and South; and spans over nine industries: processed food, textiles, garments, automobile parts, electronics, electrical appliances, rubber and plastic, furniture and wood products, and machinery and equipment.

Sampled firms are distributed across the nine industries with about 72 percent of the sample located in Bangkok and the central region. Approximately 25 percent of the samples are export-oriented firms, defined by those who export more than 60 percent of their total sales.

2.3 Firm Panel Data—Bank of Thailand and Ministry of Commerce

The paper employs two approaches to assess firms and sectors' ability to absorb and weather through shocks which are stress testing firms' balance sheets and estimating sectors' default rate sensitivity. Although shocks to businesses may come in many shapes and forms, we focus on shocks that directly impact firms' sale revenues.

The paper utilizes Thailand's largest panel data on firms, constructed from two sources: first, the database from the Ministry of Commerce (MOC), which extensively covers annual financial statements of firms registered with the Department of Business; and second, the data from the Bank of Thailand's Data Management System (DMS). Data from the period of 2003 to 2009 is employed for our study. Stress testing will be performed based on firms' balance sheet as of 2009.

The study makes use of firms' balance sheet information from the MOC database and firms' default status from the loan arrangement dataset (DS_LAR) from the DMS database. The loan arrangement dataset (DS_LAR) dataset provide information on loan facility of large corporate with a total credit line above 20 million baht within a single bank. Firms' default status is flagged if there is at least one loan facility classified as sub-standard or lower according to the BOT loan classification guideline, whose identification is based on either the past-due delinquency status of at least 90 days or any of the qualitative criteria for default status (e.g., obvious inability to pay, poor cash flow projection, or bankruptcy, etc.). In the case that the obligor has loan facilities with several institutions, the most conservative classification class and default status is assigned accordingly.

The paper assesses resiliency based on ISIC classification. The sector classification is self-reported in the MOC database, which contains information on more than 330,033 firms before

[4] See National Economic Social Development Board (NESDB) www.nesdb.go.th.

data-cleaning. An overview of firms' balance sheet data and details of sector classification are shown in Table 3.1 and 3.2 respectively.

3 Methodology

There is nothing in a caterpillar that tells you it's going to be a butterfly.

~ Richard Buckminster Fuller

For a small open economy such as Thailand, structural change emerges from the complex interplay between global and domestic factors. As such, we employ three methodologies that cover the whole spectrum—global, macro and micro. First, we use a global computable general equilibrium model to identify how global developments will play out and the implications for Thailand's sectors. Second, we measure system adaptability with regards to the market's ability to reallocate physical capital. Third, we examine firm resiliency in the face of shocks to firms' balance sheets and firms' default sensitivity.

3.1 Global Structural Change: Computable General Equilibrium

Structural change is a complex, intertwined phenomenon. Changes in supply-side factors, such as productivity or natural endowments, or demand-side factors, such as a growing middle class demand for leisure, in one market or economy will ripple across interacting markets across the globe. The effects of these first-round changes may eventually ripple back to the home country, sparking another round of readjustment until equilibrium is reached.

In order to simulate the driving forces behind global structural change, we use the Global Trade Analysis Project[5] (GTAP) framework, a multi-regional multi-sectoral computable general equilibrium (CGE) model[6] which captures global flows and economic activities. We choose this framework for two key reasons:

- Understanding the global impact of China and regional integration merits a global model. China and regional integration changes not only the regional but also the global landscape through trade and capital flows. This new pattern of trade and capital flows, will affect Thailand, both directly—such as through increased Chinese imports of Thai automobiles—and indirectly—such as through increased Thai exports of tractors to third countries that export grain to China.
- Structural change, by its very nature, should be examined by structural models that make realistic assumptions regarding optimizing behavior and technology and not by macro-econometric models based on limited historical data that cannot adequately capture large changes in the patterns of production.

[5] GTAP is a global network of researchers (mostly from universities, international organizations, or the economic ministries of governments) who conduct quantitative analysis of international economic policy issues, especially trade policy. The GTAP project is coordinated by a team at the Center for Global Trade Analysis (CGTA), based in the Agricultural Economics Department at Purdue University (see www.gtap.org).

[6] CGE models are descended from the input-output models pioneered by Wassily Leontief, but assign a more important role to prices.

The GTAP model

The underlying assumptions of GTAP model are those of standard theories widely used in many general equilibrium models: perfect competition and constant return to scale. The economic agents in each region behave in optimized manner. A utility-maximizing household consumes bundles of commodities which are combinations of domestic goods and imported commodities from other regions. The aggregator functions take the form of constant elasticity of substitution (CES) functions which imply that domestic and imported goods from different sources are substitutable. The cost-minimizing firms are supplied by two types of inputs – primary factors and intermediate inputs. The proportion of primary factor bundles and intermediate input bundles is fixed by assuming Leontief production function. The primary factors consist of land, skilled labor, unskilled labor, capital and natural resources while the intermediate inputs are the bundles of domestic commodities and imported commodities from other regions. Here again the aggregator functions are CES functions which allow for substitution among primary factors and intermediate inputs, both domestic and imported.

The household earns income from the returns to the primary factors and net tax collections. They consume part of their income and save the remainder. The sum of household savings is equal to the sum of investment at the global level. The major linkage between regions is bilateral trade. Besides demand and production in each region, the information about industry subsidy and trade protections which is included in the database is involved in shaping the world equilibrium. For this exercise, we apply the GTAP model with the aggregation version of its database which consists of 13 regions and 57 sectors (see Table 1.1 and 1.2 for details).

The Baseline and Scenarios

Baseline. We design the baseline to capture the *impact* of shocks on the Thai economy emanating from the global economy. The baseline, or indeed any other scenario, is therefore not a prediction as it does not capture all the shocks in the global economy; it captures only the changes on the margin. We specifically examine the impacts of two major shocks on the Thai economy in the baseline:

- The rise of China. We simulate industry-specific productivity shocks in strategic sectors of China. In particular, we assume 20% rise in the TFP growth in electronics chemical, rubber, plastic products, ferrous metals, electronic equipment, other machinery and equipment industries, consistent with China's 12th five-year plan.
- Regional integration. We simulate tariff cuts on traded goods between China and ASEAN as outlined in the China-ASEAN free trade agreement and envisioned AEC liberalization (see Table 1.3 for details).

Scenarios. The baseline is unrealistic in the sense that it assumes that Thailand stands still while China grows. We therefore build on the baseline by producing six alternative scenarios that add TFP growth in six different groups of sectors in the Thai economy, to reflect productivity growth possibilities. All the six scenarios retain the baseline assumptions regarding China and regional integration. We assume that Thailand's TFP growth in each scenario is such that Thailand grows additionally at half the rate of China's incremental growth rate arising from the assumed shocks. Table 1.4 in Appendix 1 summarizes the scenarios' assumptions.

3.2 System Adaptability: Capital Mobility

Structural change refers to large reallocation of factors of production—physical capital and labor—across sectors. To accommodate large scale movements of capital and labor, the Thai economy will have to prove adaptable to the winds of change by reorienting internal factors of production. We use cross-section firm data to draw macro conclusions about the effectiveness of the market mechanism in optimally allocating physical capital.

In particular, we focus on the efficient allocation of physical capital by measuring marginal revenue product of capital (MRPK)—the extra output revenue obtained by employing an additional unit of physical capital, all other factors being held constant. In theory, an efficient allocation requires equalizing MRPK with the marginal cost of capital. If there are no distortions, the return of capital and the marginal cost of capital will be the interest rate. Measuring MRPK properly therefore matters because it allows testing of theory with the data.

We focus only on physical capital, as opposed to labor, due to the quality of data available for physical capital and the inherent difficulty of accounting for labor heterogeneity.

Consider a price-taking firm j. Let π_j, Y_j, K_j, L_j, denote firm j's profit, output, capital stock, and labor, respectively. Firm j maximizes profit thus:

$$\text{Max } \pi_j = p_j Y_j - r_j K_j - w_j L_j$$

Where p_j, r_j, and w_j denote the output price, gross interest and wage rate facing firm j, respectively. Firm's production technology differs only by total factor productivity A_j.

$$Y_j = A_j f(K_j, L_j)$$

$$MRPK_j \equiv p_j A_j f'_K(K_j, L_j) = r_j$$

We measure MRPK using the following equation:

$$MRPK_j = \frac{VA_j - w_j L_j}{K_j}$$

where

$$VA_j = value\ of\ output_j - value\ of\ raw\ material_j$$

This approach avoids the need to assume that the production function is Cobb-Douglas and has the advantage of implicitly calculating the capital share for each firm.

Econometric Specification

Theory suggests a null hypothesis wherein marginal product of capital equalizes given optimally allocated capital with no distortions and no risk. We use a regression framework to examine how return to capital may be influenced by the firm's environment and also include sector fixed effects to check for sector-specific distortions.

$$\ln MRPK_j = \sum \beta_j investmentclimate_j + competition_j + accessfinance_j + \sum sector - dummies$$

Investment climate refers to the economic and financial conditions in a country that affect individuals and businesses' willingness to lend money and acquire a stake in local businesses.[7] Investment climate variables include firm's assessment of external conditions that are problematic (on a scale of 1 to 4, with 4 being very serious).[8] Competition is a dummy variable that takes on the value 1 if the firm reports the presence of serious anti-competitive practices (e.g. monopoly, oligopoly, scale of 4)). Access to finance is a dummy variable that takes on the value 1 if the firm reports serious problems (i.e. scale of 4) in accessing domestic finance.

3.3 Firm Resiliency: Stress Test of Firms

This section assesses resiliency based on two approaches: first, a stress test of firms' balance sheets and, second, assessing default sensitivity to shocks. On the first approach, the paper will stress-test firm balance sheets as of end-2009 to find the largest shock to its sales revenue that the firm can absorb and still able to produce enough earnings to repay its interest obligation, having interest coverage ratio of at least one. The maximum level of shocks will be called the "critical-sales-drop" (CSD) throughout the paper. Sectors are deemed resilient if they exhibit relatively high CSD, which also implies a relatively large financial buffer to absorb possible shocks.

Results on CSD will largely be driven by a number of factors. Firms or sectors that are financially strong especially those producing goods and services with high profit margins will likely be more resilient. In addition, firms or sectors that are able to manage their costs more effectively in case of sales drop will also likely be more resilient. We focus on sectors' ability to adjust their cost of goods sold (COGS) and operating expense (OPEX) in line with changes in sales revenue, which will be estimated from historical data of firms' profit and loss statements over 2004-2008. Firms in the same sector will have the same COGS and OPEX adjustment factors and they will be used to calculate firms' or sectors' CSD at the end of 2009. For more details on stress testing firms' balance sheet methodology, details are further discussed in the appendix 4.

On the second approach, the paper assesses level of resiliency using statistical regression between changes in firms' default status as a result of changes to sales revenues. This serves to estimate the sensitivity of sectors' default rates given changes to sales revenues. Since we observe the default status of firms as either 0 or 1, we therefore employ Logistics regression to measure sectors' default rate sensitivity. Sectors with low default rate sensitivity are deemed resilient. Shocks to the average firm in the resilient sector do not significantly change the probability of

[7] Investment climate is affected by many factors, including: poverty, crime, infrastructure, workforce, national security, political instability, regime uncertainty, taxes, rule of law, property rights, government regulations, government transparency and government accountability.

[8] Investment climate variables include the following dummy variables: telecommunications, electricity, transportation, land access, tax rate, tax administration, customs, labor regulation, skill and education of labor, business licensing, cost of financing which take on the value of 1 if firms evaluate this aspect to be very problematic (i.e. score of 4 on a scale of 1 to 4). In addition, quantitative investment climate variables include number of days to obtain a business permit and number of days required to clear customs.

default as firms are able to cope with the stress. For more details on default rate sensitivity methodology, details are further discussed in Appendix 5.

4 Results

"Toto, I have a feeling we're not in Kansas anymore."

~ Dorothy in *The Wizard of Oz (1939)*

This paper finds the following: (1) Thailand will have to redefine its role in the new global economy by confronting sizeable structural change but numerous possibilities exist regarding the precise shape and form of the impending change; (2) Thailand's capital mobility, a key element of systemic adaptability, is adequate by international standards, but rigidities exist in non-competitive sectors; (3) At the firm level, the overall picture is that of resiliency to shocks, but there are firms in non-competitive sectors that appear particularly vulnerable.

4.1 Global Structural Change: CGE

Plausible CGE scenarios suggest impending structural change may approach the scale of Thailand's economic transformation during the 1990s with respect to change along the industrial ladder. Average sectoral share change in each scenario ranges from 7 to 15 percentage points.[9] The direction of sectoral change, in terms of the shift between primary, secondary, and tertiary sectors, differs widely depending on how productivity growth is assumed to evolve.

Regarding factor returns, the return to capital and labor, both skilled and unskilled, rises across all scenarios. However, depending on the pattern of productivity growth, either capital or skilled labor may emerge as the factor with the largest relative gain.

Results from the baseline and scenarios follow, in order of increasing structural change (see Tables 1.5 – 1.9 for more details):

Baseline. The Thai economy is crowded out by China in many high-tech sectors (e.g. electronics, chemical, rubber, plastics, other machinery and equipment) and is forced into automobiles and textiles. The relative wage of unskilled labor rises compared to skilled labor and capital (in line with the Stolper-Sameulson[10] effect of an increase in the relative price of labor-intensive goods).

Service-based economy. Thailand experiences relatively small structural change. The services sector grows while automobiles expand somewhat. The relative return to skilled labor rises by the most of all the scenarios.

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[9] **Structural Change Index (SCI)** is defined as $SCI = \frac{1}{2}\sum_{i=1}^{n}\left|s_i^1 - s_i^0\right|$, where s_i^1 and s_i^0 are shares of sector *i* in the economy at years 0 and 1, respectively. The SCI reflects the average change in sectoral share across the 56 sectors covered in GTAP.

[10] The Stolper-Samuelson Theorem states that a rise in the relative price of a good will lead to a rise in the return to that factor which is used most intensively in the production of the good, and conversely, to a fall in the return to the other factor

Across the board. Thailand experiences TFP growth in all sectors. The automobile sector, in particular, expands.

Rice bowl. Thailand experiences a second green revolution, becomes the world's foremost rice exporter and breaches new export markets such as Sub-Saharan Africa and the Middle East.

Kitchen of the world. Thailand becomes a major exporter of processed food. Major markets include the G3 economies.

Riding the dragon. Thailand experiences TFP growth in sectors similar to China—electronics and machinery. Trade between ASEAN and China grows significantly. The average change in sectoral share reaches 12 percent, the second-largest of our scenarios. Returns for factors of production such as skilled labor, unskilled labor and physical capital rise. The relative return to capital rises somewhat but by the most compared to all scenarios as the prices of capital-intensive goods rise.

Detroit of Asia. Thailand experiences substantial structural change with the average change in sectoral share at 15 percent, the largest of any scenario. The share of the automobiles sectors grows by 10 percent. Export of automobiles will shift from G3 to new markets such as Australia, New Zealand, and ASEAN. Returns for factors of production such as skilled labor, unskilled labor and physical capital rise. However, the relative return to capital rises slightly.

4.2 System Adaptability: Capital Mobility

Thailand's capital mobility, a measure of systemic adaptability, is adequate by international standards. We remove outliers by excluding the bottom and top 2.5 percent, for a total of 5 percent, of extreme MRPK values due to possible mis-measurement. The median value of MRPK is 13 percent, comparable to that of developing countries—11.9 percent—but above that of developed countries—7.5 percent, not surprising given that Thailand is an emerging market economy still in the process of accumulating capital stock up to the levels of advanced economies.[11] In addition, we examine the dispersion in MRPK and find the standard deviation to lie in the range of 2.0-4.1 with the lower bound being the standard deviation for the sample trimmed by 5 percent and the upper bound being the standard deviation for the sample trimmed by 2 percent. The dispersion in MRPK, a proxy of capital mobility, compares favorably to that of developing countries—6.9—but underperforms that of developed countries—1.7.[12]

However, a look at MRPK summary statistics by sector suggests that pockets of rigidities may exist. Median MRPK ranges considerably from -0.01 to 0.20. For example, median MRPK in the furniture and wood sector is approximately zero at -0.01, suggesting that investment may be facing the point of considerable diminishing returns.

We regress log MRPK on the trimmed sample (5 percent) and find that competition is significant (90 percent significance level) and has a large effect—lack of competition increases MRPK by 36 percent. The finding is consistent with theory which suggests that firms in non-competitive sectors produce below the optimal amount and therefore under-invest. Access to domestic

[11] See Caselli and Feyrer (2005).
[12] See Caselli and Feyrer (2005).

finance is slightly significant (80 percent significance level) and increases MRPK by 30 percent. This finding, while not strongly significant, is consistent with theory. Firm's abilities to invest and build capital stock depends on external financing (See figures 2.1 – 2.3).

4.3 Firm Resiliency: Stress Tests

4.3.1 Stress testing firms' balance sheets

From the 2009 balance sheet data, the paper finds that Thai firm on average can withstand shocks to its sales revenue up to a threshold of 39.3 percent. This reflects the reasonably strong financial status of Thai firms as well as the ability to effectively manage cost under stressful times quite effectively. However, there exists a substantial dispersion between those deemed resilient and vulnerable, namely the top and the bottom 25 percents with the critical sales drop of 58.2 and 17.0 percents respectively, difference of almost 3.5 times. More importantly, a substantial proportion of firms (bottom 10 percent) appear to be quite vulnerable, incapable of withstanding sales revenue shocks higher than 7.0 percent. This limited buffer would become more binding given the current volatile environment. The distribution of all the firms' critical sales drops at the end of 2009 is shown in Table 3.3.

Given our rich database, the next natural question is to see how often in the past that the sales has dropped beyond the threshold critical-sales-drop (CSD). The paper finds that based on 5 years of historical data there is approximately a 10 percent chance that the average Thai firm will be hit by shock to its sales revenue beyond the threshold level. In other words, once every ten years, Thai firms will likely face a severe shock that put firms into financial stress, assuming independence of events from year-to-year. Historical distribution of annual sales growth from the period 2004 to 2008 is examined and shown in Table 3.4.

As for the level of resiliency across sectors, results show significant dispersion as expected. CSD by sectors are presented in Table 3.5 according to broad sector classifications. The CSD of 30 sectors according to 3 digit ISIC classification are estimated. Results show that among the tradable, the most resilient sectors are those of electronics and vehicles parts manufacturer, followed by heavy manufacturing industry, food and beverage industry and light manufacturing industry.

Electronics and vehicles parts manufacturing sector has the average critical-sales-drop of almost 50 percent. Even the firms at the bottom 25 percent are still able to withstand shocks to its sales revenue up to 25.8 percent, confirming a relatively high level of resiliency for this sector. As for the non-tradables sector, construction and real estate as well as trading sectors show significant CSD buffers of over 40 percent. Transports, logistics and telecommunication appears to be quite vulnerable with CSD of only 20 percent.

However, looking at the average critical-sales-drop alone provides only half of the picture. We must complement our analysis on CSD with the nature of risk in each sector. To provide an extreme example, one sector may have a very low CSD figure but the demand for its goods and service may prove to be perfectly income inelastic. In this case, its sales revenue may have never been hit at all even in during bad times and therefore this sector may prove to be the most resilient sector of all. On the other hand, sectors with high CSD may prove to be quite vulnerable if its sector faces volatile sales shocks. Therefore, we must look at the historical annual sales growth by sectors in order to gauge the risk and nature of businesses in each sector, similarly to the analysis performed system-wide.

Figure 3.6 confirms that Electronics and Vehicles sector still remains the most resilient sector, capable of withstanding quite extreme shocks that have a probability of occurring around 5 percent. This is equivalent to a one-in-twenty-years stress event. As for the non-tradables sector, analysis of CSD and probability distribution revealed quite a contrast especially for construction and real estate and trading sectors. From the CSD point of view, these two sectors show markedly large buffers sufficient to withstand sales shock of 46.4 and 47.2 percent respectively. However, their businesses are quite volatile in nature, which means it is not uncommon for firms in these sectors to face an extreme shock to its sales revenues with a magnitude deemed significant by other sectors' standards. As it turn out, results shows a probability of about 18 percent that firms in these two sectors will be hit by shocks beyond the CSD. They therefore exhibit signs of vulnerabilities. For more details, please see figure 3.7.

The most vulnerable sector remains the transports, logistics and telecommunication sector with an average critical-sales-drop of merely 22.3 percent. One may argue that this sector was affected by volatile oil prices during 2008-2009 more than others. However, later on when we examine the level of resiliency of the sectors across time, the conclusion remains unchanged. This sector seems to lag behind in terms of resiliency improvement over the 5 years period from 2004 to 2009 (details to be further discussed in the following sub sections), suggesting that the lack of resiliency is to some extent structural and not temporary.

Thailand has the unique geographical advantage of being located at the trading crossroads of China, ASEAN and India. In addition, results from CGE model also suggest significantly increasing trade flow within and across the said regions as well as new markets. This means that Thailand has considerable potential to become regional logistical hubs in the future. A strong transport and logistics sector is therefore needed to realize its full potential and reap the greatest benefit from the coming structural change. However, lack of basic infrastructure development coupled with lack of ability to manage the shocks and volatility confronting the sector may make Thailand miss out on the opportunity to become a regional logistical hub.

BOX 1: Default rate sensitivity

The paper also measures resiliency by estimating the sensitivity of sectors' default rates given a change in sales revenues. Specifically, logistics regression is performed on firms' default status as a result of changes to sales revenues based on Logistics regression.

In the previous section, stress testing firms' balance sheets using interest coverage ratio of one as a critical threshold serves as an indicator of firm's possible financial difficulties. In fact, firms may survive even with interest coverage ratio less than one from cash retained in the business, factoring firms' trade receivables or extra capital injection from shareholders to maintain firm's liquidity sufficient to meet interest obligation. In other words, management action under stress plays critical role in ensuring the firm's survival.

Our database from the period 2004 – 2009 contains 1191 defaulted firms over the 5 years period. The model is estimated by pooling information of firms into the broad sector classification to ensure sufficient records of defaulted firms, result shows in Table 3.8. The estimated slope coefficients β of the system is -0.019, which can be interpreted as one percentage decrease in sales revenue, the log odds of default probability for firm in will increase by 1.88% ($e^{-0.019} - 1$)

Results are broadly in line with CSD analysis in Table 3.6 especially in terms of relative default rate sensitivity and resiliency across sectors. Among the tradable, results show that Electronics and vehicles parts manufacturers, followed by food and beverage industries able to adapt and absorb shock better than other sectors.

As for the non-tradables sector, transports, logistics & telecommunication sector once again exhibit sign of vulnerability. The estimated slope coefficients β of this sector is -0.024, imply that one percentage decrease in sales revenue, the log odds of default probability for firm in transports, logistics & telecommunication sector will increase by 2.40%

4.3.2 Resiliency over time

The paper is also interested to see if there exists an evidence of improvement in terms of firms' resiliency through time. Therefore, we compute the critical-sales-drop at the end of the year 2004 to compare with results from 2009 balance sheets, with the same adjustment factor for COGS and OPEX. Result is shown in Table 3.9. It highlights a clear resiliency improvement across all parts of the distribution. As for the system-wide figure, an average CSD increase from 31.3 to 39.3 percent with firms at the top as well as the bottom of the distribution have become more resilient in the past 5 years.

At the sectoral level, we see similar improvement across the board in about three-quarters of the sectors (23 out of 30). Firms in these sectors have shown resiliency improvement through times with an average 3.5 percentage points increase in CSD as shown in Table 3.10. This proves to be quite encouraging given businesses have been affected by the global financial crisis in the year 2009.

Although there is an evidence of improvement over time, Thai firms cannot afford complacency going forward. Shocks associated with the coming structural change will definitely be more frequent and forceful. Those with marginal buffers, especially the small and medium-sized firms, must adjust themselves urgently.

4.3.3 Competition and resiliency

In addition, we examine if the level of competition drives difference in resiliency level across sectors. It is natural to think that competition will drive firms to perform. We use top decile turnover turnover as an indicator of competition in the sector similarly to one employed by Fogel, Morck, and Yeung (2008) and Liang (2010) to measure creative destruction and dynamism of the economy in respective studies.

The paper employs the same measurement, which measure the portion of the firms that are ranked among the top decile firms by sales revenue in year 2009 but fail to rank among the top decile firms in year 2004. This reflects level of competition within the sector in the past 5 years. In this paper, we generate a subsample that consists of all firms in each sector that are in our sample in both years 2009 and 2004. We rank firms based on sales revenues in year 2004, and then measure the percentage of firms that no longer in the top revenue decile in year 2009. Big Business Turnover of sector j is calculated as $\frac{1}{n}\sum_{i=0}^{n} E_i$ where $E_i = 1$ if firm is in the top decile in 2009 but not in 2004 and n is the total number of firms in sector j in the sample.

The paper finds that an average figure of the whole system is about 25 percent, which means a quarter on the leading firms in the top 10 percent of the sector entered the top decile recently within the past five years. Table 3.11 reveals that top decile turnover ranges from 20 to 40 percent. Heavy industry exhibits on average the lowest level of turnover of 20 percent. This is not uncommon given nature of the industry which requires large capital expenditure on machinery, technology and know-how.

Most importantly, figure 3.12 confirms our hypothesis: it exhibits a positive relationship regarding the level of competition and resiliency improvement of various sectors during 5 years period from 2004 to 2009. Sector with high competition show a greater level of resiliency improvement.

5 Conclusion and Policy Conclusion

The journey of a thousand leagues begins with a single step.

~ Lao Tzu

How does an economy or society prepare for change, a phenomenon that, by its very nature, eludes precise definition? For Thailand, success in meeting the challenges of structural change depends a great deal on the prescience of policymakers in designing an environment that is flexible enough to allow resources to reallocate *no matter what changes materializes*. The market mechanism should play the leading role in resource reallocation. Policymakers should facilitate resource allocation by fostering competition through, for example, liberalizing price controls to allow the market mechanism to function, and encouraging foreign participation. Financial sector liberalization should continue at least as envisioned, if not faster.

Policymakers must accept that structural adjustment entails pain and firm closures inevitable. However, the market mechanism can be made to work more smoothly by easing the pain of adjustment. For example, public policy can support job retraining and streamline licensing to facilitate firm entry and exit.

The right economic policies are important but ultimately, firms are at the frontline and first to bear the brunt of the coming storm of structural change. About 7-15 percent of firms facing challenging environments will have to close down or move sectors. Firms must prepare by continuously enhancing product value-added, seeking out opportunities in new markets, preparing for not only local but also regional competitors and managing financial risk more carefully. Firms must prepare by asking themselves "what-if" scenarios to gauge how various changes in the market can cause stress.

What is the road ahead like? We find that there are many paths that Thailand may take. Each path reflects the process of technological progress at home and the policy choices made by China. Both cannot be predicted. While there is no certainty about on which path we may end up, what is certain is that the journey will be long and arduous. Preparation must begin today.

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7 Appendices

7.1 Appendix 1 Global CGE

Table 1.1: List of countries/regions of the study

Name	Description
Oceania	Australia, New Zealand
China	China
EastAsia	East Asia
THA	Thailand
SEAsia	Southeast Asia
SouthAsia	South Asia
USA	United States of America
NAmerica	North America
LatinAmer	Latin America
EU_25	European Union 25
MENA	Middle East and North Africa
SSA	Sub-Saharan Africa
RestofWorld	Rest of World

Table 1.2: List of GTAP's sectors/commodities

Code	Description	Code	Description
PDR	Paddy rice	LUM	Wood products
WHT	Wheat	PPP	Paper products, publishing
GRO	Other cereal grains	P_C	Petroleum, coal products
V_F	Vegetables, fruit, nuts	CRP	Chemical, rubber, plastic products
OSD	Oil seeds	NMM	Other mineral products
C_B	Sugar cane, sugar beet	I_S	Ferrous metals
PFB	Plant-based fibers	NFM	Other metals
OCR	Other crops	FMP	Metal products
CTL	Bovine cattle	MVH	Motor vehicles and parts
OAP	Other animal products	OTN	Other transport equipment
RMK	Raw milk	ELE	Electronic equipment
WOL	Wool, silk-worm cocoons	OME	Other machinery and equipment
FRS	Forestry	OMF	Other manufactures
FSH	Fishing	ELY	Electricity
COA	Coal	GDT	Gas manufacture, distribution
OIL	Oil	WTR	Water
GAS	Gas	CNS	Construction
OMN	Other minerals	TRD	Trade
CMT	Bovine meat products	OTP	Other transport
OMT	Other meat products	WTP	Water transport
VOL	Vegetable oils and fats	ATP	Air transport
MIL	Dairy products	CMN	Communication

PCR	Processed rice	OFI	Financial services
SGR	Sugar	ISR	Insurance
OFD	Other food products	OBS	Business services
B_T	Beverages and tobacco products	ROS	Recreational and other services
TEX	Textiles	OSG	Public Administration, Defense, Education, Health
WAP	Wearing apparel	DWE	Dwellings
LEA	Leather products		

Table 1.3: Target tariff rates (% ad valorem)

Sector	**China's tariff**		**Thailand's tariff**	**SEAsia's tariff**
	Import from SEAsia	Import from Thailand	Import from China	Import from China
Paddy rice	68	68	30	0
Wheat	5	5	n.a.	2.92
Other cereal grains	20	0	20	0.39
Vegetables, fruit, nuts	0	0	0	0
Oil seeds	0	0.44	0	0
Sugar cane, sugar beet	0	0	0	0
Plant-based fibers	0	0	0	0.04
Other crops	0.58	0.69	10.68	1.44
Bovine cattle	0	0	0	0
Other animal products	0	0	0	0
Raw milk	n.a.	n.a.	n.a.	n.a.
Wool, silk-worm cocoons	n.a.	n.a.	0	0
Forestry	0	0	0	0
Fishing	0	0	0	0
Coal	0	0	0	0
Oil	0	0	0	0
Gas	0	0	n.a.	0
Other minerals	0	0	1.08	0
Bovine meat products	0	0	0	0
Other meat products	0	0.04	1.41	3.57
Vegetable oils and fats	26.46	8.12	0	0
Dairy products	0	0	0	0
Processed rice	0	68	30	6.61
Sugar	50	47.63	n.a.	1.31
Other food products	0.08	0.49	1.77	0.4
Beverages and tobacco products	0	31.94	10.61	0.11
Textiles	1.21	2.56	0.42	0.7
Wearing apparel	0.56	0	0	0.18
Leather products	0.32	0.23	1.14	0.58
Wood products	1.9	0.95	1.62	0.48
Paper products, publishing	2.42	3.19	7.13	2.06
Petroleum, coal products	1.01	0.59	1.43	0
Chemical, rubber, plastic products	2.32	6.6	0.5	0.6

Other mineral products	0.68	3.24	7.58	1.68
Ferrous metals	2.03	4.42	0.87	1.28
Other metals	0	0.37	0.02	0
Metal products	0.01	1.06	0.66	0.02
Motor vehicles and parts	1.36	6.46	21.84	4.82
Other transport equipment	0.02	6.04	17.73	2.5
Electronic equipment	0	0.1	0.24	0.07
Other machinery and equipment	0.05	1.68	1.42	0.09
Other manufactures	0.12	0.01	1.09	n.a.

Source: Sabhasri et al. 2005

Table 1.4: Scenarios design

Scenario	Regional Integration (Tariffs cut)	Chinese sectors with productivity improvement	Thai sectors with productivity improvement
Baseline	Yes	Chemical, rubber, plastic products Ferrous metals Electronic equipment Other machinery and equipment	None
Across the board	Yes	same as Baseline	All sectors
Rice bowl	Yes	same as Baseline	Paddy rice Wheat Other cereal grains
Kitchen of the world	Yes	same as Baseline	Bovine meat products Other meat products Other food products Beverages and tobacco products
Detroit of Asia	Yes	same as Baseline	Motor vehicles and parts
Service-based economy	Yes	same as Baseline	Trade Communication Financial services Insurance Business services
Riding the dragon	Yes	same as Baseline	Chemical, rubber, plastic products Ferrous metals Electronic equipment Other machinery and equipment

Table 1.5: SCI and macro variables

Scenario	SCI	Real GDP growth (%)	Private Consumption growth (%)	Total production growth (%)
Baseline	3.01	0.43	2.55	-0.96
Across the board	7.55	8.24	19.95	0.65
Rice bowl	9.69	8.24	10.73	2.82
Kitchen of the world	10.27	8.24	12.46	1.25
Detroit of Asia	15.04	8.24	19.87	-0.39
Service-based economy	7.13	8.24	15.62	1.64
Riding the dragon	10.78	8.25	28.24	2.25

Table 1.6: Thailand's top 5 expanding sectors

Scenario	1	2	3	4	5
Baseline	Construction (↑0.98)	Motor vehicles and parts (↑0.31)	Textiles (↑0.26)	Leather products (↑0.19)	Trade (↑0.19)
Across the board	Construction (↑4.12)	Motor vehicles and parts (↑0.87)	Trade (↑0.57)	Other mineral products (↑0.52)	Dwellings (↑0.29)
Rice bowl	Paddy rice (↑3.25)	Processed rice (↑3.24)	Construction (↑1.59)	Other food products (↑0.34)	Other cereal grains (↑0.25)
Kitchen of the world	Other food products (↑4.02)	Construction (↑2.07)	Other meat products (↑1.29)	Beverages and tobacco products (↑0.40)	Recreational and other services (↑0.39)
Detroit of Asia	Motor vehicles and parts (↑7.80)	Construction (↑4.76)	Other mineral products (↑0.57)	Trade (↑0.54)	Other transport (↑0.42)
Service-based economy	Construction (↑3.12)	Trade (↑1.31)	Business services (↑0.70)	Motor vehicles and parts (↑0.62)	Other mineral products (↑0.39)
Riding the dragon	Construction (↑5.05)	Electronic equipment (↑2.63)	Other machinery and equipment (↑1.05)	Other mineral products (↑0.48)	Ferrous metals (↑0.39)

* Percentage change of sectoral production share in parenthesis

Table 1.7: Thailand's top 5 shrinking sectors

Scenario	1	2	3	4	5
Baseline	Electronic equipment (↓1.67)	Chemical, rubber, plastic products (↓0.60)	Other machinery and equipment (↓0.42)	Business services (↓0.07)	Air transport (↓0.06)
Across the board	Electronic equipment (↓2.72)	Chemical, rubber, plastic products (↓1.36)	Other machinery and equipment (↓1.13)	Textiles (↓0.52)	Wood products (↓0.27)
Rice bowl	Electronic equipment (↓3.37)	Chemical, rubber, plastic products (↓2.08)	Other machinery and equipment (↓1.34)	Textiles (↓0.47)	Business services (↓0.24)
Kitchen of the world	Electronic equipment (↓3.73)	Chemical, rubber, plastic products (↓2.10)	Other machinery and equipment (↓1.53)	Textiles (↓0.56)	Wood products (↓0.27)
Detroit of Asia	Electronic equipment (↓5.01)	Chemical, rubber, plastic products (↓2.47)	Other machinery and equipment (↓2.05)	Textiles (↓1.22)	Other manufactures (↓0.56)

Service-based economy	Electronic equipment (↓2.99)	Chemical, rubber, plastic products (↓1.34)	Other machinery and equipment (↓0.99)	Textiles (↓0.39)	Air transport (↓0.24)
Riding the dragon	Textiles (↓2.10)	Other manufactures (↓1.16)	Wearing apparel (↓0.80)	Business services (↓0.78)	Other food products (↓0.76)

* Percentage change of sectoral production share in parenthesis

Table 1.8: Thailand's top 3 growing markets for export goods

Scenario	**1**	**2**	**3**
Baseline	China (↑2.93)	Southeast Asia (↑1.14)	Sub-Saharan Africa (↑0.13)
Across the board	China (↑3.93)	Southeast Asia (↑2.03)	Sub-Saharan Africa (↑0.36)
Rice bowl	Sub-Saharan Africa (↑4.48)	China (↑1.70)	Middle East and North Africa (↑1.25)
Kitchen of the world	China (↑1.32)	East Asia (↑0.74)	Australia, New Zealand (↑0.20)
Detroit of Asia	Southeast Asia (↑4.79)	Australia, New Zealand (↑2.93)	Middle East and North Africa (↑1.58)
Service-based economy	China (↑3.15)	Southeast Asia (↑1.18)	Sub-Saharan Africa (↑0.22)
Riding the dragon	China (↑7.89)	Southeast Asia (↑3.31)	East Asia (↑0.19)

* Percentage change of market share in parenthesis

Table 1.9: Relative price change of primary factors (percentage)

Scenario	**Land**	**Unskilled Labor**	**Skilled Labor**	**Capital**	**Natural Resources**
Baseline	-4.42	3.29	2.82	3.09	1.37
Across the board	-20.17	19.71	20.72	20.64	-9.69
Rice bowl	37.91	11.00	11.15	9.21	21.19
Kitchen of the world	14.33	11.70	12.71	11.70	113.41
Detroit of Asia	-30.59	18.54	19.84	19.68	-18.68
Service-based economy	-9.13	15.27	16.10	14.51	9.83
Riding the dragon	-31.38	26.75	28.58	30.86	-39.20

7.2 Appendix 2 System Adaptability

Figure 2.1: Distribution of system-wide MPK

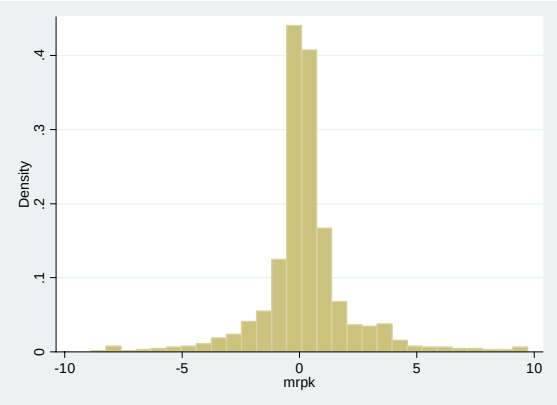


Figure 2.2: Distribution of sectoral MPK

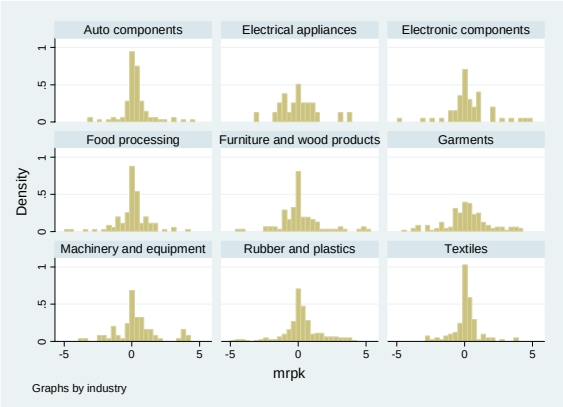


Table 2.3: Econometric result

```
      Source |       SS       df       MS              Number of obs =     987
-------------+------------------------------           F( 10,   976) =    1.44
       Model |  56.4793317    10  5.64793317            Prob > F      =  0.1563
    Residual |  3820.80308   976  3.91475726            R-squared     =  0.0146
-------------+------------------------------           Adj R-squared =  0.0045
       Total |  3877.28241   986  3.93233511            Root MSE      =  1.9786

------------------------------------------------------------------------------
        mrpk |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
accessfinanc |   .2959741    .235378     1.26   0.209     -.165931    .7578793
 competition |   .3670581   .1751271     2.10   0.036      .023389    .7107272
        food |  -.4082956   .2977191    -1.37   0.171    -.9925388    .1759476
    textiles |  -.1558404   .2859233    -0.55   0.586    -.7169355    .4052548
    garments |  -.2035846   .2797449    -0.73   0.467    -.7525553    .3453861
        auto |   .1139002   .2968811     0.38   0.701    -.4686985     .696499
  electronic |   .2802253   .3383502     0.83   0.408    -.3837523    .9442028
  electrical |   -.148008   .4488838    -0.33   0.742    -1.028897    .7328805
      rubber |  -.0782232   .2593526    -0.30   0.763    -.5871761    .4307298
   furniture |  -.2922641   .3066013    -0.95   0.341    -.8939377    .3094095
       _cons |   .2898022   .2304311     1.26   0.209    -.1623953    .7419997
------------------------------------------------------------------------------
```

7.3 Appendix 3 Firm Resiliency

Table 3.1: Data overview

		Contribution : Data 2009	
	Sector	No. (%)	Sale (%)
1	All sector	100.0	100.0
2	Primary Industry	1.0	2.3
3	Food & Beverage	1.7	6.4
4	Light Industry	8.1	5.4
5	Heavy Industry	11.8	14.3
6	Electronics & Vehicles	1.5	9.0
7	Construction & Real Estate	28.2	13.5
8	Trading	38.0	35.7
9	Transports, Logistics & Telecommunication	3.8	8.9
10	Services	5.9	4.5

Source: BOT-MOC; authors' calculation

Table 3.2: Sectors decomposition

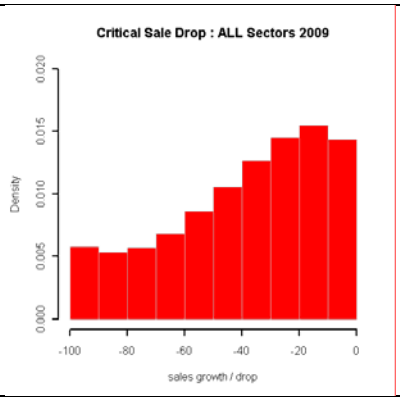
		ISIC	Description
1	All sector	All	
2	Primary industry	A	Agriculture, hunting and forestry
		B	Fishing
		C	Mining and quarrying
3	Food & Beverage	D15	Manufacture of food products and beverages
4	Light Industry	D17	Manufacture of textiles
		D18	Manufacture of wearing apparel; dressing and dyeing of fur
		D19	Manufacture of luggage, handbags, and footwear
		D20	Manufacture of wood and of products of wood
		D21	Manufacture of paper and paper products
		D22	Publishing, printing
		D36	Manufacture of furniture
5	Heavy Industry	D24	Manufacture of chemicals and chemical products
		D25	Manufacture of rubber and plastics products
		D26	Manufacture of other non-metallic mineral products
		D27	Manufacture of basic metals
		D28	Manufacture of fabricated metal products
		D29	Manufacture of machinery and equipment
6	Electronic & Vehicles	D31	Manufacture of electrical machinery and apparatus
		D32	Manufacture of radio, television and communication equipment
		D34	Manufacture of motor vehicles, trailers and semi-trailers
7	Construction & Real Estate	F45	Construction
		K70	Real estate activities
8	Trading	G50	Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of automotive fuel
		G51	Wholesale trade
		G52	Retail trade
9	Transports, Storage & Communication	I60	Land transport
		I61	Water transport

		I63 I64	Support and auxiliary transport activities Post and telecommunications
10	Services	H55 M80 N85	Hotels and restaurants Education Health and social work

*Sector with at least 50 firms will be included

Table 3.3: Distribution of system-wide critical-sales-drop at year 2009

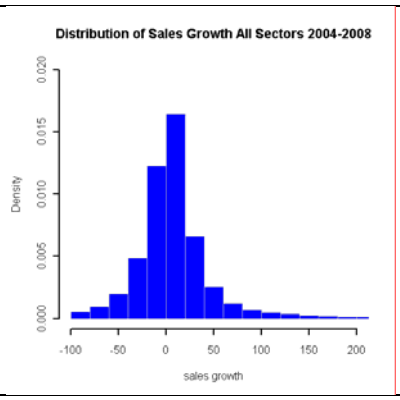
	Critical Sales Drops (%)
	2009
Sample	26018
Top Deciles	82.2
Top Quartile	58.2
Mean	39.3
Median	34.2
Bottom Quartile	17.0
Bottom Deciles	7.0



Source: BOT-MOC; authors' calculation

Table 3.4: Probability distribution of system-wide sales shock beyond given threshold

Empirical distribution	
Threshold	Probability
-50%	7.12%
-40%	9.42%
-30%	13.1%
-20%	18.8%
-10%	27.9%



Source: BOT-MOC; authors' calculation

Table 3.5: Distribution of Critical Sales Drop by Sector

		Critical Sales Drop (%)*				
	Sector	Top Quartile	Median	Average	Bottom Quartile	Bottom Deciles
1	All sector	58.3	36.6	39.3	19.1	8.7
2	Primary Industry	46.2	27.1	31.5	11.4	4.9
3	Food & Beverage	65.9	27.0	38.4	11.3	3.5
4	Light Industry	47.1	31.2	33.6	16.3	6.9
5	Heavy Industry	64.0	40.3	43.3	21.3	9.2
6	Electronics & Vehicles	72.1	48.4	49.3	25.8	10.0
7	Construction & Real Estate	65.5	46.2	46.4	26.4	13.1
8	Trading	75.6	43.1	47.2	20.5	9.0
9	Transports, Logistics & Telecommunication	30.0	19.3	22.3	10.4	4.8
10	Services	37.5	23.2	26.0	10.5	4.2

Source: BOT-MOC; authors' calculation
*Figure is calculated as weighted average of sub-sector result

Table 3.6: Cumulative probability from empirical distribution of shock beyond average CSD

	Sector	Cumulative probability
1	All sector	9.5%
2	Primary Industry	9.1%
3	Food & Beverage	6.6%
4	Light Industry	8.1%
5	Heavy Industry	7.3%
6	Electronics & Vehicles	4.9%
7	Construction & Real Estate	18.5%
8	Trading	10.4%
9	Transports, Logistics & Telecommunication	18.2%
10	Services	8.9%

Source: BOT-MOC; authors' calculation

Table 3.7: Top 15 sectors with highest cumulative probability of shock beyond average CSD

	Sector	Cumulative probability
1	I63	21.5%
2	D20	21.2%
3	F45	19.5%
4	K70	13.4%
5	D19	13.0%
6	I64	12.7%
7	D36	12.6%
8	H55	11.2%
9	G52	10.4%
10	D29	10.3%

11	I61	9.5%
12	G51	8.6%
13	I60	8.5%
14	D21	8.5%
15	D26	7.9%

Source: BOT-MOC; authors' calculation

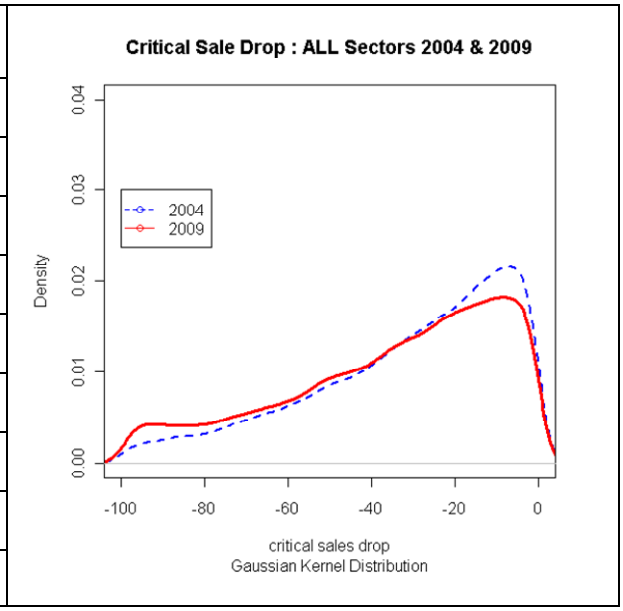
Table 3.8: Result of default rate sensitivity estimation

	Sector	Default number 2004 - 2009	Default rate sensitivity (β)
1	All sector	1191	-0.019263 ***
2	Primary Industry	29	-0.017694***
3	Food & Beverage	114	-0.017665 ***
4	Light Industry	139	-0.028981 ***
5	Heavy Industry	193	-0.036092 ***
6	Electronics & Vehicles	29	-0.014505 **
7	Construction & Real Estate	193	-0.013506 ***
8	Trading	318	-0.02349 ***
9	Transports, Logistics & Telecommunication	56	-0.024265***
10	Services	120	-0.014837***

Source: BOT-MOC; authors' calculation
*,**,*** indicates the 10%, 5%, 1% significant levels.

Table 3.9: Distribution of system-wide critical-sales-drop at year 2004 and 2009

	Critical Sales Drops (%)	
	2009	2004
Sample	26018	26101
Top Deciles	82.2	67.9
Top Quartile	58.2	46.4
Mean	39.3	31.3
Median	34.2	25.7
Bottom Quartile	17.0	11.7
Bottom Deciles	7.0	4.7



Source: BOT-MOC; authors' calculation

Table 3.10: Resiliency improvement between 2004 to 2009

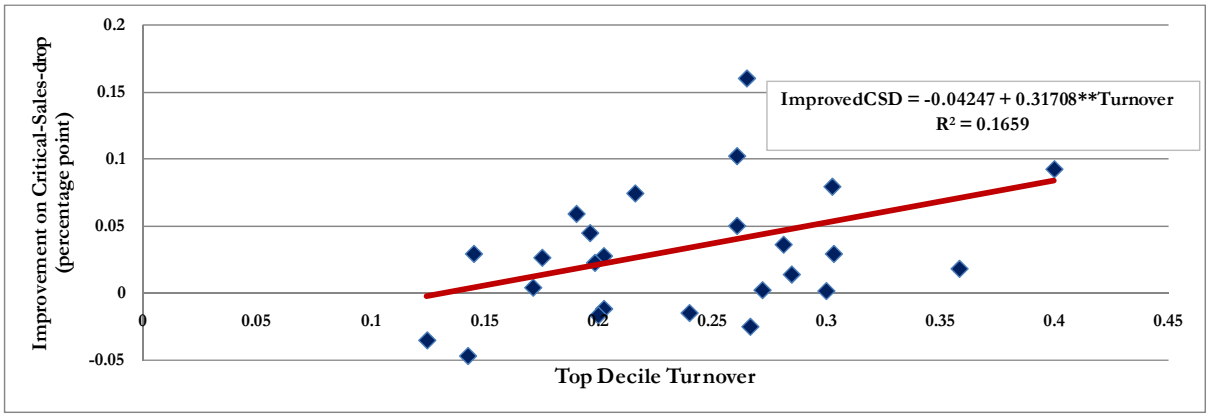
		Improvement in Critical Sales Drop (%)*				
	Sector	Top Quartile	Median	Average	Bottom Quartile	Bottom Deciles
1	All sector	12%	8%	8%	5%	2%
2	Primary Industry	10%	11%	9%	4%	2%
3	Food & Beverage	24%	6%	10%	1%	-1%
4	Light Industry	6%	5%	5%	3%	1%
5	Heavy Industry	3%	0%	1%	-1%	-1%
6	Electronics & Vehicles	2%	3%	2%	4%	0%
7	Construction & Real Estate	2%	2%	1%	0%	0%
8	Trading	31%	16%	16%	7%	3%
9	Transports, Logistics & Telecommunication	-1%	1%	0%	0%	1%
10	Services	5%	6%	4%	1%	0%

Source: BOT-MOC; authors' calculation
Positive value means resiliency improvement between 2004 to 2009

Table 3.11: Top Decile Turnover

	Sector	Top Decile Turnover
1	All sector	24.6%
2	Primary Industry	40.0%
3	Food & Beverage	26.1%
4	Light Industry	22.0%
5	Heavy Industry	20.0%
6	Electronics & Vehicles	23.2%
7	Construction & Real Estate	35.4%
8	Trading	26.1%
9	Transports, Logistics & Telecommunication	28.3%
10	Services	21.3%

Source: BOT-MOC; authors' calculation



Source: BOT-MOC; authors' calculation
** indicates the 5% significant levels
Note: data is trimmed at 1% to remove outliers in terms of both variables.

7.4 Appendix 4 Stress Testing Methodology

Critical-sales-drop level (CSD) measure the maximum level of shock to firm's sales revenue that firm can absorb and still maintain interest rate coverage ratio of one. CSD at the end of year 2009 is computed as follows:

Before stress

$$\frac{Sale_i - COGS_i - Opex_i}{Int_i} = \text{interest coverage ratio}$$

After stress

$$\frac{[(1-CSD_i)*Sale_i] - [(1-CSD_i*adj_1)*COGS_i] - [(1-CSD_i*adj_2)*Opex_i]}{Int_i} = 1$$

$$\frac{[Sale_i - COGS_i - Opex_i] - CSD_i*[Sale_i - adj_1*COGS_i - adj_2*Opex_i]}{Int_i} = 1$$

$$CSD_i = \frac{Int_i - [Sale_i - COGS_i - Opex_i]}{[Sale_i - adj_1*COGS_i - adj_2*Opex_i]}$$

Where;

$Sale_i$, $COGS_i$, $Opex_i$ and Int_i are sales revenue, cost of goods sold, operating expense and interest expense of firm i in sector j.

CSD_i is critical sales drop in percentage term for firm i in sector j.

The term Adj_1 and Adj_2reflects sector j's ability to reduce cost of goods sold and operating expense in case of sales drop respectively.

Value of Adj_1 ranges from zero to one. Adj_1 of 1 means sector able to reduce cost of goods sold in the same proportion as sales drop, e.g. if sales drop by 10%, firm able to reduce cost of goods sold by 10% as well. Similarly, value of Adj_2 also ranges from zero to one. Adj_2 of 0.5 means sector able to reduce operating expense only a half of the percentage drop in sales, e.g. if sales drop by 10%, firm able to reduce COGS by 5%.

COGS and OPEX adjustment factors for sector j, namely $Adj_{1,j}$ and $Adj_{2,j}$ are estimated based on following regressions using data from period of 2004 to 2008.

$$\%\Delta COGS_{i,j} = a1 + Adj_{1,j} * \%\Delta Sales_{i,j}$$

$$\%\Delta OPEX_{i,j} = a_2 + Adj_{2,j} * \%\Delta Sales_{i,j}$$

Where;

$\%\Delta COGS_{i,j} = (COGS_{i,t} - COGS_{i,t-1}) / COGS_{i,t-1}$ represents the percentage change in cost of goods sold of firm i in sector j from year t-1 to t.

$\%\Delta OPEX_{i,j} = (OPEX_{i,t} - OPEX_{i,t-1}) / OPEX_{i,t-1}$ represents the percentage change in operating expense of firm i in sector j from year t-1 to t.

$\%\Delta Sales_{i,j} = (Sales_{i,t} - Sales_{i,t-1}) / Sales_{i,t-1}$ represents the percentage change in sales revenue of firm i in sector j from year t-1 to t.

We find that COGS and OPEX adjustment factors are asymmetry. Estimated coefficients based on all firms data including those with positive and negative sales growth and one estimated from firms with negative sales growth only yield noted differences. Results from the first dataset are found to be in many sectors greater than one. As a result, we opt for later results which are more in line with our stress scenario. Value of Adj_1 ranges from 0.81 to 1.08 with a mean of 0.99. Value of Adj_2 ranges from 0.14 to 0.53 with a mean of 0.3. Details are as follows. Firms with net loss as at 2009 or zero cost of goods sold, zero operating or zero interest expense are excluded from the calculation of CSD.

		Adjustment factor	
	Sector	COGS	OPEX
1	All sector	0.990	0.390
2	Primary Industry	0.863	0.534
3	Food & Beverage	1.011	0.143
4	Light Industry	0.999	0.430
5	Heavy Industry	1.028	0.384
6	Electronics & Vehicles	1.083	0.402
7	Construction & Real Estate	1.022	0.408
8	Trading	1.028	0.315
9	Transports, Logistics & Telecommunication	0.880	0.343
10	Services	0.805	0.380

7.5 Appendix 5 Default Rate Sensitivity Methodology

The paper estimate Logistics model of the following form for all sectors j.

$$Pr_{i,j}(DF=1 \mid \%\Delta Sales_{i,j}) = \frac{1}{1 - e^{-(\alpha+\beta * \%\Delta Sales_{i,j})}}$$

Where;

$Pr_{i,j}(DF=1 \mid \%\Delta Sales_{i,j})$ represents an estimated probability the firm i in sector j will default for given change in sales revenue.

$\%\Delta Sales_{i,j}$ represents the percentage change in sales revenue of firm i in sector j

The coefficients term β represents default rate sensitivity of sector j. The coefficients term β is expected to take a negative value since the probability of firm in any sector should drop when firms have improved sales revenue figure.

For example, the estimated slope coefficients β of -0.015 for sector j can be interpreted as one percentage increase in sales revenue, the log odds of default probability for firm in sector j will decrease by 1.48% ($e^{-0.015} - 1$). This model is equivalent to model the log odds of probability ratio (logit) as a linear function of percentage change in sales revenue. Logit value defines as Ln ($Pr_{i,j}$ (DF=1) / (1- $Pr_{i,j}$ (DF=1)).

The paper employs maximum likelihood method to estimate the parameters of the model based on firm level data by sector. The logit takes the value Ln(1/0) if firm defaults and Ln(0/1) if firm does not default. The paper estimates the model by pooling data from the period 2004 – 2009 together to ensure sufficient records of defaulted firms. The non-default firm is randomly selected to be twice the size of the defaulted firm in each pool. Data is trimmed (5 percent) to remove possible outlier.