ECONOMIC ANALYSIS ON PRODUCTION CHANGES, MARKET INTEGRATION AND EXPORT CHALLENGES OF COFFEE SECTOR IN INDONESIA

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AGUS NUGROHO

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CHAPTER 1
INTRODUCTION

1.1 Introduction

Indonesia has a long historical relationship with coffee. This commodity has become the main income source in some regions, particularly the Java and Sumatra islands. Small-scale farming accounts for approximately ninety percent of the total production. Robusta accounts for about 70 to 80 %, and Arabica coffee accounts for the remainder.

Indonesia's long experience with coffee does not guarantee sustainability in this sector. Brazil is the largest coffee-producing country. Vietnam surpassed Indonesia in terms of total coffee production in the 1990s. Numerous factors are involved. The rice self-sufficiency program during the Soeharto New Order (*Orde Baru*) and the palm oil (including rubber) expansion policy have left coffee behind (Nelson, 2008; Feintrenie *et al.*, 2010). The development of coffee production is not a priority.

Coffee is normally sold in bulk. Intermediate traders buy coffee from farmer gates or through cooperatives. In the domestic market, the value chains are short, and the requirements are uncomplicated, with small price variations. In export markets, however, at least double the standards are required. The government has established the *National Standard* (SNI), focusing on physical appearance issues such as defect ratios, moisture content, and dirt/foreign particles.[1] In addition, trading partners and importers set additional requirements through formal or non-formal certification bodies and force farmers/suppliers to perform quality assurances such as traceability, eco-socio friendliness, and other compulsory requirements (Daviron and Ponte, 2005; Raynolds, Murray and Heller, 2007; Auld, 2010). Various types of coffee certification can easily be found, such as *Fair Trade*, *Organic*, *4C*, and *Rain Forest Alliance*. These certifications are normally done through farmer cooperatives rather than by individual farmers. Without assistance and relevant support from the government, farmers become the weakest stakeholders, for at least two reasons. First, the characteristics of the export requirements demanded by buyers change periodically. Second, the motivation of farmers involved in this certification is to ensure that their coffee can be sold according to universal export market requirements (Rice, 2001; Arifin, 2010; Pierrot, Giovannucci and Kasterine, 2010; Ibnu *et al.*, 2015).

[1] SNI 01-2907-2008 of Coffee Bean.

Issues such as productivity and coffee certification lead to an essential question: Is it worth maintaining coffee as a main commodity in Indonesia? The answer depends on at least three measurements. First, in the macro context, an analysis of the coffee sector's contribution to the Indonesian economy is examined. The aim is to observe the structural change in the coffee sector and to derive a conclusion about whether coffee is still one of the key sectors. Structural change analysis of the Indonesian economy can be found in many previous studies (Akita, 1991; Akita and Hermawan, 2000; Fujita and James, 1997; Scherr1989). However, they focus on the structural changes in the context of manufacturing and agricultural sectors in general. None has discussed the coffee sector specifically. The absence of relevant economic analyses of the coffee sector in Indonesia is interesting since this country is the fourth-largest coffee producing country in the world. For other coffee-producing countries, such as Brazil, Vietnam and Tanzania, studies on structural changes in the coffee sector are available (McCaig and Pavcnik, 2013; Ha and Shively, 2008; Giovannucci *et al*, 2004; Adams, Behrman and Roldan, 1979). Although most agricultural sectors (including coffee) are likely less important in terms of total production and share of GDP (Martin and Warr, 1993), another conclusion can be derived by analyzing the importance of particular commodities in international trade through export and import structures (Hossain, 2009; Wood and Mayer, 2001). This perspective allows an examination based on export performance and can lead to arguments regarding the importance of coffee in terms of world trade.

Coffee export performance analysis leads to the observation of coffee market structures. Logically, coffee's strong export performance is related to the integration of coffee markets. The more integrated the markets are, the higher the markets' degree of openness, and the better the export performance. Therefore, determining the integration between Indonesia and regional or world coffee markets is the second empirical task needed to test the importance of coffee in Indonesia. If the markets are well integrated, this would impact trade cost, efficiency, openness, and price transmission in the long run. Coffee in Indonesia is an export-oriented commodity; therefore, the more integrated the markets are, the more significant its effects on the importance of coffee. World coffee markets are one of the most active, and studies regarding coffee market integration as well as price asymmetric transmission are widely available (Krivonoz, 2004; Conforti, 2004; Mofya-Mukuka and Abdulai, 2013).

However, coffee trade performance can be influenced by risks. These risks may come from price volatility, exchange rates, natural disasters, or specific trade regulations. It is essential to note that food safety regulations has become a serious issue in the coffee trade. Previous studies have shown the impacts of the implementation of particular food safety regulations on agricultural trade (Otsuki, Wilson and Sewadeh, 2001). Other studies indicate that these regulations have been acting as non-tariff barriers to trade (Henson and Loader, 2001). Rapid changes in and more stringent implementation of these regulations are two main characteristics of the current situation. Therefore, it is important to identify the potential impacts of food safety regulations on the Indonesian coffee trade.

This background is a challenge to research on coffee. To maintain focus, this study is economics-based research on trade- and economics-related topics. This study contributes to trade-related research in both general and specific contexts. Although some of the methodologies used in this study are widely applied, no thorough assessment of the Indonesian coffee trade has been attempted. This study intends to provide useful findings on and constructive recommendations for the Indonesian coffee sector.

1.2 Research Objectives

Indonesia is the world's fourth-largest coffee producer after Brazil, Vietnam, and Columbia. Approximately, 60 to 70 % of total production is exported, and the remaining 30 % is consumed domestically. Since a large portion of the coffee production in Indonesia is exported, it is important to measure the significance of coffee's contribution to the economy. It is also necessary to identify whether the coffee sector had become an important sector. Furthermore, a steady state for export quantities and export destinations may indicate that Indonesian coffee markets are mature and well-developed. However, it needs to be clarified whether Indonesian and world coffee markets are well-integrated. Thus, further clarification and estimation are required to obtain a valid conclusion on the importance of the Indonesian coffee sector. Therefore, the main objective of this study is to explore the current Indonesian coffee trade situation and the fundamental constraints that prevent improvement in Indonesia's coffee export performance. For that purpose, the main objective of this study can be decomposed into three elements of assessment and estimation:

- First, to investigate the importance of the coffee sector in Indonesia in terms of production and trade.
- Second, to identify the integration and price transmission between Indonesia and world/regional coffee markets.
- Third, to analyze domestic policy in terms of its implications for coffee-specific trade challenges.

The first objective relates to the structure of the Indonesian economy. In general, a country's economy consists of many production sectors. Some may be indicated as key due to several of their contributions. For example, the sector may generate employment, thus decreasing unemployment rates and improving productivity. The sector may produce significant quantities and values of a particular commodity (e.g., rice), thus satisfying domestic demand and preventing the need for imports. Another sector may produce a small quantity of a particular product but have higher value added by satisfying foreign demand and contributing income through export. Therefore, the importance of particular sectors of the economy should be determined first. In this study, the identification of the importance of the coffee sector in Indonesia follows the latter explanation. To achieve the first objective, this study examines the structure of the coffee sector within the Indonesian economy in terms of production and trade, focusing on three periods—2000, 2005, and 2010. The structural changes in coffee production and trade are identified through several methodologies of input–output analysis. The results indicate an improvement in coffee production and in its contribution to Indonesia's economy through export. They also indicate that the export of coffee has become more significant recently. The overall evidence shows the importance of the coffee sector in Indonesia.

To meet the second objective, several estimations on coffee prices between the Indonesian and world coffee markets are calculated. A relationship between the Indonesian and world coffee markets is revealed based on the prior assessment of the structure of the Indonesian coffee market. By using several time series techniques on the cointegration and Error Correction Model (ECM), relationships represented by the existence of a long-run equilibrium between the two coffee prices (cointegration), the direction of causality, the speed of adjustment toward equilibrium, and the symmetrical movement of the deviation towards equilibrium, are identified. For example, if the conclusion of cointegration holds, then the price shock directions can be analyzed. One direction indicates that one market is the cause and the other the recipient, whereas the two directions indicate that each market causes the other's shock. Regarding the speed of adjustment, a quick adjustment speed toward equilibrium implies that the price in one market is fully adjusted following the price in the reference market. Finally, asymmetry in price transmission implies a non-linear adjustment between the prices.

The third objective is to address the current challenges faced by Indonesian coffee exports. This study attempts to create a coffee trade model and estimate the impact of certain food safety regulations on coffee exports. To achieve this objective, this study uses the concept of the gravity model of trade and applies a panel data estimator. It is expected that the findings are relevant to the current research on the gravity model regarding the negative impacts of food safety regulations on agricultural trade.

This study is significant in several ways. It assesses the coffee sector in Indonesia and evaluates its importance and structural changes. This evaluation should help the development of the coffee industry in Indonesia; one way to improve it is by strengthening exports. The study also examines how the coffee market in Indonesia is affected by the world coffee market. Several implications useful for policy intervention, market infrastructure, industry concentration, and transactional cost can be derived based on this estimation. Finally, this study provides an analytical basis for encountering future food safety regulations that may influence Indonesian coffee exports. These useful findings may help to prevent future export barriers due to regulations.

1.3 Methodology

This study is quantitative research based on an econometric methodology. The structure of this study can be viewed as a pyramid. The bottom of the pyramid discusses the role of the coffee sector in a macro-economic context in Indonesia, especially in the context of coffee export and trade. This section addresses the first objective of this study regarding the importance of the coffee sector in Indonesia. The importance of the coffee sector is analyzed using three approaches based on the application of an Indonesian input–output (IO) table: sectoral comparison and structural changes and export, or trade, inducement. The Indonesian IO table, similar to other national IO tables, consists of three main parts: (1) Intermediary input (i.e., intermediary demand); (2) final demand; and (3) value added.[2]

[2] The detailed structure of the IO table can be seen in Appendix 3.

Using the single period of the Indonesia IO table, the first approach is to describe the structure of the total production of each sector, the structure of the final demand, and the structure of the value added of the Indonesian economy. This evaluates the importance of the coffee sector in terms of production and consumption in final demand (e.g., household consumption, government spending, investment, and export) and measure the concentration of Indonesia's primary, secondary, and tertiary sectors, which leads to an analysis of the development stage. Generally, the primary sector is most important for developing countries. The second approach compares more than two Indonesian IO tables to identify structural changes in production and final demand. If the coffee sector experiences higher or positive changes in terms of production and final demand, it can be concluded that the importance of the coffee sector is growing. Finally, the third approach focuses on international trade (export–import) in terms of final demand. This approach identifies which sector has net exports or imports. Furthermore, by comparing more than two IO tables, the structural changes in the trade of each sector can be seen, revealing the importance of the coffee sector in terms of international trade. In Indonesia, for example, paddy is very important for production and is mainly consumed by households as part of final demand. However, paddy may not be important in terms of trade since most of the total production is consumed domestically. Since most of Indonesia's coffee is exported, it is useful to discuss coffee's importance in terms of international trade.

To achieve the first objective of this study, Leontief's input–output analysis is used as the main framework. This framework provides estimation methods and examines structural changes in production and final demand. For example, *linkage analysis* is a method that describes the interdependency among sectors in the economy. Linkage analysis consists of the *index of power of dispersion* (IPD) and *index of sensitivity of dispersion* (ISD), which estimate the influence and sensitivity index of each sector. A sector whose influence and sensitivity are strong is regarded as an important or key sector and vice versa. Using two IO tables for different years, sectoral shifts in the influence and sensitivity index can be identified. In addition, IO analysis provides the *RAS* analysis, a method of updating the input coefficient of a future IO table using the information from the input coefficient in the basic year. Based on the RAS analysis, each sector can be categorized as a growing or declining sector. Finally, the share of coffee production that is demanded domestically or exported internationally to satisfy foreign demand can be estimated using a *Skyline* analysis, reflecting the importance of coffee from the consumption and trade side. These analytical methods are frameworks for measuring the importance of coffee sectors in terms of production and international trade, as is discussed in detail in Chapter Three.

The prior conclusion in the structural change analysis triggers further analyses. Since Indonesia is the fourth-largest coffee-producing country and a large amount of the coffee production is exported annually, it is expected that Indonesia plays a significant role in the international coffee market. There may thus be a relationship between domestic and international coffee markets, reflected in price co-movement in both. Therefore, the second objective of this study is to investigate whether price shocks in the global coffee market are transmitted into domestic coffee markets. In economic terms, this discussion is a price transmission, or market integration, analysis. In this study, it occurs in the middle part of the pyramid. Econometrically, this topic is related to the concept of "cointegration" and the error correction model (ECM). In the cointegration concept, two markets (e.g., two prices in two spatially separated markets) are said to be integrated if the two prices are integrated in the same order (e.g., I[d]) and if there is a stationary linear combination between them. In the literature, the most well-known cointegration test is the Engel–Granger test (Engel and Granger, 1987) and the Johansen Maximum Likelihood test (Johansen, 1988; 1991). The hypothesis in this study is that at least one cointegration exists in the long run between Indonesian coffee prices and world/regional coffee prices.

Cointegration implies that prices are closely related in the long run and drift apart in the short run. Importantly, according to Engle and Granger (1987), if two non-stationary (e.g., I[d]) variables are cointegrated, the valid way to describe their relationship is through an ECM. A Vector Error Correction Model (VECM) is probably the most suitable method of describing the integration of Indonesian coffee markets. It provides an estimation that derives short-run dynamics as well as long-run relationships among the prices.[3] It also provides an estimation of the speed of adjustment toward equilibrium, which can be used to assess the impact of policy interventions, transaction costs, market infrastructure, and other distortions toward equilibrium. Error representation also provides a framework for the asymmetric testing of price transmission. In the Asymmetric ECM (AECM) proposed by Granger and Lee

[3] In the literature, there are several approaches to measuring market integration, such as Static Price Correlation, the Ravallion Dynamic Model, the Parity Bound Model, and Threshold Auto Regression. This study applies VECM and Johansen Cointegration approaches because they are widely applied in the literature.

(1989), the error components from the equilibrium can be decomposed into positive and negative; the magnitudes of these errors represent the asymmetry. A detailed discussion on market integration and price transmission in the Indonesian coffee market is presented in Chapter Four.

The next part may be seen as the top of the pyramid, as current food standards for the coffee trade are discussed here. This section addresses the third objective of this study, regarding the effects of the implementation of importing-country food safety regulations on Indonesian coffee exports. This study demonstrates how the coffee trade is determined by food safety regulations and coffee competitiveness variables in the context of the gravity of the trade framework. From the analytical perspective, this chapter must negotiate several economic and econometric methodology traps. First, the gravity model is a well-known analysis of the relationship between trade and other determining factors, such as GDP, population, distance, trade openness, trade facilitation, and trade costs. However, few studies implement this methodology on a single commodity such as coffee. Therefore, some adjustment is needed. Additionally, the model used in this study attempts to explain the dynamic relationships among the variables; therefore, a simple static OLS or static panel data analysis (fixed or random effect) is not appropriate. The Generalized Method of Moment (GMM) estimator (Arellano and Bond 1991; Arellano and Bover, 1995; Blundell and Bond 1998) is one of the few dynamic panel data analyses that have advantages over other estimation options. For example, the gravity equation may have endogeneity issues because the explanatory variables may be correlated with the error term. Another issue flows from time-invariant country characteristics such as distance or geographical location, which may correlate with the explanatory variables. The GMM estimator consists of two techniques: the Difference GMM and System GMM. This estimator can deal with several econometric problems. Details on this technique and a discussion of the results about the impact of food safety regulations on Indonesian coffee exports are provided in Chapter Five.

1.4 Structure of the Dissertation

This introductory chapter has provided the rationale and motivation for this thesis. It has also outlined its core problem, research questions, and methodological framework. The rest of this study is organized as follows. Chapter Two explores the background and reviews the development of the Indonesian coffee sector. Following the characteristics of the three objectives and methodologies used in this study, each chapter covers a single topic. Accordingly, chapters Three, Four, and Five discuss the structural changes in the coffee sector, market integration, and the impact of food safety policy on the coffee trade, respectively. A literature review on related topics and a discussion of the study's methodology are presented in each chapter. Chapter Six provides a conclusion and policy implementation proposals. Figure 1-1 illustrates the structure of this study.

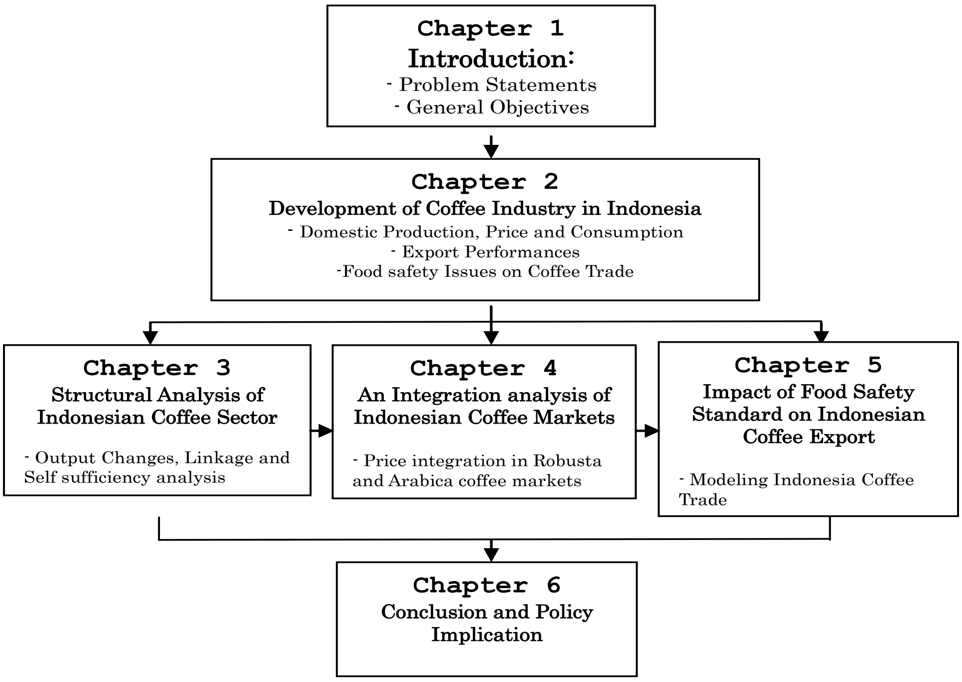

Figure 1-1. Structure of Dissertation

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CHAPTER II
DEVELOPMENT OF THE COFFEE INDUSTRY AND COFFEE TRADE IN INDONESIA

2.1 Domestic Production, Prices, and Coffee Consumption

2.1.1 Coffee Estate Area

Coffee is cultivated across Indonesia's major islands, from west to east, as shown in Figure 2-1. Most coffee plantation areas are located on Sumatra island. Aceh, North Sumatra, South Sumatra, and Lampung are some of the well-known coffee-producing provinces on the island. Relatively small coffee areas are also located in East Java, Bali, Toraja, and Papua.

Coffee areas account for about 1.2 million ha in Indonesia. Around 96 % of this total area is dominated by small estates, and the remaining 4 % are private and government estates (PTP Nusantara). It is estimated that around 77 % (920,000 ha) of this total area is productive.[4]

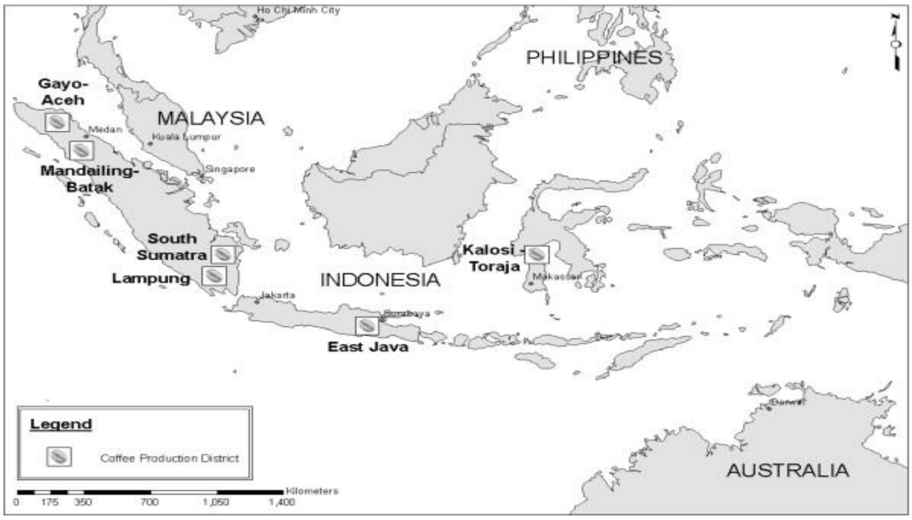

Figure 2-1. Coffee Producing Areas in Indonesia

Source: Nelson (2008)

The total coffee production area has increased considerably over the last 20 years, as is illustrated by Figure 2-2. In 1996, the total area was 1.15 million ha. Although growth was slow, this increased to 1.35 million ha by 2014, representing 17.8 % growth. Figure 2-2 also illustrates that small estates constitute ninety percent of the total coffee area.

[4] AEKI (www.aeki-aice.org).

There were 1.3 million small coffee estates in 2014, showing a rate of growth (around 18 %) similar to that in 1996.

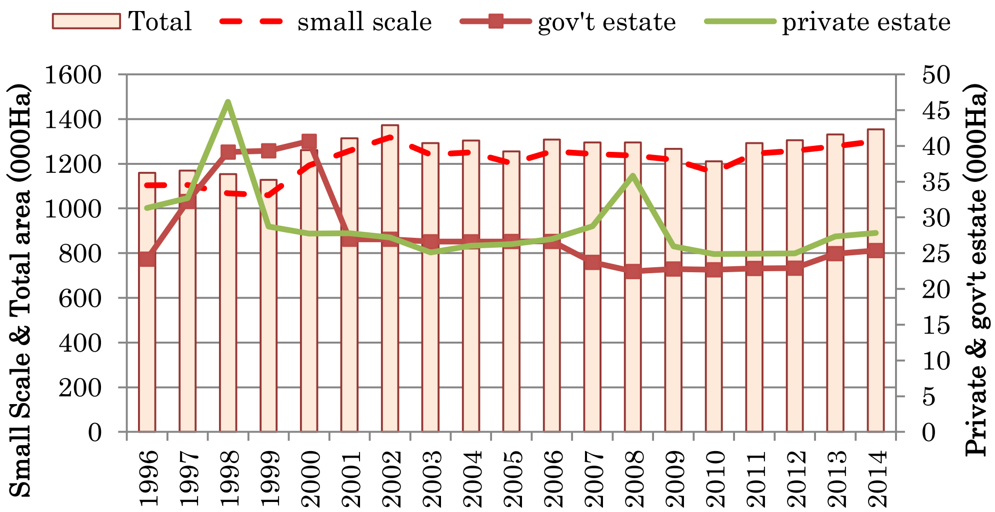

Figure 2-2. Coffee Area Size based on Ownership

Source: AEKI (www.aeki-aice.org)

In contrast to small estates, government and private estates have not shown significant growth. The coffee area owned by the government was estimated at around 24,000 ha in 1996. This increased to 43,000 ha in 2000, but returned to 25,000 in 2014. It grew by 4 % from 1996 to 2014. Private coffee estate areas decreased from 31,000 ha in 1996 to 27,800 in 2014, representing a 10 % reduction. Details on the changes in total coffee areas are illustrated in Figure 2-3.

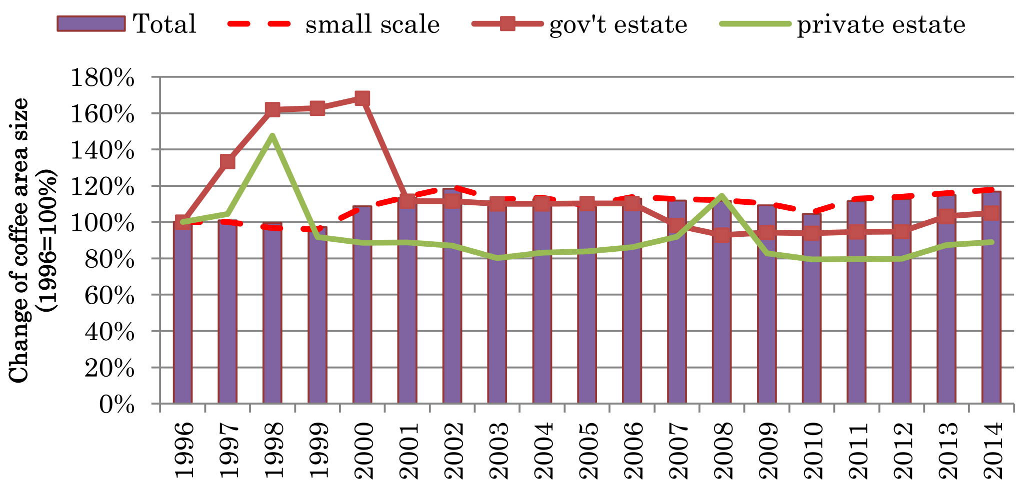

Figure 2-3. Changes in Coffee Area Size based on Ownership

Source: AEKI (www.aeki-aice.org)

2.1.2 Production and Productivity

According to Wahyudi and Misnawi (2012), Sumatra contributes 74.2% of the nation's total production, distributed among South Sumatra (21.4%), Lampung (12.6%), Aceh (8.7%), and Bengkulu (7.4%). The remainder is produced in Sulawesi (9.0%), Java (8.3%, with 7.2% produced in East Java), Nusa Tenggara (5.8%), Kalimantan (2.0%), and Maluku and Papua (0.6%).[5]

Figure 2-4 illustrates the total production of coffee based on estate ownership. Total coffee production has been increasing considerably over the last 20 years. Total production increased from 459,206 tons in 1996 to around 738,000 tons in 2014. Small estates dominate this production, accounting for 435,757 tons in 1996 and 706,690 in 2014. Although production on government and private estates is relatively small, there were significant increases from 1996 to 2000. The highest production on government estates was 29,754 tons in 2000, and the highest production on private coffee estates was around 19,020 tons in 1998. However, both figures declined dramatically and then reached stable levels, at between 10 and 15 thousand tons.

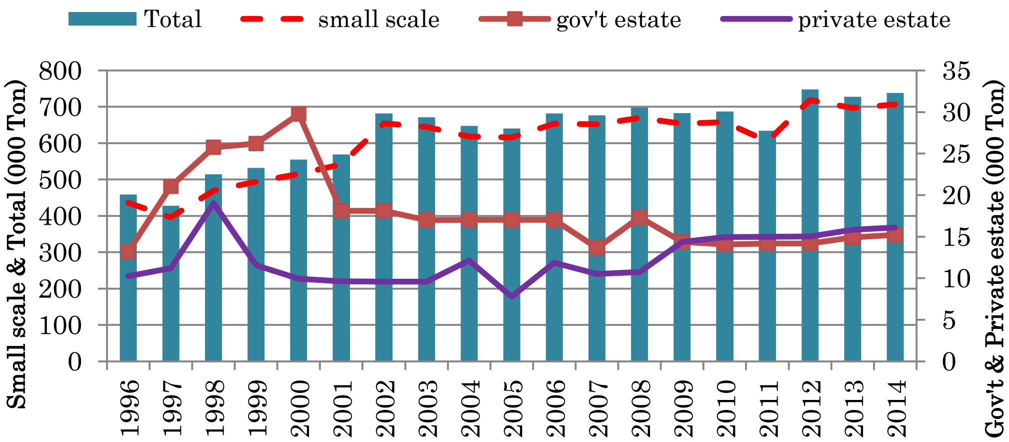

Figure 2-4. Coffee Production based on Ownership

Source: AEKI (www.aeki-aice.org)

In terms of production changes (base year=1996), small estates show the highest growth, accounting for 62.2 % of total growth from 1996 to 2014, as indicated in Figure 2-5. Private coffee estate production grew to 56 % during the same period. The private estate figure shows rapid fluctuation. It is estimated that growth reached 85 % in 1998, then moved to negative 24 % by 2005. From 1996 to 2000, government estates showed

5 Wahyudi and Misnawi (2012). For details, see http://www.ico.org/event_pdfs/seminar-certification/certification-iccri-paper.pdf.

significant growth in production, reaching 125 % in 2000. Afterward, production fell dramatically, to 15 % in 2014, the lowest rate of overall production change.

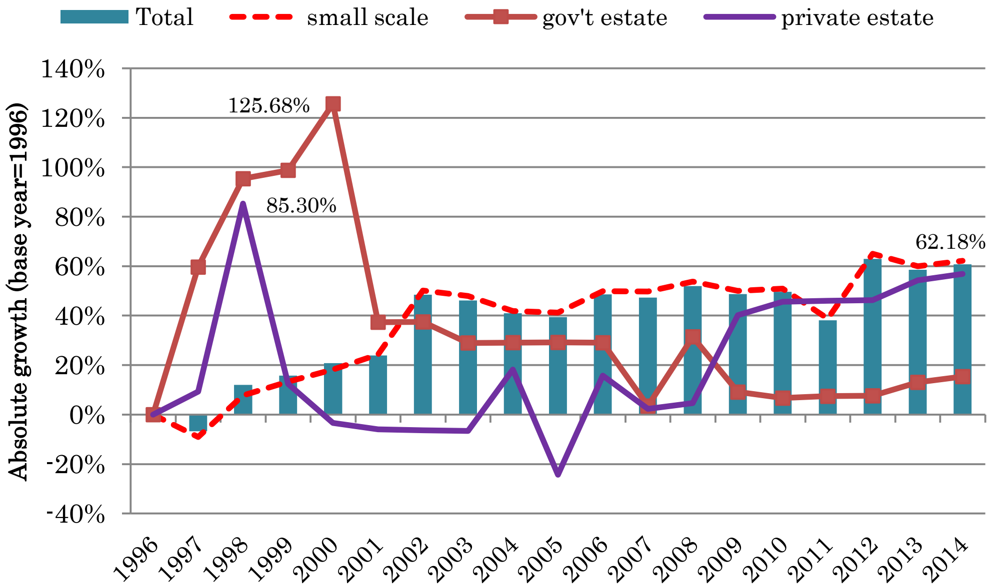

Figure 2-5. Changes in Coffee Production based on Ownership
Source: AEKI (www.aeki-aice.org)

Indonesia produces Robusta and Arabica coffee. Robusta dominates, accounting for 80 % of all production. Figure 2-6 illustrates this composition. Although Arabica has a small share of the total coffee production, this share grew significantly, from 13.9 % in 1999 to 19.6 % in 2012. This growth indicates a rapid change in the coffee plantation structure in Indonesia due to Arabica's higher economic gain. Arabica is mostly

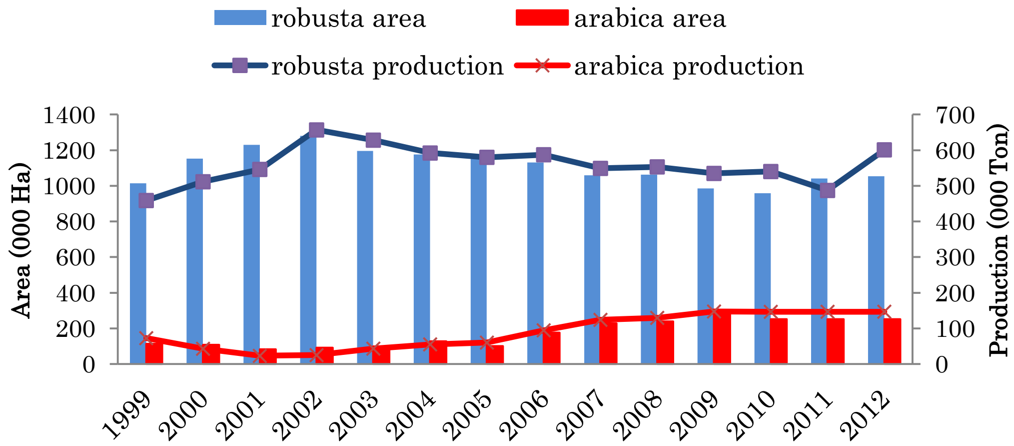

Figure 2-6. Arabica and Robusta Structures
Source: AEKI (www.aeki-aice.org)

produced in Aceh and North Sumatra due to their altitudes, whereas Robusta is the main crop in other areas, such as Lampung, South Sumatra, and East Java.

On average, 500 to 600 thousand tons of Robusta are produced annually. Although there was a declining trend after 2002, Robusta production climbed to 601,092 tons in 2012. Interestingly, there has been an increasing trend in Arabica production since 2001. It was around 23,000 in 2001, rose to 97,000 tons in 2007, and finally reached 147,000 tons in 2012. This represents a 102 % growth from 1999 to 2012. This increasing trend for Arabica implies a significant change in the structure of coffee production in Indonesia

In terms of quantity, Lampung and South Sumatra, the largest coffee-producing areas in Indonesia, produced around 140 to 150 thousand tons annually. Bengkulu, North Sumatra, Aceh, and East Java produced approximately 50 thousand tons each year. Around 30 thousand tons of coffee are produced in South Sulawesi, a mid-eastern part of the Indonesian archipelago. Coffee production in selected coffee-producing regions is presented in Table 2-1. Annual growth in these regions is relatively low, less than 5 % on average. In terms of quality, popular Indonesian coffees such as Mandheling (North Sumatra), Gayo (Aceh), Luwak, and Toraja are well-known internationally. These coffees are traded as specialty coffees, usually at premium prices.

Table 2.1 Coffee Productions in Selected Provinces

	Aceh		North Sumatra		South Sumatra		Lampung		East Java	
	Q	Δ(%)	Q	Δ(%)	Q	Δ(%)	Q	Δ(%)	Q	Δ(%)
2007	48.10		50.20		148.30		140.10		47.00	
2008	47.80	-0.6	54.90	9.4	155.40	4.8	140.10	0.0	51.60	9.8
2009	50.20	5.0	54.40	-0.9	131.60	-15.3	145.20	3.6	54.00	4.7
2010	47.70	-5.0	55.80	2.6	138.40	5.2	145.00	-0.1	56.20	4.1
2011	52.30	9.6	56.80	1.8	127.40	-7.9	144.50	-0.3	37.40	-33.5
2012	54.90	5.0	58.61	3.2	144.88	13.7	136.17	-5.8	54.91	46.8
2013	54.31	-1.1	57.98	-1.1	143.33	-1.1	134.72	-1.1	54.19	-1.3
average	50.76	2.2	55.53	2.5	141.33	-0.1	140.83	-0.6	50.76	5.1

Source: Statistic Indonesia (www.bps.go.id in agriculture and mining/plantation)
Note: Q = quantity in 000 ton
Δ = year of year growth in %

Coffee productivity in Indonesia has become an important issue. Governments and policymakers suspect weak agricultural technology application and poorly managed agricultural inputs (e.g., fertilizer) intended for cost saving on most small estates are causing this productivity problem. Additionally, small farmers rely on inherited plantations, which may have lower levels of productivity. Farmers are sometimes reluctant to rejuvenate their coffee plantations due to the high costs.

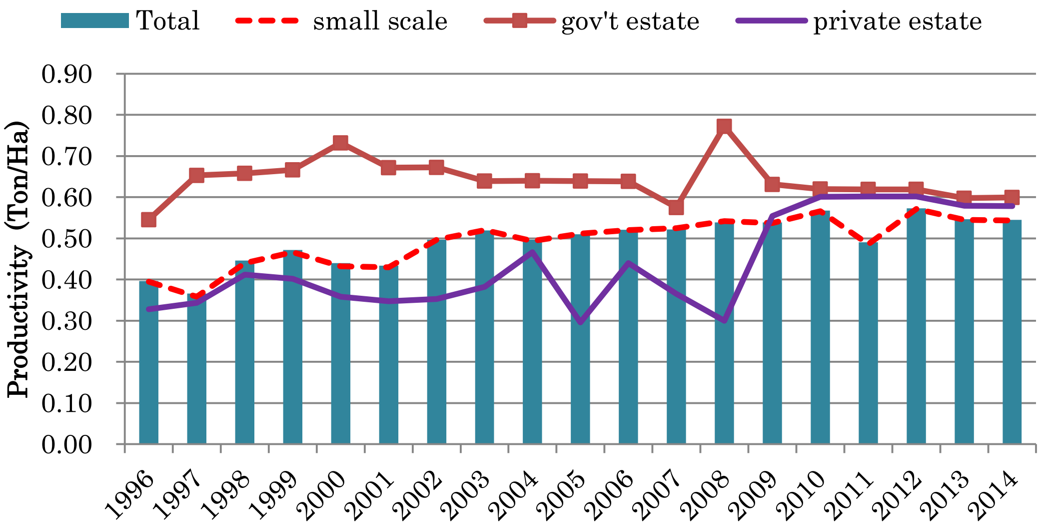

Figure 2-7 Coffee Productivity based on Estates Ownerships

Source: AEKI (www.aeki-aice.org)

As Figure 2-7 illustrates, the average productivity of coffee plantations and small estates is about 0.5 tons/ha. Prior to 2009, the productivity of private estates was below that of the small estates. However, it later increased to about 0.6 tons/ha, somewhat higher than the level of small estates. Government estates have the highest productivity, maintaining a level of 0.6 tons/ha or above from 1996 to 2014.

Similar productivity trends are found in each coffee region. Figure 2-8 illustrate that Lampung has the highest productivity level, at 0.8 tons/ha in 2013, followed by North Sumatra, at 0.7 tons/ha. Productivity in South Sumatra and Aceh is at 0.6 and 0.45 tons/ha respectively. On average, the productivity of these four major coffee regions is at around 0.6 tons/ha, somewhat higher than the average productivity across all areas. Thus, the productivity levels in these four areas represent the productivity at the country level, and the surplus or shortage of Indonesian coffee also depends on the situation in these four regions.

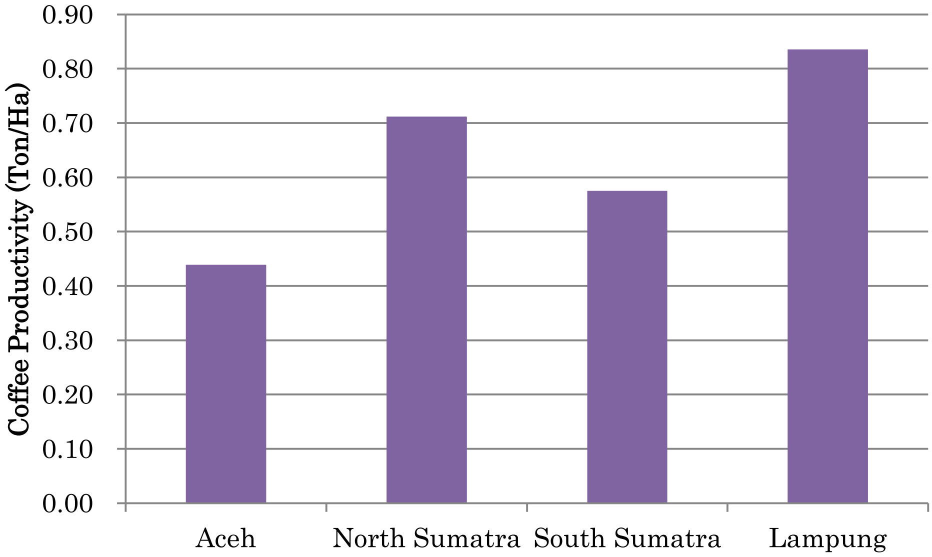

Figure 2-8. Coffee Productivity in Selected Provinces (Ton/Ha-2013)
Source: Statistic Indonesia (www.bps.go.id in agriculture and mining/plantation)

2.1.3 Comparison of Coffee with Other Crops

Small farmers tend to plant coconut or rubber rather than coffee. It is estimated that the total area of coconut and rubber farming is around 3.5 million ha and 3 million ha respectively, much higher than that for coffee (1.2 million ha). The oil palm area increased from 1 million ha in 2000 to 4.5 million ha in 2014, an increase of 2.82 times its total area. This indicates that oil palm became the most influential crop during this period. Furthermore, since 2006, cacao cultivation has surpassed coffee cultivation, representing a shift in crop structures in Indonesia. A comparison of the crop area sizes of small estates is presented in Figure 2-9.

Similar characteristics are found in the large estate figures. Total coffee plantation in this category is between 50 and 70 ha. Cacao and rubber cultivation have grown, accounting for around 100 and 500 ha respectively. Oil palm development has been impacting the massive expansion of this commodity's cultivation area, which accounted for more than six million hectares in 2014. The total crop areas of some of the commodities cultivated by large estates are presented in Figure 2-10.

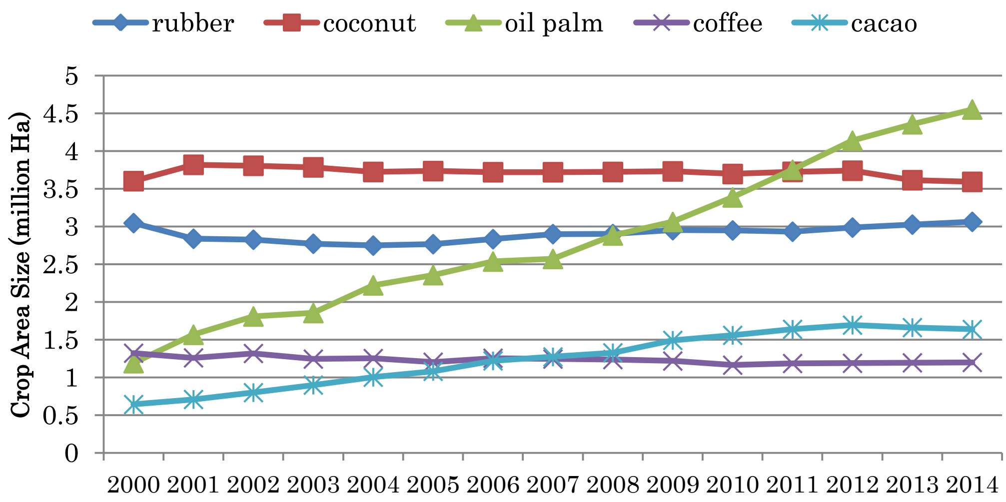

Figure 2-9. Crop Area Size of Small Scale Estate (million Ha)
Source: Statistic Indonesia (www.bps.go.id in agriculture and mining/plantation)
Note: this figure uses different source of data and it is assumed that coffee area is similar to the previous figure

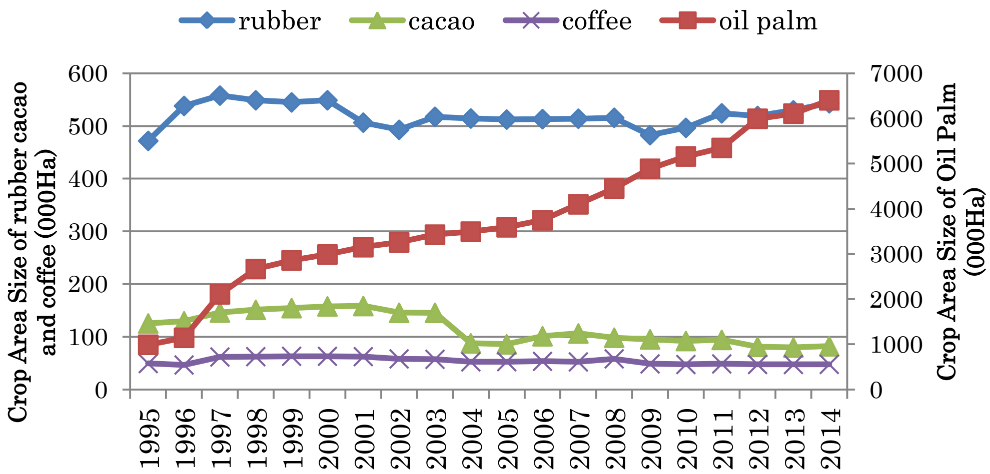

Figure 2-10. Crop Area Size of Large Scale Estate (000 Ha)
Source: Statistic Indonesia (www.bps.go.id in agriculture and mining/plantation)
this figure uses different source of data and it is assumed that coffee area is similar to the previous figure

The volume of coffee produced by small estates is much lower than that of rubber and coconut but similar to the total production of cacao. Rubber production was around 2 million tons and coconut around 2.5 million tons on average. More than 10 million tons of oil palm were produced in 2014, indicating a boom in this crop. Details on the production of several crops on small estates are presented in Figure 2-11.

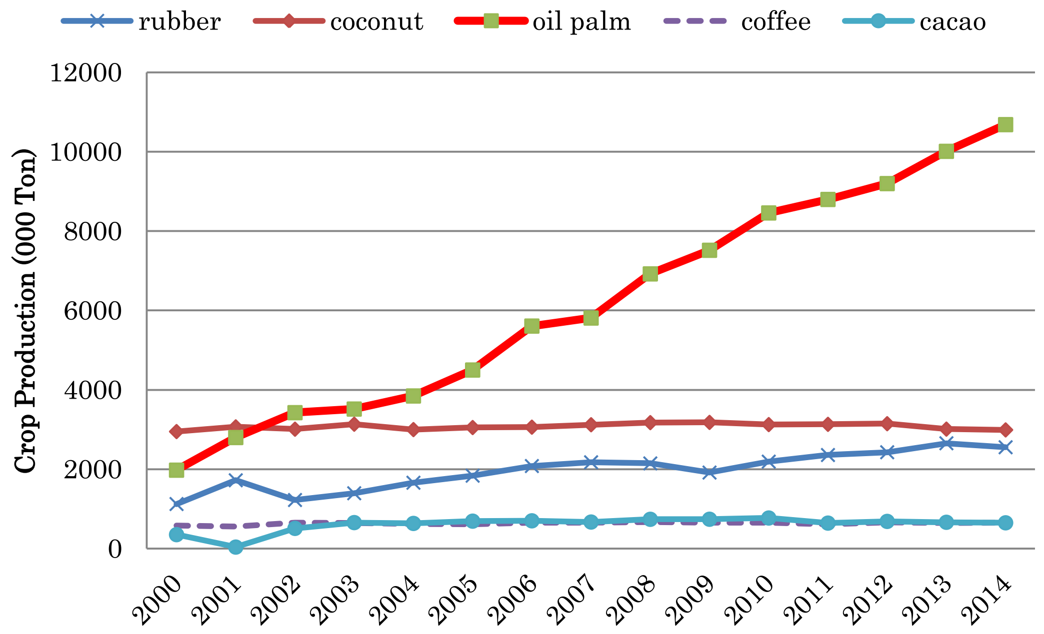

Figure 2-11. Production of Small Scale Estate (000 Ton)
Source: Statistic Indonesia (www.bps.go.id in agriculture and mining/plantation)

Large estates contribute around 30 to 40 thousand tons of coffee on average annually. Although this amount is small compared to the total production of small estates, large estates diversify their business by buying coffee from farmers and provide technology for coffee production and processing chains. Large estate companies are more interested in oil palm cultivation, as indicated by the huge amount of oil palm production shown in

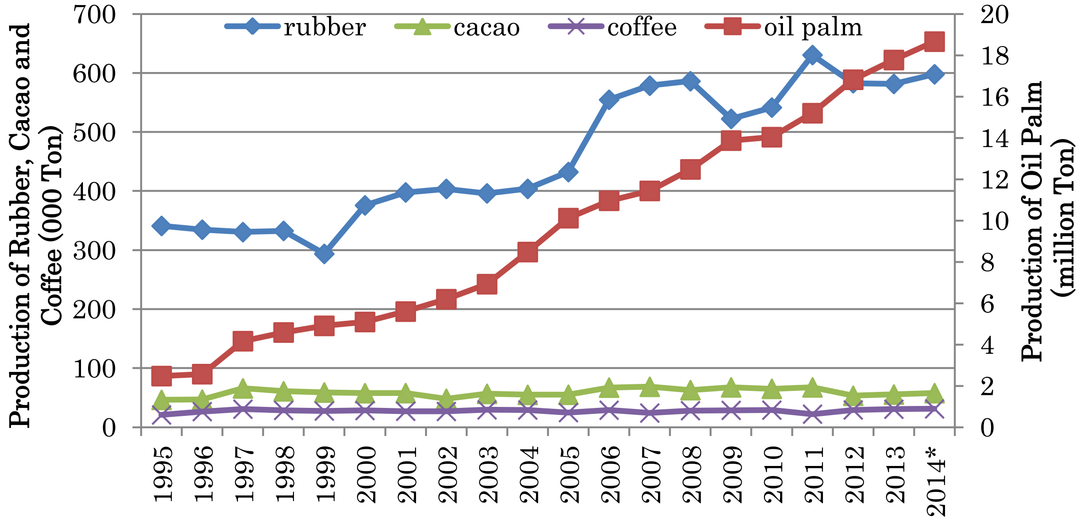

Figure 2-12 Production of Large Scale Estate (Ton)
Source: Statistic Indonesia (www.bps.go.id in agriculture and mining/plantation)

Figure 2-12. Production of oil palm was estimated at around 18 million tons in 2014, much higher than the production of other crops.

A deeper understanding of coffee production characteristics in Indonesia can be obtained by observing the share of crop areas in some of the coffee producing regions. The share of crop areas measures the composition of each crop area out of all six crops areas, revealing the importance of a particular crop in each region. Coffee accounts for the majority in Lampung (23 % of the total crop area), followed by Aceh and South Sumatra (15 and 11 % respectively). North Sumatra favors oil palm plantation, since 64 % of the total crop area is planted with this crop. Aceh and South Sumatra also have significant shares of oil palm, at almost fifty percent. Lampung seems to have a balanced composition, indicating that cultivation in this province is well diversified. Crops such as tobacco and sugarcane are relatively large in Lampung province compared to other regions. Details on the composition of each crop area share are provided in Figure 2-13.

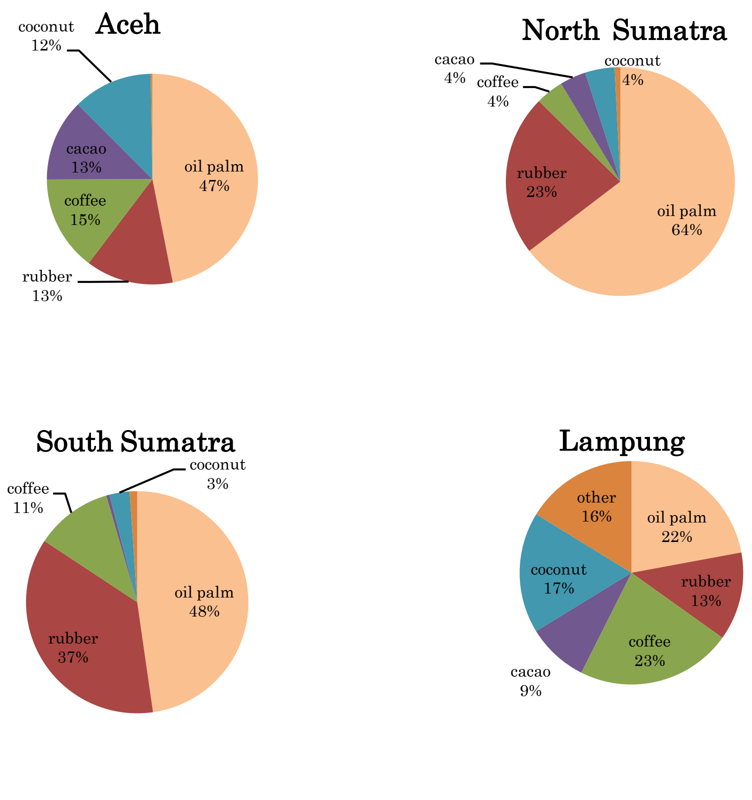

Figure 2-13. Share of Crop Area Over Total Plantation Area (2013)
Source: Statistic Indonesia (www.bps.go.id in agriculture and mining/plantation)
*) others (tea, tobacco, sugar cane)

The interest of estate companies in the oil palm sector is indicated by Figure 2-14. There is an opposite trend in the number of large estate firms between oil palm and other crops. The number of oil palm companies increased significantly from 2000 to 2014. Around 1,600 companies were established on oil palm estates in 2014. Coffee has become less attractive: fewer than 100 companies established assets in this crop in 2014. The number of companies involved in large coffee estates has also been declining since 2000. A similar trend is found for other crops during the same period.

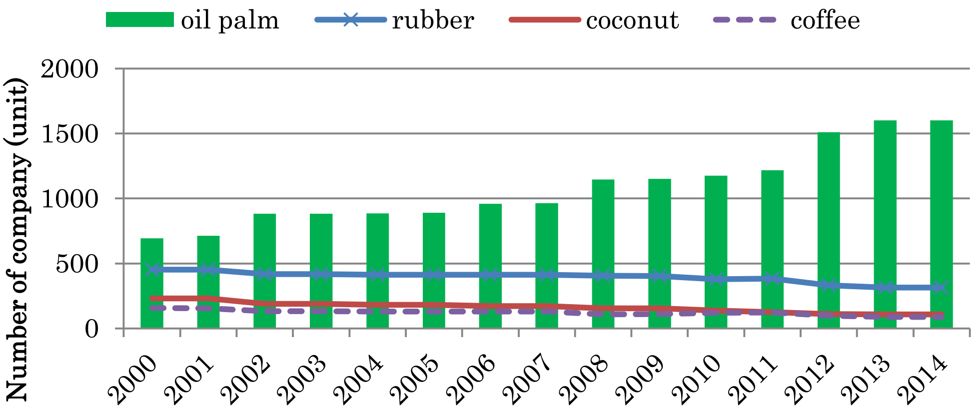

Figure 2-14. The Number of Enterprises in Large Scale Estate
Source: Statistic Indonesia (www.bps.go.id in agriculture and mining/plantation)

2.1.4 Domestic Coffee Prices

Arabica prices are normally higher than those for Robusta due to strong demand and limited supply both domestically and internationally. Figure 2-15 illustrates the trend in Arabica and Robusta prices paid to Indonesian growers. The discrepancy between the prices is almost double. Production of Arabica is limited in Indonesia (around 10%), as this type of coffee is seldom blended with other types in the final products. Consumers prefer to consume it alone (i.e., non-blended). The production risk is also higher since this type of coffee is less resistant to disease; therefore, its price fluctuation is high. Robusta is produced in large amounts and is normally blended. Therefore, prices are at a discount. From 2000 to 2007, the highest price for Arabica was around 130 US cents a pound, whereas it was approximately 70 US cents a pound for Robusta.

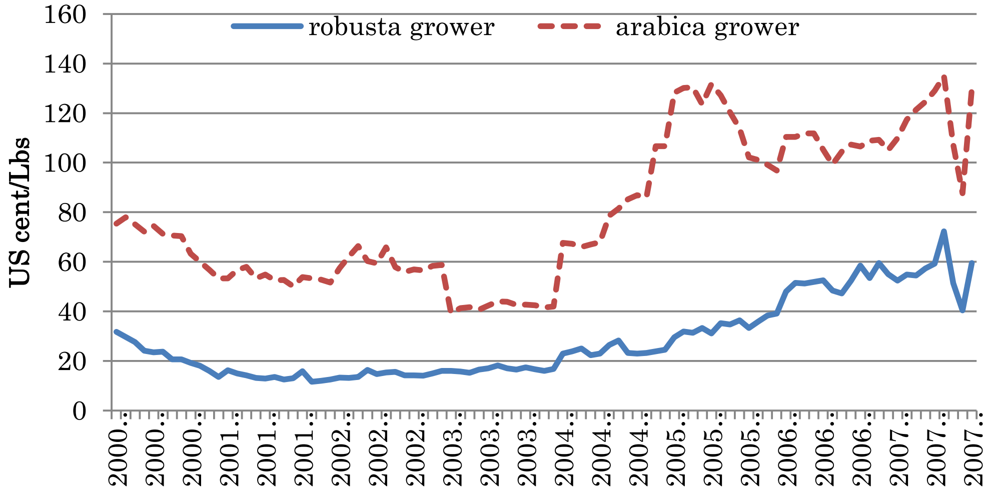

Figure 2-15. Coffee Grower Prices in Indonesia (US cent/lbs)
source: ICO (www.ico.org in historical price data)

Another coffee price indicator is coffee spot prices on the commodity market. Figure 2-16 illustrates the spot prices for Arabica and Robusta in Indonesia. The spot price for Arabica is based on North Sumatra prices, since Arabica is traded actively from this region, whereas that for Robusta is based on Lampung prices. These spot prices are used as a reference for farmers and traders dealing with domestic and export contracts.

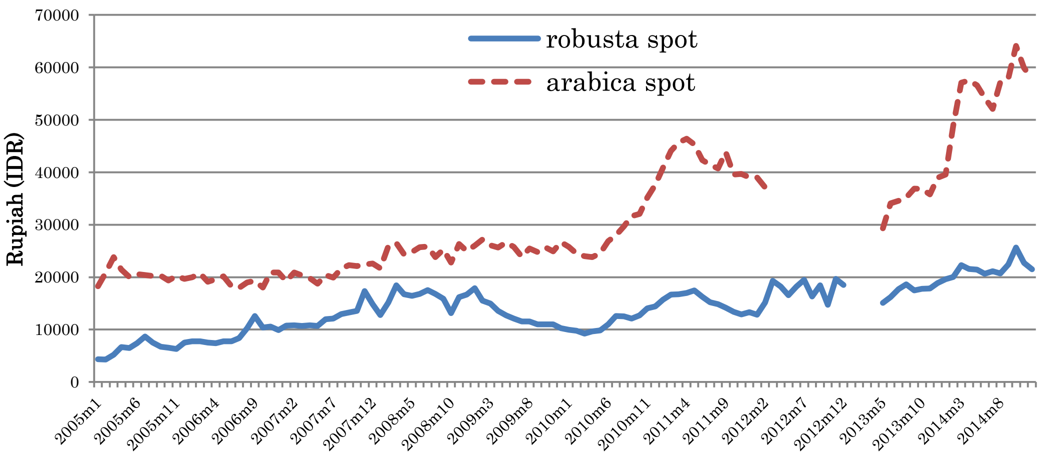

Figure 2-16. Arabica and Robusta Spot Prices in Indonesia (Rupiah/kg)
source: Bappepti/ IDX (www.bappepti.go.id in commodity prices)
note: The break represent no data. Bappepti calculates domestic spot prices and uses New York Arabica future price and London Robusta future price as references.

2.1.5 Coffee Consumption

Domestic per capita consumption of coffee in 2015 was around 1.378 kg/year, an increase of around 7 % over the figure for 2010. During the same period, the total domestic consumption of coffee (bean and soluble) also increased to 14 %, or approximately 325,150 tons in 2015, as indicated in Figure 2-17. Domestic consumers have preferred soluble to ground coffee recently, particularly in urban areas.

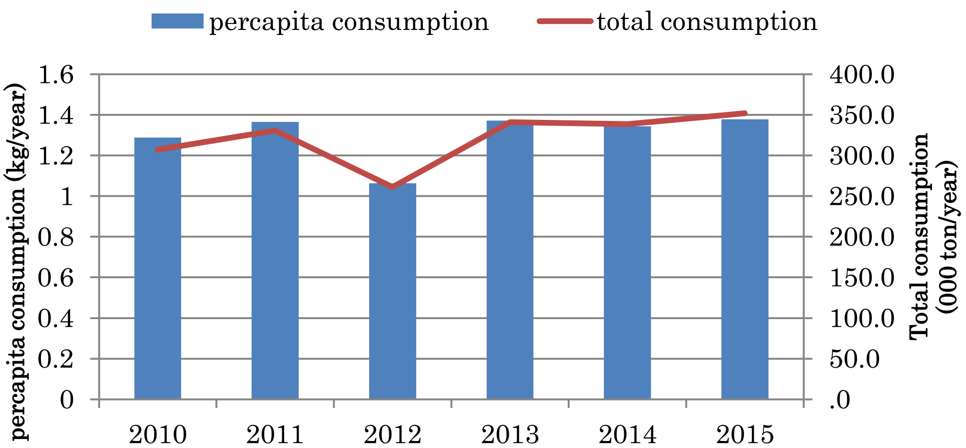

Figure 2-17. Domestic Consumption of Coffee

Source: Directorate General of Plantation (www. http://ditjenbun.pertanian.go.id/)

2.2 Indonesian Coffee Export Performance

Coffee is an important global commodity, accounting for approximately US$21.6 billion in trade in 2011–12 and reaching a record total of 109.4 million bags, for an increase of 4.5 % over 2010–11. Indonesia is the third-largest coffee producer in the world (based on 2012–2013 figures[6]). Domestic consumption is estimated at 38 %, and the remaining 62 % is exported.[7]

During the 2002 to 2011 crop year calendars, the total production of coffee in Indonesia was approximately 650 thousand tons. Stagnant growth in crop areas less attractive for oil palm and rubber cultivation and a lack of rejuvenating support for coffee plantations are among the causes of this low productivity. The share of world production was stable

[6] Detailed historical coffee data can be found at www.ico.org.

[7] For details, see http://gain.fas.usda.gov/Recent%20GAIN%20Publications/Coffee%20Annual_Jakarta_Indonesia_5-31-2012.pdf.

at 8 to 9 % prior to 2010 but fell to 7.65 % in 2011. Similar features are found in export volumes. It is estimated that around 300 to 500 thousand tons were shipped globally, accounting for 50 to 60 % of total production. The production and export shares of Indonesian coffee are presented in Table 2.2

Table 2.2. Production and Export Profiles of Indonesia's Coffee (2002-2011)

Year	Production (000 tons)	Share of world production	Share of world export volume (%)
2002	682.0	8.66	5.88
2003	663.6	9.24	6.02
2004	647.4	8.40	6.03
2005	640.4	8.83	7.76
2006	682.2	8.56	6.26
2007	676.5	8.24	4.69
2008	698.0	8.40	6.57
2009	682.6	8.35	7.20
2010	684.1	8.29	6.00
2011	634.0	7.65	4.54

Note: Data on production are collected from FAO (*www.faostat.org*). Data on export are collected from Trade Map (*www.trademap.org*)

Table 2.3 shows the top 10 major importers of coffee from Indonesia for 2002 to 2011. The Unites States is the largest importer, accounting for approximately US$140 million of export yearly, or 23.2 % of total coffee exports from Indonesia. Japan is the second-largest export destination, accounting for US$93 million in exports each year. Germany is the major European buyer of Indonesian coffee, with an average export

Table 2.3 Top ten major importers and growth rate of export profiles (2002-2011)

Rank	Importers	Average annual export value (000USD)	Share of total export value (%)	Cumulative percentage of Export Value (%)	Average annual growth rate of export value (%)
	World	617291.9	100	100	
1	USA	143352.5	23.22	23.22	23.06
2	Japan	93367.7	15.12	38.34	17.17
3	Germany	79973.9	12.95	51.30	21.14
4	Italy	35349.4	5.72	57.03	29.90
5	Belgium	24228.6	3.92	60.95	92.82
6	Malaysia	20509.2	3.32	64.27	32.92
7	United Kingdom	19794.2	3.20	67.48	31.73
8	Algeria	17233.7	2.79	70.27	57.52
9	Singapore	15497.1	2.51	72.78	14.42
10	Egypt	12073.9	1.95	74.74	39.07

Source: Trade Map (*www.trademap.org*)

value of approximately US$80 million per year. The export values of coffee to Italy and Belgium are around US$35 million and US$ 24 million respectively. In total, these 10 major importer countries account for 72.78% of all coffee exports from Indonesia. Other countries contribute a small percentage of export value (at or less than 1%).

In the regional distribution, Europe (i.e., Germany, Belgium, Italy, and the UK) dominates, accounting for 36% of Indonesia's total coffee exports. US imports are estimated at 32%. Japan is Indonesia's largest Asian trading partner, accounting for 21% of total coffee exports (see Figure 2-18).

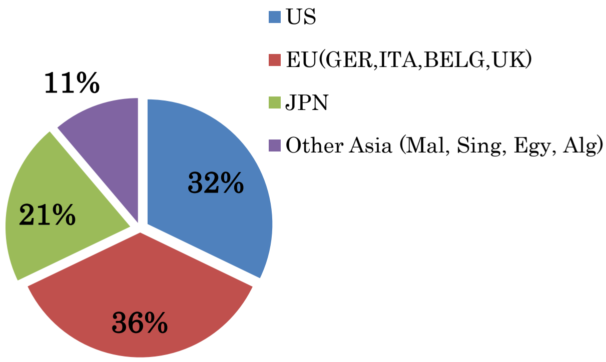

Figure 2-18. Distribution of Total Indonesia's Coffee Export (2002-2011)
Source: Trade Map (*www.trademap.org*)

Demand for Indonesia's coffee from all regions grew from 2002 to 2007 (see Figure 2-19). The peak was 2008, when Europe doubled its demand. In this period, the value of exports increased from US$13.3 million to US$33.3 million, or a 145% growth. Belgium

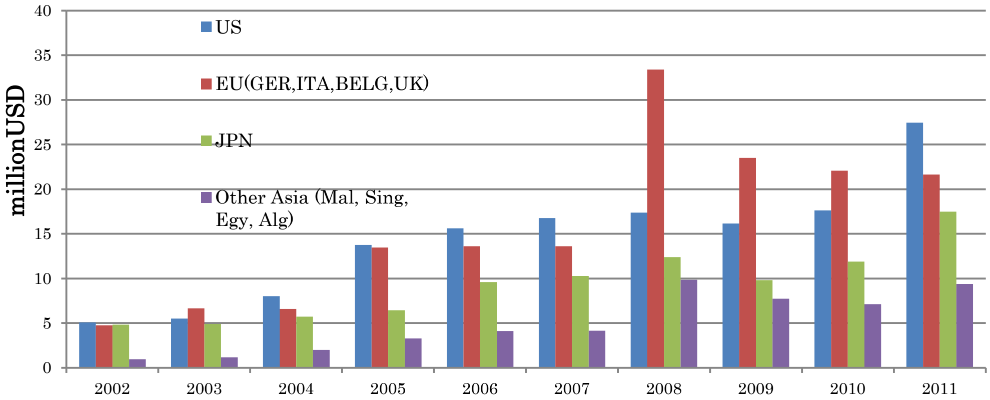

Figure 2-19. Historical export values from selected regions (2002-2011)
Source: Trade Map (*www.trademap.org*)

recorded a 92.82% average growth. A sudden decrease occurred in 2009 in all regions. A change in food safety regulations may have contributed to this drop in overall export values.

2.3 Food Safety Challenges for Indonesian Coffee Export

One major challenge for Indonesia's coffee is meeting quality standards; there have been several recent cases of export rejection. However, no data on SPS notification for Indonesian coffee are available, suggesting that the magnitude of the violation of food safety regulations may be minor or that the Indonesian government has not defended its trade.[8] Presumably, the risk of rejection is a burden to both exporters and importers.

Normally, buyers demand a higher quality of coffee. Unfavorable changes in quality standards may arise from individual importers or country-specific regulations. Changes in this quality standard are frequent and normally become more stringent. As a result, any changes in individual importer quality standards or country-specific regulations will have significant effects on Indonesia's coffee exports.

One of the major changes in food policy for the coffee trade is Ochratoxin A, or OTA. The OTA on coffee has been a sensitive topic since Europe, one of the largest coffee importers, set an OTA limit for roasted and soluble coffee in mid-2005. Since then, the awareness of OTA has spread widely in the coffee world and has become the main concern for global food safety regulators such as the FAO (Codex). Another change, more specific to Indonesia, is Japan's 2006 Positive List of Regulation on Food Safety, which impacts only Indonesian coffee exporters and farmers. This regulation lists the permitted pesticide limits for food and sets a "uniform limit" for all pesticides not included on the list; one of these is Carbaryl. Food policy changes in Europe and Japan have impacts on Indonesia's coffee exports because Europe and Japan are the major importers of coffee from Indonesia.

Both OTA and Carbaryl may impact Indonesia's coffee exports. This section reviews the regulatory developments concerning them. Ochratoxin A is a mycotoxin produced by fungi belonging to the genera *Aspergillus* and *Penicillium*. Based on the International Agency for Research on Cancer's evaluation, there is inadequate evidence of OTA's carcinogenicity in humans, but there is sufficient evidence of carcinogenicity in

[8] For details on the WTO SPS notification system , see http://spsims.wto.org.

experimental animals. Ochratoxin A belongs to group 2B, meaning that it may be carcinogenic to humans (IARC, 1993). Several studies have reported the occurrence of OTA in foods and beverages such as cereals (Čonkova et al., 2006), wine and beer (Reddy *et al.*, 2010), and coffee (Nandhan *et al.*, 2005).

As indicated in Table 2-4, OTA has been found in various type of coffee. A nationwide survey conducted by German Food Control from 1995 to 1999 found various levels of OTA in all types of coffee (Otteneder and Majerus, 2001). Research on OTA occurrence has been undertaken on green coffee (Romani et al., 2000), roasted coffee (Tozlovanu and Pfohl-Leszkowicz, 2010), and instant coffee (Almeida *et al.*, 2007). Several recent studies have shown that OTA levels in coffee can be minimized during processing (Heilmann *et al.*, 1999) and roasting (Suárez-Quiroz *et al.*, 2005).

Originally, OTA in coffee was regulated under European Commission (EC) No. 123/2005 of January 26, 2005 (European Commission, 2005). This regulation sets the maximum limits for roasted and soluble coffee at 5 ppb and 10 ppb respectively. This regulation amended Commission Regulation (EC) No. 466/2001 (European Commission, 2001) and entered into force on April 1, 2005. As stated in paragraph 2a article 1, the reference for green coffee was to be reviewed by June 30, 2006. The debate focused on a proposal of an OTA limit of 5 ppb in green coffee. However, that could lead to a rejection rate for African coffee of around 17% (FAO, 2006). The most recent OTA regulation is European Commission (EC) No. 1881/2006 of December 19, 2006 (European Commission, 2006) which entered into force on March 1, 2007. This latest revision maintained the maximum limits for OTA in roasted coffee (including ground coffee) and soluble coffee and did not provide a reference limit for OTA in green coffee

At the macro level, the implementation of the OTA regulation lacks harmonization (Duarte *et al.*, 2010). The Codex Alimentarius Commission, an organization established by the FAO and WHO for food safety standards, does not specifically mention a maximum limit for OTA in coffee. However, in 2008, the Codex adopted a maximum level of 5 ppb of OTA for raw wheat, barley, and rye (CAC, 2008). The US, Canada, Australia, and Japan are among the developed countries that do not regulate OTA.

Since 2001, the FAO has conducted projects focused on prevention in producer countries, which is more effective and less costly than physical control maintenance at ports. Several producer countries, including Indonesia, were targeted. Several provinces, such as Lampung, North Sumatra, and East Java were selected due to their major export quantities. FAO reports from 2005, just a few months before the latest EC regulation on OTA entered into force, found very low levels of OTA (from 0 to 2.7 ppb). However, coffee exports from Indonesia would have been severely affected if the new regulation on OTA were adopted (FAO, 2006).

Table 2.4. Occurrence of OTA in Selected Countries.

Country	Type of coffee	OTA level (μg/kg or ppb)
Africa-various countries	Robusta	1.4-23.3
Brazil	green, roasted, instant	0.1-6.5
Canada	Roasted	0.1-2.3
Colombia	Arabica	0-3.3
Ethiopia	Arabica	<0.1
Germany	Roasted	0.21-12.1
Kenya	Arabica	<0.1
Mexico	Arabica	1.4
Japan	green and instant	0.16-1.1
USA	Roasted	0.1-1.2
Indonesia	Robusta	0.2-1.0

Source: Reddy et al.(2010)

In 2008, the National Standard Body (*Badan Standarisasi Nasional*) published a standard (*SNI Biji Kopi 2008*) for coffee requiring that green bean coffee for export be free of odors caused by fungi (BSN, 2008). In 2009, Indonesia's National Agency of Drugs and Food Control (*Badan Pengawas Obat dan Makanan- POM*) adopted the EC's regulation of OTA and set the same OTA limits: 5 ppb and 10 ppb for roasted and soluble coffee respectively (NA-DFC, 2009)

Another problem for Indonesia's coffee exports may come from the Maximum Residual Level (MRL) policy for Carbaryl. In June 2005, Japan introduced the Positive List System for Agricultural Chemical Residues in Foods, which took effect on May 29, 2006, and established the maximum residual level at 799 chemical substances. Additionally, under MHLW Notification No. 497,[9] chemicals for which no maximum residual level (MRL) has been established have a "Uniform Limit" of 0.01 ppm. Carbaryl is included in this uniform limit list.

Unlike OTA, the source of which is fungi, Carbaryl is a common name for 1-naphthyl methylcarbamate (NMC). Carbaryl is used on a variety of crops, fruits, vegetables, and

[9] For details, see http://www.mhlw.go.jp/english/topics/foodsafety/positivelist060228/dl/n01.pdf.

building foundations to control a wide variety of pests and insects. It was first registered in the US in 1959 for use on cotton. In 2001, approximately 1 to 1.5 million pounds of Carbaryl active ingredient (lbs ai) were used in agriculture; however, usage began to decline the following year. Carbaryl is currently classified as "likely to be carcinogenic to humans" and may be harmful to the environment. As a result, approximately 80% of all Carbaryl end-use products have been canceled since 2004. On September 24, 2007, the Re-registration Eligibility Decision (RED) for Carbaryl was finalized, with a reassessment of the human health risk and risk mitigation methods.[10] Carbaryl substances above the uniform limit (0.01 ppm) have been found in several samples of Indonesian coffee (mainly in Robusta coffee) at some Japanese ports. It is being argued that Carbaryl is used intensively in Indonesia coffee plantations. However, many Indonesian exporters argued that the contamination came from the use of Carbaryl on poly-culture between coffee and other crops, such as corn, beans, and spices, on which it is used as an insecticide.

Table 2.5 shows the total number of violations of Japan's food sanitation law from April 2008 involving coffee from Indonesia. Ten out of 11 violations were due to Carbaryl levels exceeding 0.01 ppm, although most levels were 0.02 ppm. Major importers such as Volcafe Ltd and Nestle Japan Ltd were affected. Marubeni Corporation incurred major costs due to seven ship-backs. Problems with the import of Indonesian green coffee have increased sharply since Japan moved from "monitoring inspection" to "mandatory inspection" in 2010. The mandatory inspection order was issued against Indonesian green coffee beans immediately after two violations occurred in October and November 2009.

Japan is the second-largest importer of green coffee from Indonesia. Total imports are approximately 50,000 tons per year, valued at US$10 billion of yearly trade. Although the Carbaryl cases occurred in 2009, the impact of the mandatory inspections (begun in mid-2010) might have reduced the 2012 import volume of Indonesian green coffee. The regulation of Carbaryl in green coffee is not as stringent as that of OTA, for a variety of reasons. Carbaryl usage is not common on coffee plantations, and many other insecticides perform similar functions. Problems in the coffee trade have occurred due to Carbaryl cases, but few studies have been done on the occurrence of Carbaryl in coffee. This paper discusses Carbaryl because it has several impacts on Indonesia's green coffee exports due to Japan's Positive List Standard. Furthermore, measuring the effect

[10] For details, see http://www.epa.gov/oppsrrd1/REDs/Carbaryl _ired.pdf.

on trade if other countries follow Japan's Carbaryl regulation might provide a valuable prediction for trade and food policy analysis.

Table 2.5. Indonesian Coffee Violations on Japan Food Policy

No	Details of the Violation	Year	Importer	Disposal	Quarantine	Remark
1	Isoprocarbo 0.03ppm	2008.1	Marubeni Corporation	Ordered Scrap or Ship-back	Kobe	Monitoring Inspection
2	*Carbaryl* 0.04ppm	2009.1	Marubeni Corporation	Ordered Scrap or Ship-back	Nagoya	Monitoring Inspection
3	*Carbaryl* 0.03ppm	2009.1	S. Ishimitsu & Co. Ltd	Ordered Scrap or Ship-back	Kobe	Monitoring Inspection
4	*Carbaryl* 0.04ppm	2010.6	Marubeni Corporation	Ordered Scrap or Ship-back	Yokkaichi	Mandatory Inspection
5	*Carbaryl* 0.03ppm	-	Marubeni Corporation	Ordered Scrap or Ship-back	Yokkaichi	Mandatory Inspection
6	*Carbaryl* 0.02ppm	2010.9	Marubeni Corporation	Ship-back	Yokkaichi	Mandatory Inspection
7	*Carbaryl* 0.02ppm	-	Marubeni Corporation	Ship-back	Yokkaichi	Mandatory Inspection
8	*Carbaryl* 0.02ppm	2011.3	Volcafe Ltd	Ordered Scrap or Ship-back	Yokohama	Mandatory Inspection
9	*Carbaryl* 0.02ppm	2011.1	Marubeni Corporation	Ordered Scrap or Ship-back	Yokkaichi	Mandatory Inspection
10	*Carbaryl* 0.02ppm	2012.2	Nestle Japan Ltd	Ordered Scrap or Ship-back	Kobe Sect-2	Mandatory Inspection
11	*Carbaryl* 0.03ppm	2012.5	Nestle Japan Ltd	Ordered Scrap or Ship-back	Kobe Sect-2	Mandatory Inspection

Source: All Japan Coffee Association (AJCA) report (2013)

Because Carbaryl in coffee is not a wide occurrence around the world, it has been difficult to find data and similar regulations among importer countries for this chemical. The Codex set limits on 21 pesticides used on coffee in December 2012, but none applies to Carbaryl.[11] Green coffee beans are subjected to 31 types of pesticide in the US, but Carbaryl is not one of them. Japan also published 124 MRL for coffee, but not Carbaryl; Japan applies the uniform limit of 0.01 ppm. Germany initially adopted a 0.05 ppm limit for Carbaryl in green coffee; after the 2008 EU harmonized MRL system was adopted, the limit was loosened to 0.1 ppm. However, the EU amended its MRL for Carbaryl from 0.1 ppm to 0.05 ppm on April 26, 2013.[12]

2.4 Conclusion

Small estates dominate the share of total domestic production and total area. Coffee plantation areas in both small and large estates have not changed significantly. However, total coffee production has been increasing considerably over the last 20 years, reaching over 700,000 tons in 2014. Of this total coffee production, small estates

[11] For details, see http://dev.ico.org/documents/cy2012-13/icc-110-3-r2e-maximum-residue-limits.pdf.
[12] For details, see http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:273:0001:0075:EN:PDF.

comprise more than 90 %. Robusta accounts for 70 to 80 % of the total production and Arabica around 20 to 30 %.

Although some areas are well-known as coffee-producing regions, the share of the coffee production area of the total plantation area is relatively small, at around 10 to 20 %, much smaller than palm oil areas. Robusta faces area competition with other crops, since they are planted at similar altitudes; however, this is not the case for Arabica.

Arabica is normally sold at higher prices than is Robusta, but its prices are more volatile. The higher price of Arabica is due to its better quality, more difficult cultivation, and smaller production quantities, among other reasons. Domestic coffee consumption has increased significantly over the last five years, driven by an increased consumer preference for soluble/instant coffee.

The considerable growth in coffee production has been followed by export growth. However, Indonesia's share of coffee exports out of the global average is relatively small, particularly compared to Brazil and Vietnam. On average, the share of Indonesian coffee exports out of the global total is around 6 to 7 %, making Indonesia the fourth-largest coffee-exporting country, with more than sixty percent of domestic production destined for export. Therefore, Indonesia plays an important role in the international coffee trade. Moreover, export figures to some destinations, such as EU countries, the US, and Japan, show increasing demand.

Food safety regulations in the coffee trade change rapidly. Stricter regulations have become a barrier to Indonesian coffee exports. These food safety issues are related to pesticide residue and other food contaminants, and dissimilarities in regulatory implementation are common.

The findings in this chapter lead to the analyses in the chapters below. The considerable growth in coffee production and export may indicate a significant change in the structure of the coffee sector. Importantly, the increase in coffee exports during the last 15 years indicates that Indonesia is playing a significant role as one of the world's largest coffee exporters. This conclusion triggers a further analysis on the importance of the coffee sector to the Indonesian economy. For example, what is the contribution of the coffee sector to Indonesia's GDP? What is the nature of the interdependence between the coffee sector and other economic sectors? Has the structure of Indonesia's coffee export trade changed considerably? These questions, combined with related analytical methods, are used to discuss the importance of the coffee sector in a broader context in Chapter Three.

Another important development concerns the coffee market structure. Previous findings show that the coffee sector experienced considerable export growth. The increasing export trend points to a relationship between the domestic and global coffee markets. This finding requires a discussion on the integration of coffee markets. For example, by using the variable of coffee prices in two separate markets, this study clarifies their relationship. Econometrically, a long-run relationship between the two prices would indicate that the two markets are integrated. This discussion is the focus of Chapter Four.

Finally, the findings on how recent food safety regulations affect the coffee trade are also developed in more detail. For example, using bilateral coffee trade data, this study discusses the future impacts of food safety regulations on the coffee trade. A detailed discussion on the current challenges for Indonesian coffee exports posed by food safety regulations is presented in Chapter Five.

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CHAPTER III
STRUCTURAL CHANGE ANALYSIS OF THE INDONESIAN COFFEE SECTOR

3.1 Introduction

The Indonesian economy's structure has changed as it has developed. Indonesia's economy has moved from being dominated by agriculture to being dominated by manufacturing. For example, from 1961 to 2013, Indonesia's nominal GDP grew at an average annual rate of 5 to 6 %. World Bank statistics show that the contribution of agriculture (in terms of value added to GDP) declined significantly, from 51 % to only 14 %, within the same period. By contrast, the contribution of the manufacturing sector increased from 9 % to 24 %. Similar figures are given in Hayashi (2005). In 1989 and 1990, the value added rates of the two sectors intersected at approximately 19 and 20 %.

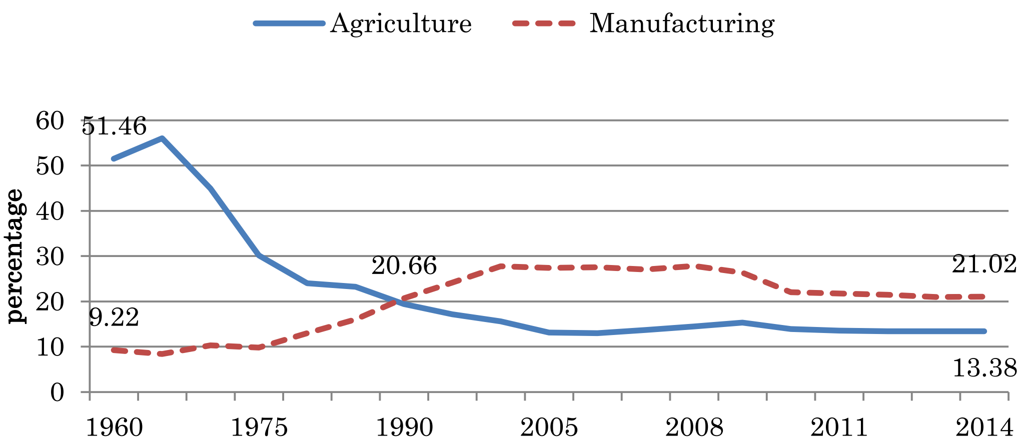

Figure 3-1. Value Added of Agriculture and Manufacturing Sector (%of GDP)
Source: WDI (http://databank.worldbank.org/)

In 1970, Indonesia's export of agricultural raw material was relatively high, at 38.8 % of total merchandise export, much higher than for manufacturing merchandise export, which was only at 1.2 %. However, the share of agricultural raw material kept declining and was eventually surpassed by manufacturing exports when it fell to 6.5 % in 1983. Afterwards, manufacturing exports kept growing, reaching 57.1 % in 2000, while agricultural raw material exports stayed at 3.6 %. Indonesia is less dependent on agricultural raw material imports. This sector's import share was above the export share only from 1997 to 2003. By contrast, the manufacturing sector depends heavily on imports. Although the percentage has declined considerably, manufacturing imports were 60 % of total merchandise imports in 2013.

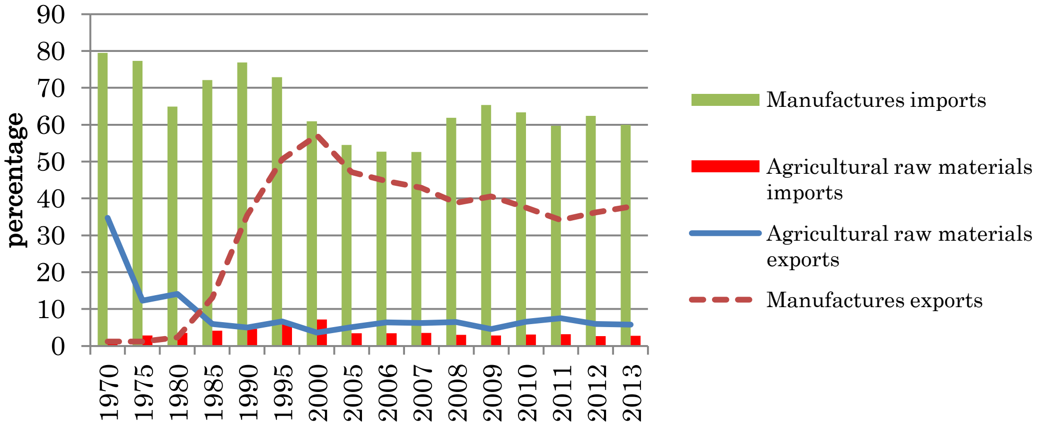

Figure 3-2. Export and Import Comparison in Agriculture and Manufacturing Sectors

Source: WDI (http://databank.worldbank.org/)

Sectoral structures in terms of share of GDP are presented in Figure 3-3. The agricultural sector's share declined slightly from 15.6 % in 2010 to 14.8 % in 2014. This sector includes food and grains, plantation/estate crops, livestock and poultry, fisheries, and forestry. The manufacturing sector's share fell considerably from 24.6 % to 23.4 during the same period[13].

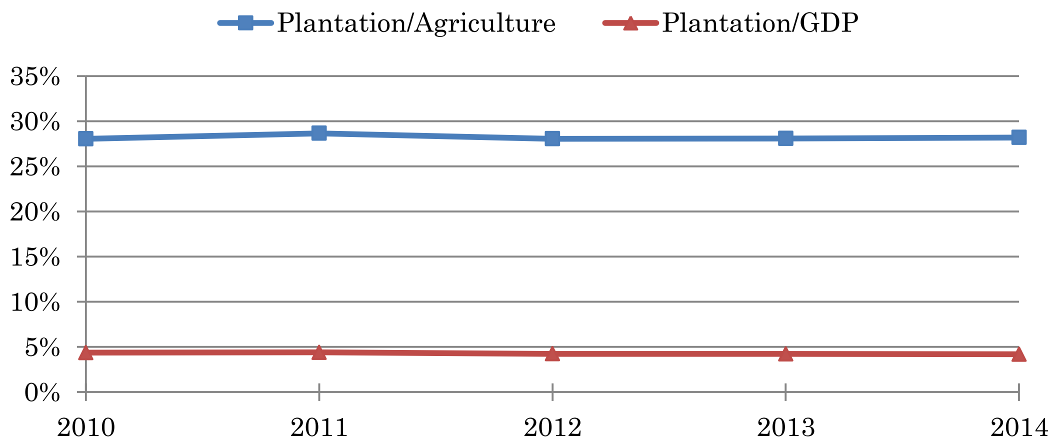

Figure 3-3. Plantation Share in Indonesian Economy

Source: Directorate General of Plantation (www. http://ditjenbun.pertanian.go.id/)

Note: Mining sector is excluded in this GDP.

The coffee sector is included as a perennial plantation in the agricultural sector. As

[13] The share of agriculture and manufacturing over GDP are not presented in the Fig.3-3

indicated in Figure 3-3, the share of the plantation crops sector of total agriculture was relatively stable, at around 27 to 28 % from 2010 to 2014. The figure decreases when plantation is divided by total GDP, which is around 4 % on average. This plantation sector normally consists of many crops such as coffee, oil palm, rubber, coconut, cocoa, and tea. Therefore, it is suspected that the share of the coffee sector out of total GDP is much smaller than what Figure 3-3 indicates.

The objective of this study is to examine the role of the coffee sector in particular and the agriculture sector in general by studying the structural changes in production and trade in Indonesia using IO analysis. Although the share of the coffee sector out of GDP is relatively small, more than 60 % of coffee production in Indonesia is exported annually. This active trading pattern indicates that coffee in Indonesia is strongly linked to international trade. Therefore, it is important to analyze the importance of the coffee sector not only in terms of production but also in terms of trade.

The IO analysis used in this study is based on the application of an Indonesian IO table. This provides information on the total production of each sector of the Indonesian economy, including the coffee sector. It can also assess the equilibrium between supply and demand. A comparative analysis can be performed based on the total production of each sector. A large production share may indicate that the sector has a significant influence on the economy. From the demand perspective, the structure of demand can be identified from the final demand element in the IO tables. For example, the "Export" element in the IO table can be used to evaluate the export significance of a particular sector. This study attempts to confirm the importance of the coffee sector through this approach.

Additionally, the IO analysis can identify interdependence among sectors. For the coffee sector, this interdependence consists of linkages in which coffee is used as an input in the production process of other sectors and in which other sectors' products are used as production inputs in the coffee sector. Identifying the magnitudes of these linkages can help determine if the coffee sector can be classified as a key one. This linkage analysis follows Rasmussen (1956) and uses the Index of Power of Dispersion (IPD) and Index of Sensitivity of Dispersion (ISD) as "key sector" indicators for coffee. Moreover, the RAS method is used to forecast whether the coffee sector will grow or decline.[14] Finally, the

[14] The name of this analysis refers to the R, A, and S matrices—the substitution, input coefficients, and fabrication matrices, respectively. Details on RAS calculation are presented in Appendix 3.1

development stage and trade structures of the coffee sector and other agricultural sectors are analyzed using skyline analysis. The expansion of the coffee production scale is clearly shown by the horizontal axes, while the vertical axes show changes in coffee production and domestic consumption as well as the patterns of export and import in the respective periods.

3.2 Methodology

3.2.1 Linkage Analysis

Input–output analysis is a method of analyzing structural changes in an economy, the relationships between one sector/industry and the others, and the ways a sector affects the whole economy. It is based on a national IO table, comprising several economic sectors. An IO table with two sectors is presented in Figure 3-4.

	Sector 1	Sector 2	Final Demand	Import	Domestic Production
Sector 1	z_{11}	z_{12}	Y_1	$-M_1$	X_1
Sector 2	z_{21}	z_{22}	Y_2	$-M_2$	X_2
Gross Value Added	V_1	V_2			
Domestic Production	X_1	X_2			

Figure 3-4. Basic Transaction Table

The equilibrium between total demand and total supply for each good *i* is

$$z_{i1} + z_{i2} + \dots + z_{ij} + Y_i - M_i = X_i \quad (3.1)$$

where X_i is the domestic output of sector *i*, and M_i denotes supply from the import side. Therefore, X_i and M_i reflect total supply. z_{ij} is sector i's product absorbed by sector *j* (intermediate demand), and Y_i is the total final demand for sector *i*'s product.

Define a_{ij}, the direct input coefficient, as

$$a_{ij} = \frac{z_{ij}}{x_j} \quad (3.2)$$

Combining Equations 3.1 and 3.2 produces $X = A X + Y^*$ in matrix terms. By using an *n x n* Identity matrix (I) manipulation, Equation 3.3 can be obtained:

$$X = (I - A)^{-1} Y^* \quad (3.3)$$

where Y^{*}equals $Y - M,$ and $(I - A)^{-1}$ is known as the Leontief inverse matrix.[15] Let B represent the elements of Leontief inverse matrix $(B = (I - A)^{-1})$. The coefficient b_{ij} indicates by how much the output of the i^{th} sector (x_i)would increase as a result of a one unit increase in final demand Y_j $\left(b_{ij} = \partial x_i/\partial y_j\right)$.

Provided that the employment rate (e) in each sector is available, the vector of employment coefficients can be denoted as

$$\widehat{e_j} = [e_1/x_1 \;\; e_2/x_2 \; \dots \; e_m/x_m] = [\widehat{e_1} \;\; \widehat{e_2} \; \dots \; \widehat{e_m}\,] \qquad (3.4)$$

Then, $\epsilon_j = \widehat{e_j}\, X = \widehat{e_j}\, (I - A)^{-1}\, Y^{*}$ produces a vector whose elements are the total employment in each sector as a result of a new exogenous final demand.

The Leontief inverse matrix is a preliminary step but an important one in linkage analysis, which measures interconnectedness among sectors. If sector *j* increases its output, sector *j* increases its demand for goods produced by other sectors as input in its production (i.e., demand side/backward linkage). When more products are produced by sector *j*, more inputs will be used by other sectors (i.e., supply side/forward linkage). The most interconnected sector, or that with the strongest backward and forward linkages, is a key sector (Hirschman, 1958). Backward Linkages (BLj) is a sum of the elements in the *j*th column of the Leontief matrix, and Forward Linkages (FLi) is the sum of the elements in *i*th row of the same Leontief matrix. The normalized BL is the Index of Power of Dispersion (IPD), and the normalized FL is the Index of Sensitivity of Dispersion (ISD).[16] These can be written as

$$\text{IPD} = \frac{\text{b}_{\blacksquare\text{j}}}{\overline{\text{B}}} \qquad (3.5)$$

$$\text{ISD} = \frac{\text{b}_{\text{i}*}}{\overline{\text{B}}} \qquad (3.6)$$

where $\text{b}_{\blacksquare\text{j}} = \sum_i^n b_j = BL$; $\text{b}_{\text{i}*} = \sum_j^n b_{ij} = FL$; and $\overline{\text{B}} = \frac{1}{n}\sum_i b_{i*} = \frac{1}{n}\sum_j b_{\blacksquare j}$

Studies on linkage formulation include Hazari (1970), Schultz (1977), and Cella (1984). For example, Cella (1984) described linkage measurements based on the *output approach* and *hypothetical extraction approach*, while Hazari (1970) developed the coefficient of variations method and compared several methods of identifying the key

[15] A thorough explanation of IO analysis can be found in Miller and Blair (2009), and a detailed transformation is provided in Appendix 3.1

[16] See Rasmussen (1956), *Studies in Inter-Sectoral Relation*, Chapter 8.

sectors in the Indian economy.

3.2.2 RAS method

The RAS method is based on a similar foundation. This method estimates a new input coefficient matrix in time *t* ($A_{(t)}$) using information from the input coefficient in the base year ($A_{(0)}$). Suppose the input coefficient matrix in the base year is $A_{(0)} = [a_{ij}]_0$ and the total rows and columns of the intermediary input in the projection year are $X_{\blacksquare j}$ and $X_{i\blacksquare}$ respectively. Then, using the multiplier R and S to satisfy the following condition

$$\hat{R} \bullet A_{(0)} \bullet \hat{S} = A_{(t)}$$

where $\hat{R}$ is a diagonal matrix whose elements indicate the effect of substitution, and $\hat{S}$ is a diagonal matrix whose elements describe the effect of fabrication (Kaneko, 1988). The effect of substitution shows how much of a commodity (by row in the IO tables) can be replaced by another commodity in the production process, and the effect of fabrication shows how much a sector (by column in the IO table) can absorb the intermediary input out of the total input.

If more than one period of an IO table is available, a comparative analysis on the dynamic change or matrix $\hat{R}$ and $\hat{S}$ can be done. Kagatsume (2006) stated that the elements of matrix $\hat{R}$ show the rate of increase in intermediate demand for sector *i* for each sector, while the elements of matrix $\hat{S}$ show the rate of increase in intermediate input in sector *i* for every sector. Therefore, he suggested that the sector in which $\hat{R}$ is greater than one and $\hat{S}$ is smaller than one can be considered a growing sector, and vice versa.

3.2.3 Self-sufficiency Rate Analysis

In the context of international trade, IO analysis can be used to determine the production available to satisfy domestic consumption as well as export by measuring the rate of self-sufficiency in the skyline charts. Self-sufficiency ratio, or skyline, analysis can be used to analyze the structure of economic development, describing the industrial and trade structures of a country via a skyline figure. It produces a graphical illustration based on sectoral analysis in which a country produces domestically or trades in order to meet domestic demand. A skyline chart is derived based on the following equilibrium production model:[17]

$$X = (I - A)^{-1}(D + E - M) \qquad (3.7)$$

X, D, E, and M are vectors as shown below:

$$X_i = \begin{pmatrix} X_1 \\ \vdots \\ X_n \end{pmatrix};\ D_i = \begin{pmatrix} D_1 \\ \vdots \\ D_n \end{pmatrix};\ E_i = \begin{pmatrix} E_1 \\ \vdots \\ E_n \end{pmatrix};\ M_i = \begin{pmatrix} M_1 \\ \vdots \\ M_n \end{pmatrix} \qquad (3.8)$$

X_i is the vector of domestic production in sector *i*, and D_i, E_i, and M_i reflect final domestic demand, exports, and imports in sector *i* respectively. A is the input coefficient matrix, as shown in Equation 3.2.

From Equation 3.7, domestic production can be decomposed into three factors, as in Equation 3.9: X_D, the volume of production necessary to meet domestic final demand; X_E, the volume of production necessary to meet exports; and X_M, the volume of production necessary to produce the same volume as imports based on a domestic technological structure:

$$X = (I - A)^{-1}D + (I - A)^{-1}E - (I - A)^{-1}M = X_D + X_E - X_M \qquad (3.9)$$

With X_D placed on the left-hand side, Equation 3.9 can also be expressed as follows:

$$X_{Di} = X_i - X_{Ei} + X_{Mi} \quad (i=1,2,....,n) \qquad (3.10)$$

If both sides of Equation 3.10 are divided by X_{Di}, the following equation results:

$$1 = \frac{X_i}{X_{Di}} - \frac{X_{Ei}}{X_{Di}} + \frac{X_{Mi}}{X_{Di}} = \theta_i - \theta_{Ei} + \theta_{Mi} \qquad (3.11)$$

Based on Equation 3.11, θ_i will be greater than 1, and the self-sufficiency ratio will be above 100% if domestic production is greater than the volume of production necessary to meet domestic demand ($X_i > X_{Di}$). Conversely, θ_i will be less than 1 if domestic production is insufficient to meet domestic demand ($X_i < X_{Di}$). Equation 3.11 can be used for the whole sector to evaluate the production and trade structure of a country.

In addition to the production and trade structure analysis, a skyline chart also provides information regarding the production or demand scale. The production scale of the

[17] The derivation of skyline analysis in this study refers to the explanation in METI's White Paper on International Economy and Trade 2005 (www.meti.go.jp).

agriculture sector may be large in one country, while the scale of manufacturing may be large in another. Evaluating a country's scale of production in each sector allows a comparative analysis of the nation's development stage and industrial structure.

To analyze the production and trade structure as well as the scale of production, the ratio of production in each sector to the total ($S_i = X_i / \sum_j X_j$) needs to be included.

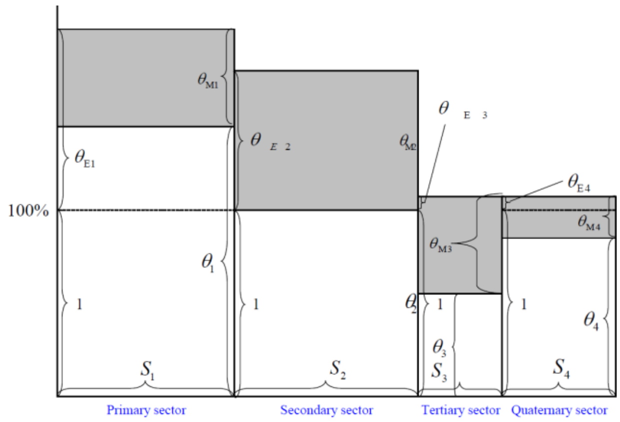

Figure 3-5. Skyline Chart Illustration
Source: White Paper on International Economy and Trade 2005 of METI (www.meti.go.jp)

In the skyline chart (see Figure3-5), the width of the bar corresponds to the share of each sector of total production, or S_i, while the height of each bar represents the production and demand structures expressed in Equation 3.11. The grey area reflects the domestic demand covered by imports. If the grey area is below the 100% self-sufficiency ratio line, domestic production cannot meet domestic demand, and imports are required, as is shown in the tertiary sector. In the primary sector, production is surplus, and exports exceed imports. In the quaternary sector, the grey area is narrow and located around the self-sufficiency ratio line, meaning that the trade pattern (export–import) in this sector is not intense.

The IO analysis is used to evaluate structural changes in the Indonesian economy in several studies. Jacob (2005) identified strong structural changes, especially in the manufacturing sector, from 1975 to 1995. Hayashi (2005) and Okuhira (2005) emphasized the use of skyline analysis to show production expansion in some sectors. Based on his findings, Hayashi (2005) also found that a decrease in investment created a bottleneck in industrialization and suggested that improvement in the investment environment was crucial.

The analyses discussed above (i.e., linkage analysis, RAS method, skyline analysis) will be used to identify structural changes in the Indonesian economy in general as well as changes in production and trade structures within sectors in particular.

3.3 Statistical Data and Preparation

In this chapter, the main data used are IO tables for 2000, 2005, and 2010 provided by Statistics Indonesia[18]. The original 66-sector I-O tables were aggregated into 20 sectors. To achieve the objective of this study, several small agricultural sector units were aggregated into one sector, and the coffee sector was kept as is. The manufacturing sectors were divided into two sectors: agriculture-related and non-agriculture related.

The coffee sector in Indonesia is the focus of this study. This commodity's characteristics are suitable for the approaches and methodologies used in this study. Historically, the coffee sector has played significant roles in agriculture development and employment in the Indonesian economy as an export-oriented commodity. Moreover, regarding data availability, the IO table of the Indonesian economy considers the coffee sector as a single sector. Thus, no further aggregation or data manipulation is needed for this sector, ensuring accuracy during calculation.

3.4 Effect of Structural Changes in the Coffee Sector on the Indonesian Economy

3.4.1 Output Structure

From 2000 to 2010, the total output structure was dominated by five major sectors, as indicated in Figure 3-6. In 2000, agricultural-related manufacturing output was highest, at around 21.5% of total output. However, this figure declined to 16.4% by 2010. A slight increase occurred in non-agricultural-related manufacturing output, followed by a sharp decrease (of around 4%) in the final period. The construction sector saw a significant increase during this period, going from around 8% in 2000 to 14% in 2010. A similar but slightly milder trend is found in finance, real estate, and services output.

In the agricultural sectors, the output of each sector is insignificant, as shown in Figure 3-7. Outputs for paddy and forestry and fisheries were dominant. A decline occurred from 2000 to 2005, when most of the output figures in the agricultural sectors plummeted. Therefore, the actual output growth among agricultural sectors from 2000

[18] The 20 sector IO Tables of 2000;2005 and 2010 are presented in Appendix 3.2

to 2010 is hard to measure.

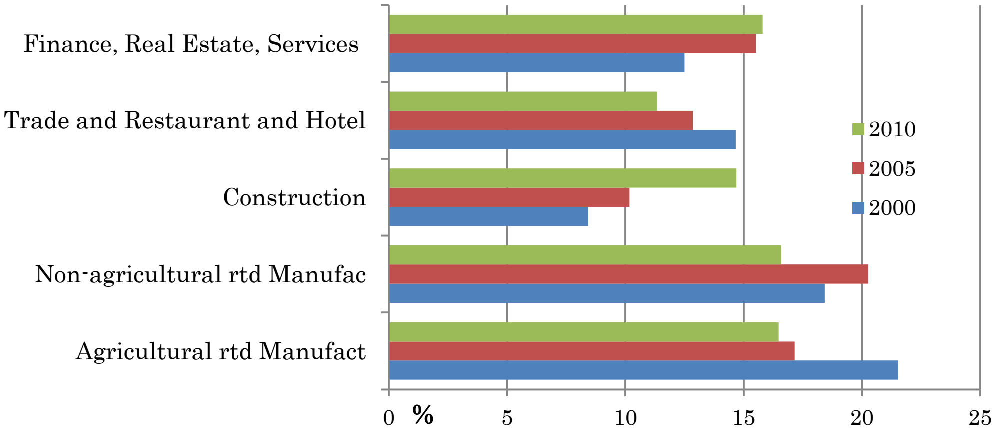

Figure 3-6. Output Structure of Five Major Sectors

Source: Author calculation based on IO Tables

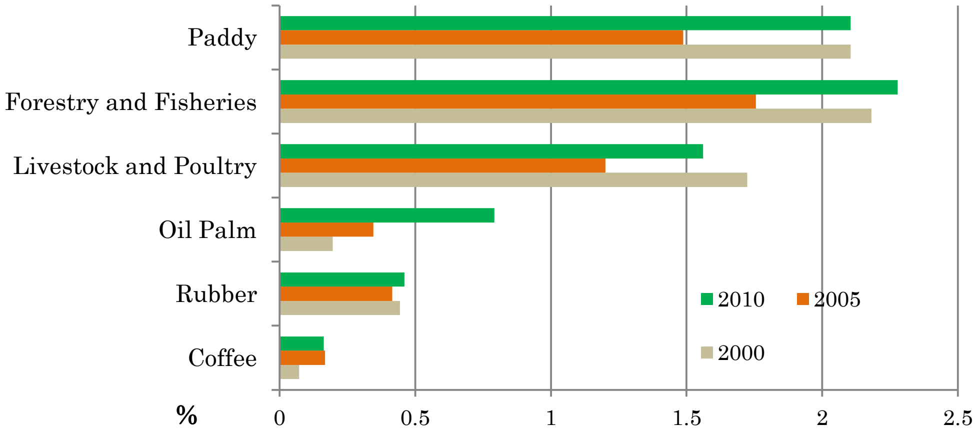

Figure 3-7. Output Structure of Agricultural Sectors.

Source: Author calculation based on IO Tables

The output of the coffee sector increased slightly, accounting for 0.07% of the total output in 2000 and 0.14% in 2010. Although the figure doubled during this period, the share out of the total economy is insignificant. A similar trend is found in the output of the rubber sector. By contrast, oil palm output rose significantly, from 0.2% in 2000 to 0.79% in 2010, indicating the direction of the development in the agricultural sectors from 2000 to 2010: only the oil palm sector experienced significant growth. The results suggest that the coffee sector has been managed poorly and has been ignored in favor of the oil palm sector.

3.4.2 The Result of Linkage Analysis and Key Sector

The minor intersectoral effect of the coffee sector is an interesting finding, given that

Indonesia is the third-largest coffee-producing country in the world. The changes in final demand in that sector do not correspond with the sector's total output. Therefore, an additional analysis is required to confirm the prior result.

One option is to measure the interconnectedness of the coffee sector through a linkages analysi using the Index of Power of Dispersion and the Index of Sensitivity of Dispersion. The estimation result is presented in Table 3.1. A sector is said to have a strong interconnectedness with other sectors if the number of indexes exceeds 1. If a sector has a value equal to 1 or higher in both indexes, the sector may be categorized as a key sector.

Table 3.1 Index of Power of Dispersion and Index of Sensitivity of Dispersion

Code	Sector	2000		2005		2010	
		IPD	ISD	IPD	ISD	IPD	ISD
1	Paddy	0.76	0.82	0.86	0.80	0.84	0.91
2	Beans and Corn	0.76	0.67	0.82	0.67	0.79	0.70
3	Root crops	0.66	0.62	0.71	0.63	0.70	0.67
4	Vegetables, Fruits, other food crops	0.69	0.64	0.72	0.66	0.70	0.69
5	Rubber	0.89	0.77	0.91	0.74	0.93	0.70
6	Oil Palm	0.97	0.62	1.01	0.63	1.07	0.74
7	***Coffee***	***0.97***	***0.69***	***0.99***	***0.68***	***0.98***	***0.74***
8	Other estate crops	0.86	0.76	0.88	0.76	0.92	0.87
9	Other crops	0.87	0.78	0.84	0.70	0.82	0.70
10	Livestock and Poultry	1.21	0.74	1.03	0.70	1.07	0.87
11	Forestry and Fisheries	0.86	0.71	0.79	0.69	0.74	0.76
12	Mining and Quarrying	0.74	1.61	0.76	1.33	0.76	1.27
13	Agricultural related Manufacturing Industries	1.32	1.86	1.29	1.90	1.26	2.16
14	Non-agricultural related Manufacturing Industries	1.28	2.44	1.26	2.88	1.29	2.14
15	Electricity, gas and water supply	1.26	0.75	1.40	0.82	1.48	0.89
16	Construction	1.37	0.79	1.33	0.78	1.37	0.80
17	Trade and Restaurant and Hotel	1.10	1.74	1.05	1.28	1.05	1.28
18	Transport and Communication	1.29	1.10	1.19	1.10	1.14	1.06
19	Finance, Real Estate and Business Services	1.00	1.28	1.06	1.64	1.07	1.45
20	Unspecified sector	1.15	0.61	1.09	0.60	1.03	0.60

Source: Author calculation based on IO Tables.

From 2000 to 2010, the IPD of the coffee sector is around 0.97 to 0.99, and the ISD is around 0.68 to 0.74. The indexes suggest that the coffee sector has an adequately strong backward linkage, demanding input from other sectors, but a weak forward linkage, as the sector is not strongly demanded as input by other sectors. Judging from the combinations of IPD and ISD, the results suggest that the coffee sector is not a key sector. This finding supports the result in the previous section. Most agricultural sectors have values of less than 1 in the indexes. By contrast, the secondary and tertiary sectors seem to have strong interconnectedness with other sectors. For example, both manufacturing sectors show strong backward and forward linkages, meaning that these sectors are key sectors.

Based on the IPD and ISD indexes, the whole sector can be distributed into four areas of a quadrant chart with the reference line at 1 on both axes. The sectors with strong forward and backward linkages are located in quadrant I, while the sectors with weak backward and forward linkages are located in quadrant III. The selected sectors of the Indonesian economy are presented in Figure 3-8, [19] which shows that the manufacturing sectors (codes 13 and 14) are located in quadrant I. The agricultural-related manufacturing sector showed an increasing trend in the sensitivity index, meaning that the output of this sector is demanded more by other sectors as inputs. However, the opposite tendency is seen in the non-agriculture-related manufacturing sector.

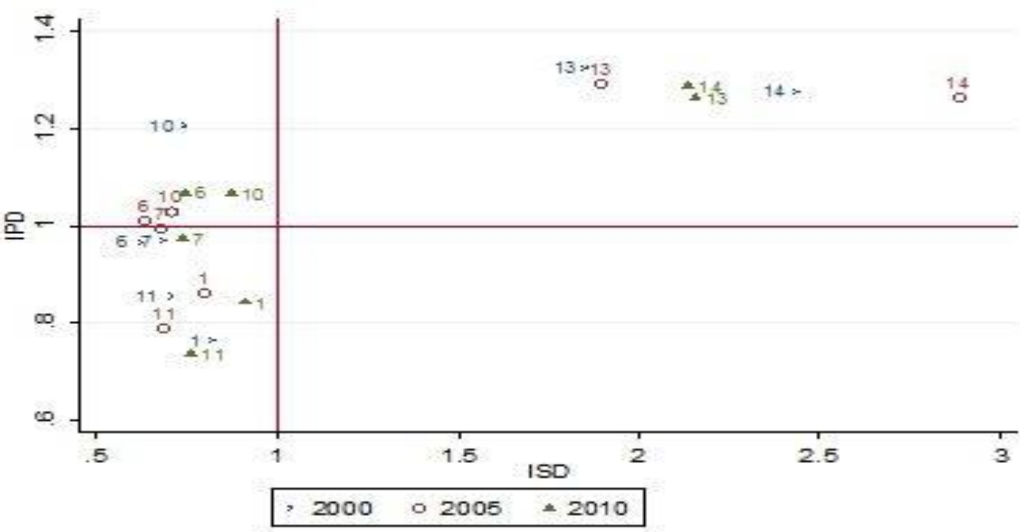

Figure 3-8. IPD and ISD in Selected Sectors
Source: Author`s calculation based on IO tables

The figure also illustrates that most agricultural sectors are located in the third or fourth quadrant, with low ISD values. These weak forward linkages suggest a strong sectoral independence and a weak push to the other sectors. However, the oil palm and livestock and poultry sectors show relatively strong backward linkages, suggesting that these sectors have weak independence but a strong economic pull to other sectors. The

[19] The labelled numbers represent the code of the sector.

coffee sector shows strong independence but weak push and pull to other sectors, since it is located in quadrant III (i.e., it has a low IPD and ISD).

3.4.3 Estimation Result of RAS Analysis

The previous section describes the coffee sector in terms of interconnectedness with the remaining sectors. This section uses RAS analysis to identify whether each sector is either declining or growing. A correlation between the results of the linkage analysis and the RAS analysis is expected. This analysis estimates the values of the R and S coefficients. A comparison of the R (*Substitution effect*) and S (*Fabrication effect*) values in two periods (2000–2005 and 2005–2010) illustrates whether a particular sector is growing or declining. The estimation results for the R and S coefficients are presented in Table 3.2.

As Okuyama et al. (2002) claim, the economic interpretation of the coefficients ***r*** and ***s*** is arguable.[20] However, Kagatsume (2006) suggests that matrix R (row-wise correction matrix) indicates the substitution change effect and that matrix S (column-wise correction matrix) indicates the processing degree change effects matrix, following Stone (1962). In accordance with Kagatsume (2006) and Stone (1962), the element ***ri*** is used as a measure of substitution effects—the extent to which the input *i* has substituted for other inputs or been replaced by them. It shows the increasing rate of intermediate demand for sector *i*. The element ***si*** is a measure of the fabrication effect in the production of *j*—the extent to which sector j has decreased (increased) its intermediate inputs per unit of gross output. It shows the increasing rate of intermediate input in sector *i*.

Figure 3-9 illustrates the increase in the R and S coefficients in the coffee sector. Kagatsume (2006) indicates that a growing (declining) sector can be identified based on the movement of each sector towards region IV (growing sector) or II (declining sector). The result indicates that the coffee sector experienced a considerable increase in its intermediary inputs and a significant increase in its intermediate demand. As a result, the coffee sector failed to move toward region IV (growing sector). By contrast, the paddy and oil palm sectors did move toward region IV

[20] The interpretation refers to Stone (1962), who offered the definitions of “substitution effect” and “fabrication effect.” Although criticisms of and new methods for this interpretation of R and S coefficients have been offered in recent studies, it remains widely accepted.

Table 3.2. Estimation Result of R and S Coefficient

Code	Sector	2000-2005		2005-2010	
		R-adj	S-adj	R-adj	S-adj
1	Paddy	0.972	1.140	1.095	0.950
2	Beans and Corn	1.009	1.092	1.048	0.952
3	Root crops	1.016	1.192	1.151	0.926
4	Vegetables, Fruits, other food crops	1.132	1.085	1.050	0.952
5	Rubber	0.978	1.030	1.037	0.981
6	Other estate crops	1.149	1.051	1.223	1.070
7	Oil Palm	1.056	1.005	1.092	0.698
8	Coffee	0.965	1.039	1.015	1.276
9	Other crops	0.878	0.997	1.022	0.973
10	Livestock and Poultry	0.986	0.946	1.114	1.007
11	Forestry and Fisheries	0.991	0.968	1.082	0.969
12	Mining and Quarrying	0.946	1.071	0.983	1.009
13	Agricultural related Manufacturing Industries	1.012	1.000	1.027	0.959
14	Non-agricultural related Manufacturing Industries	1.023	1.002	0.954	1.026
15	Electricity, gas and water supply	1.051	1.016	1.049	1.030
16	Construction	1.009	0.988	1.063	1.032
17	Trade and Restaurant and Hotel	0.909	0.982	0.995	0.976
18	Transport and Communication	1.011	0.973	1.012	0.996
19	Finance, Real Estate and Business Services	1.050	1.020	1.005	1.004
20	Unspecified sector	0.963	1.003	1.070	1.013

Source: Author`s calculation based on IO tables

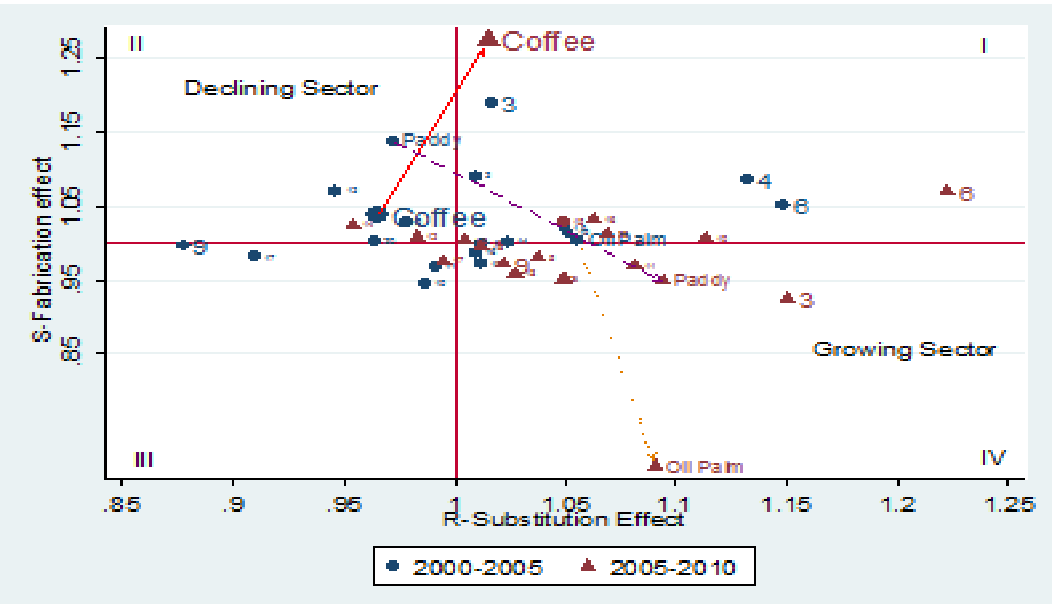

Figure 3-9. Movement of R and S Coefficients Based on RAS Analysis

Source: Author`s calculation based on IO tables

3.4.4 Self-sufficiency Rate Estimation Result

The skyline charts illustrate the industrial and trade structures in each period. For the convenience of presentation, the skyline charts provided in this section are limited to the agricultural sectors.[21] For 2000, the skyline chart representing all industries along the horizontal axis shows that the primary sectors such as paddy, bean and corn, fruits and vegetables, livestock and poultry, and forestry and fisheries accounted for a large share of domestic production. Paddy and forestry and fisheries accounted for more than 40% of total production in the agricultural sectors. Figure 3-10 shows that the coffee sector has the smallest share of domestic production among the agricultural sectors.

Along the vertical axis, Figure 3-10 also shows that most of the agricultural sectors' self-sufficiency rates amounted to over 100%, except for two (bean and corn and fruit and vegetables), indicating that domestic demand could be supplied by domestic production. The demand in beans and corn and in fruit and vegetables indicates that domestic production in these sectors is lower than is the domestic demand and that additional supply from imports is thus needed. This is crucial for beans and fruits in terms of Indonesia's agricultural policy. Domestic production insufficiency and unnecessary import volumes for these commodities have caused serious problems, such as domestic price instability and loss of farming income.

The 2000 percentages of exports and imports (as indicated by the shaded bars) vary, indicating that some sectors have larger net exports.[22] Paddy, forestry and fisheries, and coffee have larger net exports than do other sectors. This indicates that coffee and forestry and fisheries are export-oriented commodities. The large export and import ratios may be explained by the implementation of product differentiation and international division of labor.[23]

From 2000 to 2010, the horizontal axis shows that oil palm and forestry and fisheries significantly increased their share of domestic production (see Figures 3-10, 3-11, and 3-12), while the paddy sector's share decreased from around 20% in 2000 to from 17 to 18% in 2010. The coffee sector's share increased significant, indicating that coffee

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[21] The full 20-sector skyline charts are presented in Appendix 3.3. I wish to acknowledge the assistance of the Ray program of Kenjiro Uda (University of Yamanashi) in the application of the skyline charts used in this study.

[22] Net export is the discrepancy between the 100% reference line and the self-sufficiency rate line.

[23] METI White Paper on International Economy and Trade 2005 (www.meti.go.jp).

production was growing during that period. Along the vertical axis, we see a declining trend in the self-sufficiency rate, and some sectors move below the 100% reference line. The rubber sector, whose rate was above the 100% reference line in 2000, experienced a significant decline to around 80 to 85% in 2010. A similar but milder decrease occurred in the livestock and poultry sector.

Interestingly, the coffee sector's self-sufficiency rate rose significantly, from around 130% in 2000 to 230% in 2005, and then reached around 175% in 2010. As Figure 3-10 shows, exports more than doubled in 2005, while the import figure changed little. Although the export share of this sector fell in 2010, Figures 3-11 and 3-12 indicate that coffee exports performed more strongly than other agricultural sectors. This provides a perspective on the coffee sector different from the analysis in the previous subsection, which indicated that the coffee sector was unimportant to the Indonesian economy.

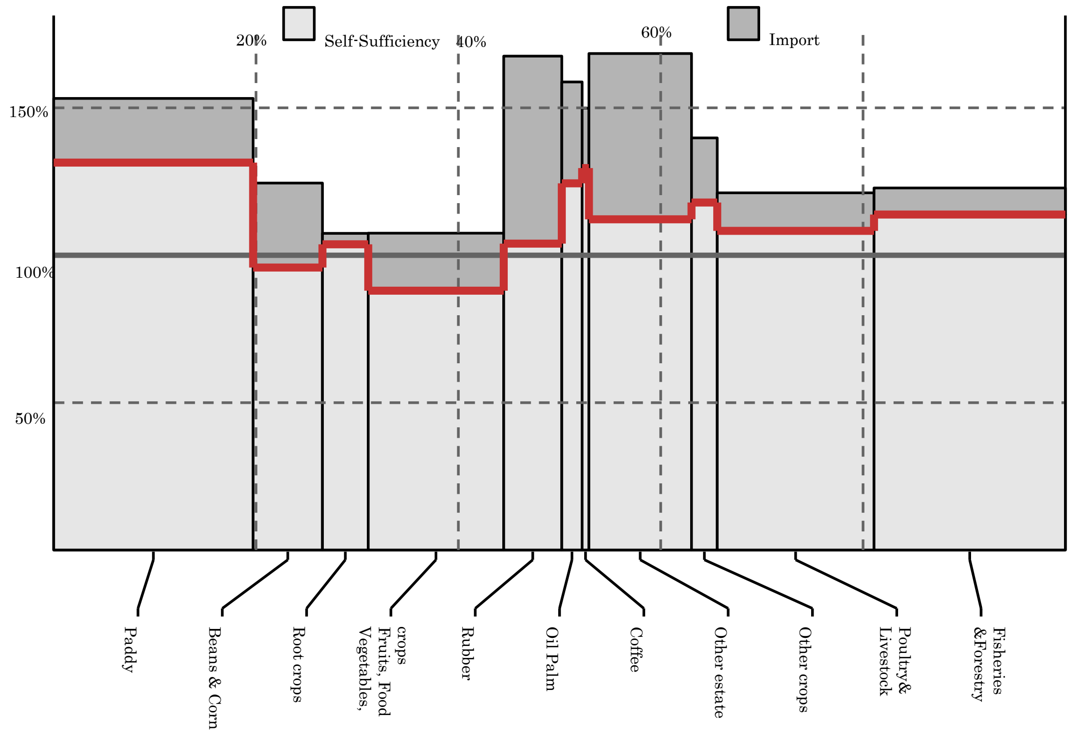

Figure 3-10. Skyline Chart of Agricultural Sectors in Indonesia (2000)
Source: Author`s calculation based on IO tables

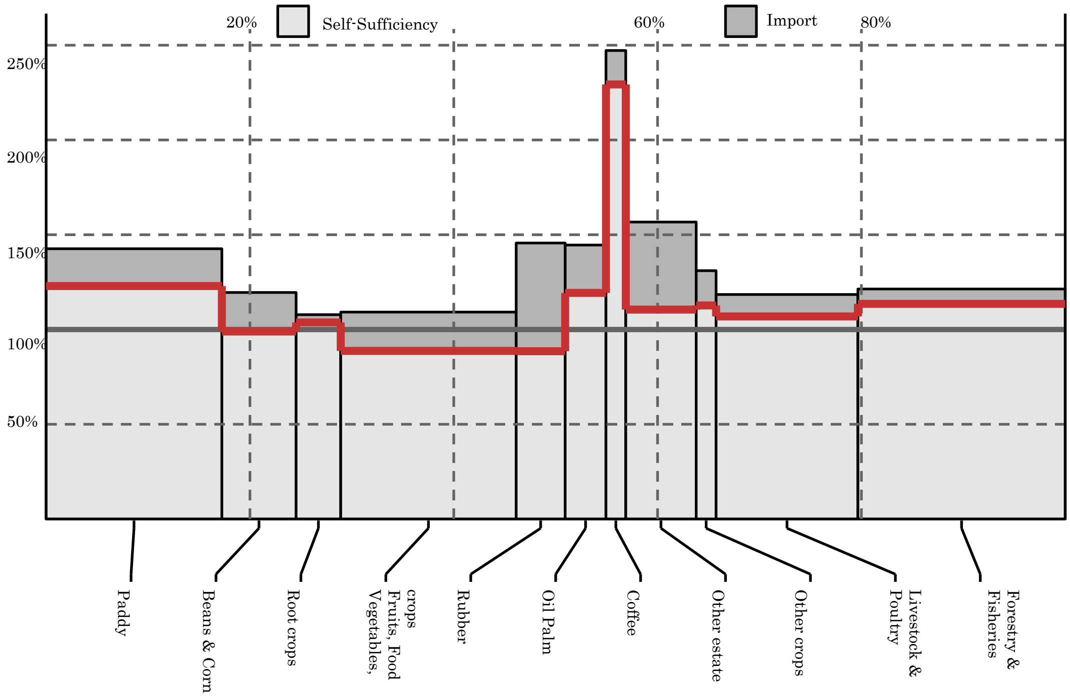

Figure 3-11. Skyline Chart of Agricultural Sectors in Indonesia (2005)
Source: Author`s calculation based on IO tables

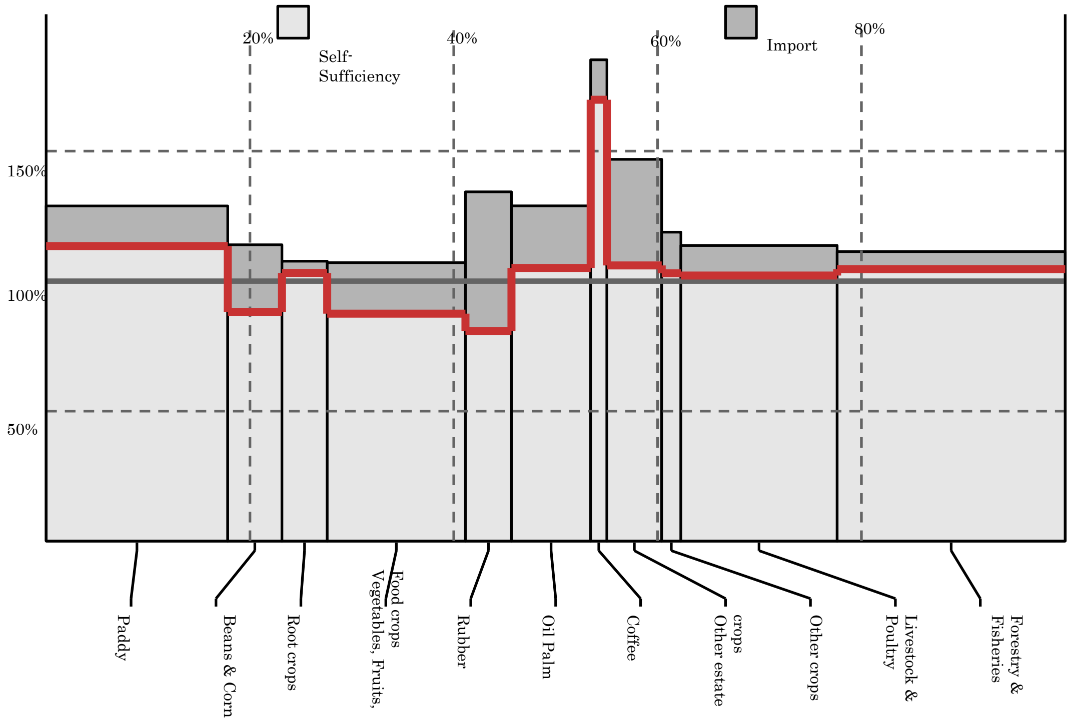

Figure 3-12. Skyline Chart of Agricultural Sectors in Indonesia (2010)
Source: Author`s calculation based on IO tables

3.5 Conclusion

The output of the coffee sector increased considerably from 2000 to 2010. Although the 2010 figure is double that of the previous period, the share of the coffee sector out of total sectoral production is insignificant. The indexes in the linkage analysis suggest that the coffee sector has an adequately strong backward linkage, demanding inputs from other sectors, but a weak forward linkage, as the sector is not strongly demanded as input by other sectors. Thus, coffee is not a key sector in the Indonesian economy. In fact, none of the agricultural sectors was classified as a key sector through this approach; only the manufacturing sectors, which satisfied the IPD and ISD indexes, were key. Moreover, the coffee sector experienced a considerable increase in its intermediary inputs and intermediate demand (region IV), indicating that the sector cannot be classified as a growing sector.

Surprisingly, the coffee sector's self-sufficiency rate rose significantly from 2000 to 2010, indicating that the sector's export performance was strong relative to the other agricultural sectors. This result suggests that further analysis on the importance of coffee should be conducted by considering its export performance in the global coffee market.

The findings in this chapter support the conclusion in the previous chapter in several ways. First, the previous chapter indicates a considerable increase in coffee production and export over 20 years. Through an IO analysis, this chapter confirms the direction of the changes in the production structure, production scale, and trade structure of the coffee sector. Importantly, the significant changes in the trade structure shown by the skyline analysis also confirm the results in the previous chapter. Although the coffee sector is not a key one according to the IPD and ISD indexes, the skyline analysis suggests that its export performance improved significantly, even more than other agricultural sectors.

This chapter revealed the importance of the coffee sector in terms of its export performance. This finding indicates that the Indonesian coffee market structure is well-connected to international markets. However, this indication needs to be supported by further evidence. For example, the transmission of coffee price shocks in the international market to the domestic market (and vice versa) would provide valid evidence. Therefore, the next chapter focuses on coffee market integration in order to obtain strong evidence based on price behavior between the domestic and international coffee markets and to provide findings on coffee export performance that support the findings in this chapter.

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CHAPTER IV
COINTEGRATION ANALYSIS OF INDONESIAN COFFEE MARKETS

4.1 Introduction

Coffee is an important commodity for developing countries, including Indonesia. Most coffee production in Indonesia is exported. As Indonesia is a coffee-exporting country, the structure of the markets will have a great impact on its coffee prices. Coffee is not a homogenous good, and prices depend on quality. The market is generally divided into four groups based on coffee quality: Brazilian Natural, Columbian Mild, Other Mild, and Robusta. One can expect price relationships within individual quality markets.

The objective of this study is to evaluate the integration among coffee markets. Doing so is important for two reasons: (1) Coffee is one of the main export commodities in Indonesia, and price shocks in the international coffee market may affect prices in the domestic market; (2) markets in less-developed countries seem to be less integrated although the production of certain agricultural commodities is important to their economies. Integration among the markets depends more on market structures (e.g., market players, price formation, type of market) than on production structures.

Market integration and price transmission for coffee have been studied using time series analysis from various perspectives, such as focusing on both international and domestic markets, on the domestic market (producer–wholesaler–exporter), and all four quality markets. Studying the domestic and international markets, Mofya-Mukuka and Abdulay (2013) employed an error-correction mechanism for the Tanzanian and Zambian coffee markets and found that domestic prices reacted differently depending on the countries' reform stage. Li and Saghaian (2013) analyzed the integration among world coffee prices and Vietnamese and Columbian prices. Krivonos (2004) evaluated how coffee sector reforms during the late 1980s and early 1990s impacted coffee growers in the main coffee-producing countries, finding that, in most countries, the long-term producer price share increased substantially after liberalization. Coffee price transmission has also been studied within domestic markets using several producer prices. Worako *et al.* (2008) indicated that market reforms induced stronger long-run relationships among the prices of growers, wholesalers, and exporters. Ghoshray (2009) evaluated price transmission among the four coffee quality markets.

The discussion in this study uses a world–domestic coffee market integration analysis, for two reasons: (1) Around 60 to 70 % of Indonesian coffee production is for export, and this research seeks to clarify the results from the previous chapter; (2) domestic prices (for growers, wholesalers, and exporters) are not available, imposing constraints on horizontal market integration analysis. Indonesian and Vietnamese coffee prices are studied, as they both involve Robusta, whereas Indonesia and Costa Rica are in the same Other Mild Arabica group.

4.2 Methodology

4.2.1 Cointegration and Error Correction Mechanism

The essence of market integration has been studied using several approaches. Studies have examined price equilibrium among spatially separated markets (Enke, 1951; Samuelson, 1952; Takayama and Judge, 1971). The research predicts that prices as equilibrium are affected by any shocks in demand and supply of tradable goods in one market and that prices in other markets as equilibrium are restored through spatial arbitrage.

Traditionally, market integration has been tested using simple static prices correlation via a bivariate model (see Lele, 1969). This approach has been criticized in the literature on market integration testing because of several inferential dangers. On this basis, Ravallion (1986) proposed a dynamic spatial differential model using monthly rice price data in Bangladesh, finding integration in the rice market. However, Palaskas (1993) claimed that Ravallion's model suffered from an inefficiency problem. Palaskas proposed an ECM using weekly rice spot prices in West Bengal and found a lower degree of integration for paddy and rice. Working with a similar ECM method, Alexander and Wyeth (1994) identified the direction and strength of price formation causality between the markets.

The concept of market integration is largely based on the cointegration and stationarity of price variables among several markets. Therefore, it normally begins with the stationarity test of the time series variables. Limited stationary series are available in the real world because most are not stationary. If non-stationary series are applied in a normal statistic treatment, it may produce a misleading result. Granger and Newbold (1974) introduced the concept of "spurious regression" concerning the meaningless relationship among the series indicated by a high R-square and statistically significant parameters. Afterward, the concept of "cointegration" was introduced (Granger, 1988; Engle and Granger, 1987; Johansen, 1988) to solve spurious regression and help develop time series theories.

A series is said to be stationary if its statistical properties are invariant with respect to time (i.e., when the mean and variance and its covariance between the two periods do not depend on time). A non-stationary series is a series that fails to satisfy the above conditions. To illustrate the conditions for stationarity, consider the following first-order autoregressive model:

$$Y_t = \emptyset Y_{t-1} + e_t, \quad t = \cdots., -1,0,1, \ldots \tag{4.1}$$

where e_t is assumed to be an independently and identically distributed (IID) random variable with an expected value of 0 and a variance σ^2. The process in Equation 4.1 is stationary when $\emptyset$ is less than 1 in absolute value (i.e., -1 < $\emptyset$ < 1). The lag operator, L, is introduced, so that $LY_t = Y_{t-1}$, and Equation 4.1 can be written as

$$Y_t - \emptyset Y_{t-1} = Y_t - \emptyset LY_t = (1 - \emptyset L)Y_t = e_t \tag{4.2}$$

After a mathematical calculation, Equation 4.3 is obtained:

$$Y_t = e_t + \emptyset e_{t-1} + \emptyset^2 e_{t-2} + \emptyset^3 e_{t-3} + \cdots \tag{4.3}$$

This implies that the $AR(1)$ process in Equation 4.3 can be represented as a moving average process of infinite order. Therefore, the following results are confirmed: $E(Y_t) = 0; Var(Y_t) = \frac{\sigma^2}{1-\emptyset^2};\ cov(Y_t, Y_{t-\tau}) = \frac{\tau^2\sigma^2}{1-\emptyset^2}$ $, \tau = 1,2,.; corr(Y_t, Y_{t-\tau}) = \emptyset^\tau,$

$\tau = 1,2, \ldots$

The fact that $E(Y_t)$, $\text{var}(Y_t)$, and $\text{cov}(Y_t, Y_{t-\tau})$ do not depend on t means that the $AR(1)$ process is indeed stationary when $\emptyset$ is less than 1 in absolute value. By contrast, the series is not stationary when $\emptyset = 1$ or is known as a random walk. A stationary series can be obtained from a non-stationary series after d times differencing transformation. It is said that the series contains d unit root, or the series is said to be integrated of order(d) or is denoted by $I(d)$. If the assumption that the disturbance term e_t is an IID process cannot hold, the critical Dickey–Fuller values cannot be applied.

Stationarity is an important assumption in the cointegration concept. Two or more integrated series might be cointegrated, so that some linear combination of these series could be stationary although each series is not. If two series are both integrated (e.g., I[1]), a VAR model can explain the interrelationships among the series. However, a VAR model would express only the short-run relationships if cointegration exists among the series. A simple VAR model in first differences, though properly specified, will be misspecified because it will not capture the long-run tendencies (Granger and Lee, 1987).

Consider the cointegration regression:

$$Y_t = \alpha + \beta X_t + \mu_t \tag{4.4}$$

If series Y_t and X_t are both I(1) and the error term μ_t is I(0), then the series is said to be cointegrated of order I(1,0). The equilibrium relationship between Y_t and X_t is measured by β, and the deviation from long-run equilibrium is measured by μ_t.

Because the traditional VAR cannot capture the long-run tendencies of the series, the Vector Error Correction Model (VECM), an extended VAR model in which the lagged *error correction term* is included in the relationship, is applied. The VECM is applied where the evidence of cointegration among the series is found.

For a K-variable VAR with p lags,[24]

$$\mathbf{y}_{\mathrm{t}} = \mathbf{v} + \mathbf{A}_1\mathbf{y}_{\mathrm{t-1}} + \mathbf{A}_2\mathbf{y}_{\mathrm{t-2}} + \cdots + \mathbf{A}_{\mathrm{p}}\mathbf{y}_{\mathrm{t-p}} + \boldsymbol{\epsilon}_{\mathrm{t}} \tag{4.5}$$

where $\mathbf{y}_{\mathrm{t}}$ is a K x 1 vector of variables, $\mathbf{v}$ is a K x 1 vector of parameters, $\mathbf{A}_1 - \mathbf{A}_{\mathrm{p}}$ is a K x K matrices of parameters, and $\boldsymbol{\epsilon}_{\mathrm{t}}$ is a K x 1 vector of errors, with a 0 mean, covariance matrix Σ, and i.i.d normal overtime. In VECM form, Equation 4.5 can be rewritten as

$$\Delta\mathbf{y}_{\mathrm{t}} = \mathbf{v} + \boldsymbol{\Pi}\mathbf{y}_{\mathrm{t-1}} + \sum_{\mathrm{i=1}}^{\mathrm{p-1}} \boldsymbol{\Gamma}_{\mathbf{i}}\Delta\,\mathbf{y}_{\mathrm{t-i}} + \boldsymbol{\epsilon}_{\mathrm{t}} \tag{4.6}$$

where $\boldsymbol{\Pi} = \sum_{\mathrm{j=1}}^{\mathrm{j=p}} \mathbf{A}_{\mathrm{j}} - \mathbf{I}_{\mathrm{k}}$ and $\boldsymbol{\Gamma}_{\mathbf{i}} = -\sum_{\mathrm{j=1+1}}^{\mathrm{j=p}} \mathbf{A}_{\mathrm{j}}$. The $\mathbf{v}$ and $\boldsymbol{\epsilon}_{\mathrm{t}}$ in Equations 4.5 and 4.6 are identical. Engle and Granger (1987) show that, if all variables in $\mathbf{y}_{\mathrm{t}}$ are *I*(1), matrix $\boldsymbol{\Pi}$ has **a** rank of 0 ≤ r ≤ K, where r is the number of linearly independent cointegrating

[24] A more comprehensive technical explanation of VECM can be found in Johansen (1988) and the STATA Time Series Manual (VEC introduction).

vectors. This rank (r) determines the following treatment. If the variables are cointegrated (r>0), the VAR in first differences is misspecified, as it excludes the error correction term ($\mathbf{\Pi y}_{t-1}$). If matrix $\mathbf{\Pi}$ has a rank equal to 0, there is no cointegration among the non-stationary variables, and a VAR in first differences is consistent. If matrix $\mathbf{\Pi}$ has a rank equal to K, all the variables in $\mathbf{y}_t$ are I(0) or stationary, and a VAR in their levels is consistent. If $\mathbf{\Pi}$ has **a** reduced rank of $0 < r < K$, it can be expressed as $\mathbf{\Pi} = \boldsymbol{\alpha\beta}'$, where α and β are K x r matrices of rank r. Restriction (r^2) should be placed on these matrices' elements in order to identify the system.[25]

Theoretically, if no integration is found or if there is no cointegration in the markets, a VAR can be used to estimate the short-run parameters. By contrast, markets are integrated if there is cointegration among them; then, short- and long-run tendencies in the equilibrium can be estimated via VECM.

4.2.2 Asymmetric Price Transmission

Several theoretical price transmission models have been developed for coffee and related agricultural products (Mofya-Mukuka and Abdulai, 2013; Mehta and Chavas, 2008). Von-Cramon-Taubadel (1996) described two methods in examining asymmetric price transmission, the Wolffram–Houck (Wolffram, 1971; Houck, 1977) and ECM (Engel and Granger, 1987) models. In the Wolffram–Houck (W–H) method, the transmission process is represented as

$$\sum_{t=1}^{\tau} \Delta P_{i,t} = \beta_0 + \beta^+ \sum_{t=1}^{\tau} \Delta P_{j,t}^+ + \beta^- \sum_{t=1}^{\tau} \Delta P_{j,t}^- + \varepsilon_t \qquad (4.7)$$

where $\Delta P^+$and $\Delta P^-$are the positive and negative changes in prices respectively, while $\beta_0, \beta^+, \beta^-and\tau$ are beta parameters and current time period respectively. Asymmetry is clarified by testing $\beta^+ = \beta^-$. However, if cointegration is found between the two prices, then this W–H method is not relevant due to spurious regression (Granger and Newbold, 1974).

If two price variables are cointegrated, a test of asymmetry can be done through the

[25] Johansen derived two (nxr) matrices, α and β, where n is the number of variables, and r is the rank of ($A_1 + A_2 - I$). The properties of these matrices are ($A_1 + A_2 - I$) = αβ'. Matrix β represents the cointegration parameter, while matrix α is the speed of adjustment towards long-run equilibrium. When the two variables p_{1t} and p_{2t} are used, the VECM is represented as follows (Rapsomanikis, Hallam and Conforti, 2006): $\begin{pmatrix}\Delta p_{it} \\ \Delta p_{2t}\end{pmatrix} = \begin{pmatrix}\mu_1 \\ \mu_2\end{pmatrix} + \begin{pmatrix}\alpha_1 \\ \alpha_2\end{pmatrix}(p_{1,t-1} - \beta p_{2,t-1}) - A_2 \begin{pmatrix}\Delta p_{it-1} \\ \Delta p_{2t-1}\end{pmatrix} + \begin{pmatrix}\Delta v_{it} \\ \Delta v_{2t}\end{pmatrix}$.

ECM (Engle and Granger, 1987). The standard ECM can be written as the following equation (see Von Cramon, 1996, p. 5):

$$\Delta P_{i,t} = \beta_0 + \beta_1 \Delta P_{j,t} + \beta_2 ECT_{t-1} + \beta_3(L)\Delta P_{i,t-1} + \beta_4(L)\Delta P_{j,t-1} + \varepsilon_t \quad (4.8)$$

Granger and Lee (1989) modified Equation (4.8) into the following:

$$\Delta P_{i,t} = \beta_0 + \beta_1 \Delta P_{j,t} + \beta_2{}^{+} ECT_{t-1}^{+} + \beta_2{}^{-} ECT_{t-1}^{-} + \beta_3(L)\Delta P_{i,t-1} + \beta_4(L)\Delta P_{j,t-1} + \varepsilon_t \quad (4.9)$$

where L represents the lags, and ECT is the error correction term, so that an asymmetric test can be conducted by determining $\beta_2{}^{+} = \beta_2{}^{-}$.

4.3 Data Preparation

Concerning the data used in market integration analysis, all of each country's coffee price series are provided by the International Coffee Organization (ICO).[26] The data set consists of the monthly prices paid to growers and ICO group indicator prices. The world prices of Robusta coffee are taken from the ICO's Robusta group indicator, and the world prices of Arabica coffee are obtained from the Other Mild Arabica group. The domestic prices are the prices paid to Robusta or Arabica coffee growers in each country. The cointegration analysis of Arabica coffee markets involves prices for Indonesia and Costa Rica as well as the ICO's Other Mild group, whereas the integration analysis of Robusta coffee markets includes prices for Indonesia, Vietnam, and the ICO's Robusta group.[27] All price series are in US cents per pound.[28]

The estimation consists of two separate groups of coffee. Monthly Robusta coffee prices are contained in the variables `lnidn`, `lnivnm`, and `lnico`, whereas monthly Arabica coffee prices are denoted as `lnaraidn`, `lnaracosta`, and `lnaraico`.[29] The terms *idn, ivnm, costa*, and *ico* refer to Indonesia, Vietnam, Costa Rica, and ICO (world coffee price indicator) respectively. Figures 4-8 and 4-9 describe the data.

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[26] The author is grateful to Mr Darcio De Camillis (ICO) for providing the historical coffee price data.
[27] Details on the coffee quality categories are provided in Appendix 4.1.
[28] In this study, the period for Robusta coffee prices spans 1994m1 to 2007m7, and the period for Arabica coffee price spans 2000m1 to 2007m9.
[29] The series ranges from January 1990 to September 2007 for Robusta and March 2001 to September 2007 for Arabica. A complete data series for both coffee groups is available only for those periods.

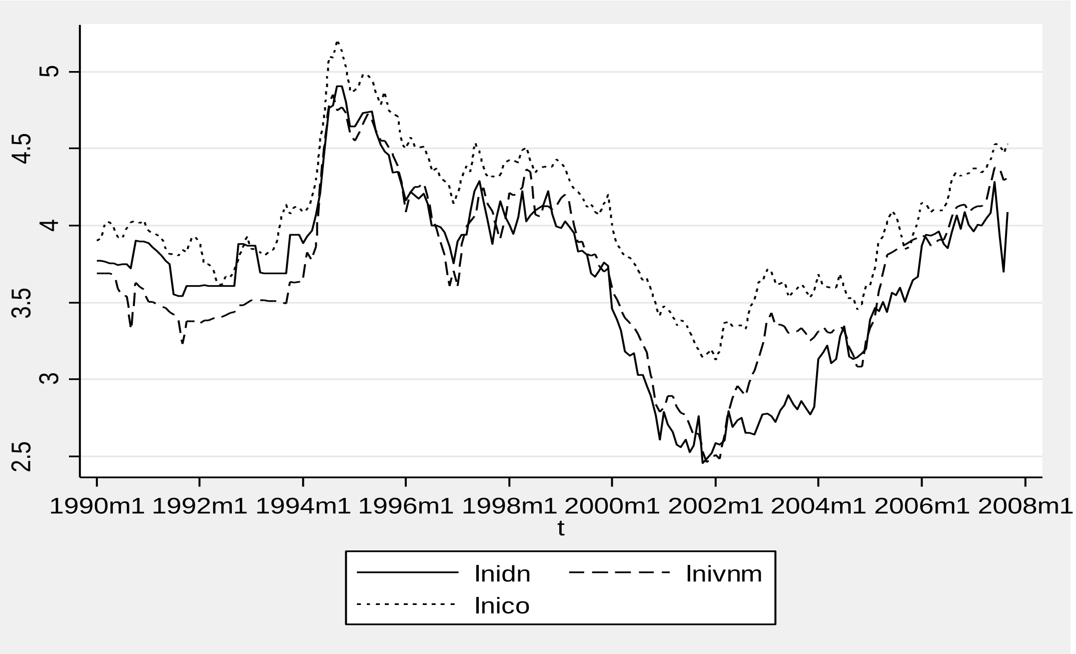

Figure 4-1. Robusta Price Series
source: ICO (www.ico.org in historical price data)

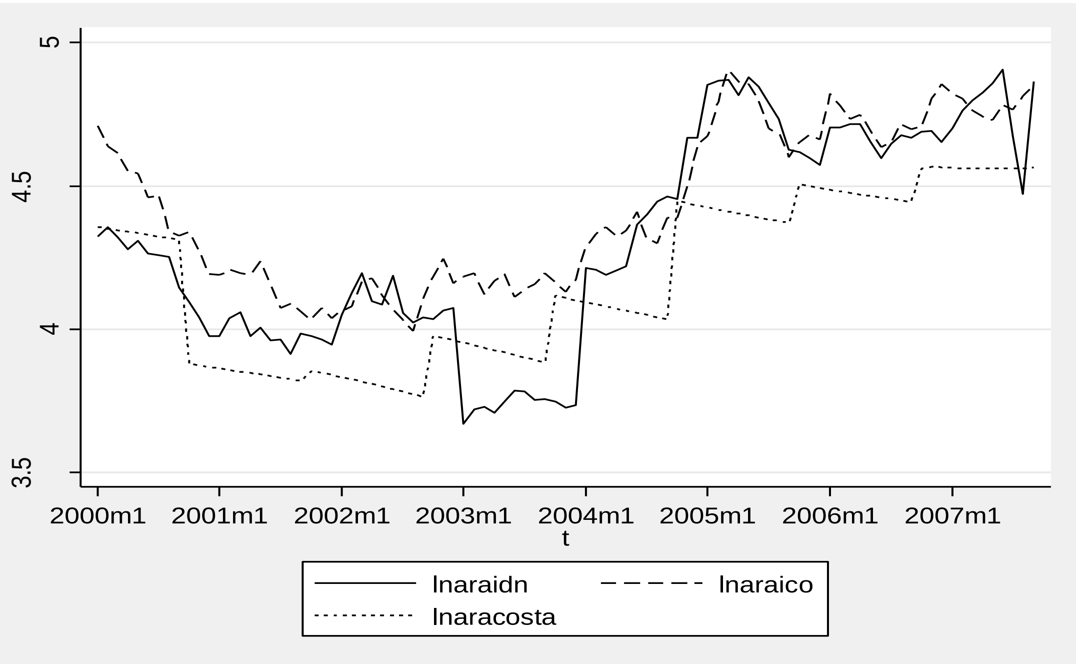

Figure 4-2. Arabica Price Series
source: ICO (www.ico.org in historical price data)

The Robusta plots indicate that the series are wandering and potential I(0) processes. They also show a similar pattern among these series. A different behavior appears in the Arabica series since the pattern indicates less dependence among the series, and prices could suddenly drop or increase.

4.4 Estimation of Long-run Equilibrium in Indonesian Coffee Prices

To begin, a stationarity test is applied using an Augmented Dickey–Fuller (ADF) test and Phillip–Perron test in both level and first differences series. A summary of the statistics is presented in Table 4.1. The result of the price level test statistics is less negative than any critical values of either the ADF or Phillips–Perron test, thus confirming the null hypothesis that the price series in level exhibits a unit root. Hence, the results suggest that the price series are all non-stationary. By contrast to the price series in level, the result of the unit root test in the first differences rejects the null hypothesis, indicating that the price series in first difference are I(1) or stationary of order 1.

Table 4.1. Summary of Stationarity Test

	Level		Differences		Result
	ADF test	Phillips-Perron Test	ADF test	Phillip-Perron Test	
Robusta					
ICO	-1.514	-4.396	-10.757	-157.40	I(1)
Indonesia	-1.166	-3.190	-13.121	-192.10	I(1)
Viet Nam	-1.605	-4.590	-10.541	-155.04	I(1)
Arabica					
ICO	-0.867	-2.291	-8.086	-79.90	I(1)
Indonesia	-0.867	-1.898	-9.161	-91.87	I(1)
Costa Rica	-0.944	-2.342	-9.608	-91.27	I(1)
Critical Value		5%		10%	
ADF test		-2.883		-2.573	
Phillips-Perron test(Zρ)		-13.62		-10.946	

Source: Author`s calculation

4.4.1 Cointegration in Robusta Coffee Series

After the unit root test has been applied to verify the stationarity of both levels and first difference prices, a cointegration test can be conducted to determine whether cointegration exists among the series.[30]

[30] Before proceeding to the cointegration test, a lag selection test should be applied. The Hannan–Quinn information criterion (HQIC) method and Schwarz Bayesian information criterion (SBIC) method test use two lags, but three lags are used, following the AIC (Akaike Information Criterion).

Table 4.2. Johansen Tests for Cointegration of Robusta Series

Rank	Eigenvalue	Trace Statistic	5% Critical Value
r=0		36.98	29.68
r=1	0.11	16.99	15.41
r=2	0.08	1.86*	3.76

Source: Author`s calculation
Note : Trend: constant; Number of obs=165; Sample:1994m1 - 2007m9; Lags= 2

The result of a Johansen cointegration test indicates that the null hypothesis of no cointegration is strongly rejected but the null hypothesis of at most two cointegrating equations is not rejected. We thus accept the null hypothesis that there are two cointegrating equations in the Robusta model.

Having determined that there are two cointegration equations in the Robusta series, the next step is to estimate the parameters in the cointegrating equations using VECM. A summary of the estimation result is presented in Table 4.3. Three types of parameter can be identified: a parameter of cointegrating equations (β), adjustment coefficients (α), and short-run parameters (r).[31]

The long-run equilibrium relationships among ICO Robusta indicator prices (world prices), Indonesian grower prices, and Vietnamese grower prices are summarized in the two cointegrating equations:

$$\text{lnico} - 0.736\,\text{lnidn} - 1.4$$

and

$$\text{lnico} - 0.854\,\text{lnivnm} - 0.865$$

should be stationary series.

The first contegrating equation can be interpreted as indicating an equilibrium relationship between Robusta coffee prices on the world market and Robusta coffee prices in Indonesia. Similarly, the second cointegrating equation indicates an equilibrium relationship between Robusta coffee prices on the word market and Robusta coffee prices in Vietnam.

Overall, the results of the adjustment parameters shown in Table 4.3 indicate that the model fits well. Most of the coefficients are significant, except those on `lnidn` in the first

[31] Details on the estimation results are provided in Appendix 4.2 under “STATA output.”

contegrating equation and lnico in the second. Although those adjustment parameters are not significant, they have the correct adjusting signs toward equilibrium. When the prediction from the cointegrating equation is positive, lnico is above the equilibrium value because the coefficient on lnico is positive. The estimate of adjustment coefficients (α) on lnico is -.204. Therefore, when world Robusta prices are above the equilibrium, it quickly falls back toward Indonesian Robusta price levels. The estimate of adjustment coefficients (α) on lnidn is .006. However, since it is not statistically significant, the issue is whether Indonesia Robusta prices adjust when the first cointegrating equation is out of equilibrium.

Table 4.3 VECM Estimates for Robusta Coffee Prices

Parameter estimates	1st Cointegrating equation: Indonesia (lnidn)	Viet Nam (lnivnm)	World (lnico)	2nd Cointegrating equation: Indonesia (lnidn)	Viet Nam (lnivnm)	World (lnico)
Long-run equilibrium relationship (β)	-.737***	-	1	-	-.854***	1
The speed adjustment (α)	.006	-.164***	-.204***	-.138*	.130**	-.045

Short run parameters

		Indonesia (lnidn)	Viet Nam (lnivnm)	World (lnico)
Indonesian grower prices	($\Gamma_{idn,t-1}$)	-.191*	-.042	-.072
	($\Gamma_{idn,t-2}$)	-.312***	.011	-.100
Viet Nam grower prices	($\Gamma_{ivnm,t-1}$)	.076	.160	.047
	($\Gamma_{ivnm,t-2}$)	.049	.085	.170**
World prices	($\Gamma_{w,t-1}$)	.527***	.541***	.314***
	($\Gamma_{w,t-2}$)	.189	-.065	.029

Source: Author`s calculation

In the second cointegrating equation, the beta estimate of Vietnamese Robusta coffee is significant, as is the adjustment parameter. Similarly, the adjustment parameters show the correct signs. Since the coefficient on the world Robusta coffee price is positive, it is above the equilibrium value when the prediction of the cointegrating equation is positive. World Robusta coffee prices should fall toward Vietnamese Robusta coffee prices by -.045 when these prices are too high, while Vietnamese Robusta coffee prices should increase by .130 towards world Robusta prices when those prices are too high.

The difference in the adjustment parameters of Robusta coffee prices between Indonesia and Vietnam indicates that Vietnam's market is more integrated with the global market in terms of Robusta coffee prices. Furthermore, this three-series model cannot identify the cointegrating equation between Indonesia's and Vietnam's Robusta markets. The short-run parameters suggest that both markets are more affected by world Robusta coffee series. For Vietnamese and world Robusta markets, the causality runs in both directions; for Indonesian and world Robusta markets, the causality runs toward the Indonesian market. The Granger causality (Wald) test confirms that no causality runs between the Indonesian and Vietnamese markets.[32]

The parameters in the cointegrating equations are identified by constraining some of them to be fixed, and the fixed parameters do not have standard errors. In this study, the coefficients of `lnico` have been normalized to 1, so the standard error is missing. As discussed by Johansen (1995), if there is *an r cointegrating equation*, then at least r^2 restrictions are required to identify the free parameter in β.[33]

4.4.2 Cointegration in Arabica Coffee Series

Using the series of Arabica coffee prices from Indonesia, Costa Rica, and the ICO, similar estimation steps have been applied. This is fitted with two cointegration equations by placing four constraints on the parameters in β.[34] The parameter estimates are summarized in Table 4.4.

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In general, the parameter estimates indicate that the model behaves well. The parameters on `lnaraidn` and `lnaraico` are significant in the first and second cointegrating equations respectively, indicating cointegration between Indonesian and world Arabica coffee as well as between the Costa Rican and world Arabica series. The adjustment parameters on the Indonesia Arabica series in the first cointegrating equation is .099, indicating that, when world Robusta prices are too high, the

[32] The causality test is based on VAR with a three-lag model and is provided in Equation 4.3.
[33] Two cointegrating equations are found in the Robusta price series; therefore, four restrictions are set up ([_ce1]lnico = 1 and [_ce1]lnvnm = 0; [_ce2]lnico = 1 and [_ce2]lnidn = 0).
[34] Instead of following the normal steps that suggest including lag (1) and rank =1, the estimation in the Arabica series places three lags and rank=2 and puts four constraints on the parameters in β to produce more stable estimation results.

Indonesian Arabica price rises toward world Arabica prices. At the same time, world Arabica prices fall quickly toward Indonesian Arabica prices by -.156.

In the second cointegrating equation, the β parameter in `lnaracosta` is set to be unity and positive. Therefore, when the predicted Costa Rica prices are above the equilibrium value, they fall back gradually toward world Arabica coffee prices by -.234. On the other hand, world Arabica prices adjust toward Costa Rican prices by .3 when Costa Rican prices are too high and as Costa Rican Arabica prices are adjusting. The adjustment parameters indicate that Costa Rican Arabica prices adjust more rapidly toward world Arabica prices than do Indonesian Arabica prices.

Table 4.4. VECM Estimates for Arabica Coffee Prices

Parameter estimates	1st Cointegrating equation: Indonesia (lnaraidn)	Costa Rica (lnaracosta)	World (lnaraico)	2nd Cointegrating equation: Indonesia (lnaraidn)	Costa Rica (lnaracosta)	World (lnaraico)
Long-run equilibrium relationship (β)	-.770 ***	-	1	-	1	-.980***
The speed adjustment (α)	.099	-.051	-.156***	.229	-.234**	.300***

Short run parameters

		Indonesia (lnaraidn)	Costa Rica (lnaracosta)	World (lnaraico)
Indonesian grower prices	(ridn,t-1)	-.101	-.001	-.073
	(ridn,t-2)	-.165	.054	-.0008
Costa Rica grower prices	(rivnm, t-1)	.443**	.114	-.204
	(rivnm, t-2)	.157	.051	-.013
World prices	(rw,t-1)	.071**	.112	.276**
	(rw,t-2)	-.112	.078	.084

Source: Author`s calculation

The results for the short-run parameters seem subtle, implying the need for cautious interpretation and further tests. Similar results are also found in the causality (Granger) test for the VAR model using three lags. Therefore, it is kept as is to avoid invalid inferences.

4.5 Testing Asymmetry in Coffee Prices

4.5.1 Asymmetric Price Test for Robusta

This study uses estimation methods suggested by von Cramon-Taubadel and Loy (1996) using the ECM to identify asymmetry in Robusta and Arabica prices. Using the variable of Indonesian prices (robIDN) and world Robusta prices (robICO), the equation is presented as

$$\Delta \text{robIDN}_{i,t} = \beta_0 + \beta_1 \Delta \text{robICO}_{j,t} + \beta_2{}^{+} ECT^{+}_{t-1} \quad + \beta_2{}^{-} ECT^{-}_{t-1} \quad + \beta_3(L)\Delta \text{robIDN}_{i,t-1} + \beta_4(L)\Delta \text{robICO}_{j,t-1} + \varepsilon_t \qquad (4.10)$$

The previous cointegration test indicated that the two variables are cointegrated. Additionally, the Granger causality test suggests that robICO Granger causes robIDN but not vice versa. The estimation result is presented in Table 4.5.

Table 4.5 Asymmetric Test Result for Robusta

Independent Variable	Asymmetric Error Correction
constant	-.006 (.012)
$\Delta robICO^{+}$	.593*** (.132)
$\Delta robICO^{-}$	.603*** (.170)
ECT^{+}_{t-1}	-.008 (.055)
ECT^{-}_{t-1}	-.078 (.061)
$\Delta \text{robICO}_{t-1}$	.334**(.097)
$\Delta \text{robICO}_{t-2}$	.236***(.099)
$\Delta \text{robICO}_{t-3}$	.115 (.098)
$\Delta \text{robIDN}_{t-1}$	-.181***(.076)
$\Delta \text{robIDN}_{t-2}$	-.276** (.075)
$\Delta \text{robIDN}_{t-3}$	-.044 (.075)
r-square	.33
$ECT^{+} = ECT^{-}$	F(1,198)= 0.51 Prob > F = 0.4747
$ICO^{+} = ICO^{-}$	F(1,198 = 0.00 Prob > F = 0.9677

Source: Author estimation

The result in Table 4.5 indicates that both $ECT^{+}$and ECT^{-} parameters are insignificant. This result suggests that, in the long run, the deviation (positive or negative) will not be corrected to the equilibrium. In the F-test, it failed to reject that asymmetry exists in the price transmission of Robusta from the world market to domestic growers. This result suggests that the transmission of these two prices is symmetric in the long run. The Wald test on short-run asymmetric ($ICO^{+}$and ICO^{-}) also failed to reject the asymmetry. Therefore, price is transmitted symmetrically in the short run.

4.5.2 Asymmetric Price Test for Arabica

Similarly, a typical ECM equation can be applied to Arabica coffee. Using Indonesian coffee (araIDN) and world Arabica (araICO), the proposed equation for analyzing asymmetry in Arabica prices is as follows:

$$\Delta \mathrm{araIDN}_{i,t} = \beta_0 + \beta_1 \Delta \mathrm{araICO}_{j,t} + \beta_2{}^{+} ECT_{t-1}^{+} \quad + \beta_2{}^{-} ECT_{t-1}^{-} \quad + \beta_3(L)\Delta \mathrm{araIDN}_{i,t-1} + \beta_4(L)\Delta \mathrm{araICO}_{j,t-1} + \varepsilon_t \qquad (4.11)$$

Based on the lag selection criteria, using one lag is suggested. As indicated in the previous cointegration test, both ICO and IDN prices are cointegrated. The causality test revealed that causality runs in one direction, from ICO to IDN.

Table 4.6 Asymmetric Test Result for Arabica

Independent Variable	Asymmetrc Error Correction
constant	-.024 (.020)
$\Delta araICO^{+}$	.964** (.320)
$\Delta araICO^{-}$	.105 (.366)
ECT_{t-1}^{+}	-.101** (.144)
ECT_{t-1}^{-}	-.245** (.118)
ΔaraICO$_{t-1}$	.201 (.177)
ΔaraIDN$_{t-1}$	-.063 (.118)
r-square	.21
$ECT^{+} = ECT^{-}$	F(1,84) = 0.42 Prob > F = 0.5166
$ICO^{+} = ICO^{-}$	F(1,84) = 2.13 Prob > F = 0.1484

Source: Author estimation

The significant coefficient on ECT^{+} indicates that the deviation in the short run will be corrected to the equilibrium in the long run. In other words, when the deviation is above the equilibrium (when a decline in world Arabica prices is not followed by a decline in Indonesian Arabica prices), the deviation will be corrected back to the equilibrium (when Indonesian Arabica prices will decline according to the decline in world Arabica prices). The Wald test on $ECT^{+}$and ECT^{-} suggests that it failed to reject the asymmetry, indicating that long-run transmission is symmetric. A similar result is found in the short-run asymmetric test.

4.6 Conclusion

Using the traditional Johansen's error correction model, this study attempts to evaluate the cointegration in coffee prices between Indonesia and several export markets. The results indicate that long-run equilibrium exists between Indonesian and world coffee markets as well as between Vietnamese and world coffee markets. However, the test failed to identify a cointegrating equation between Indonesian and Vietnamese Robusta markets. The results also suggest that Vietnam's market seems to be more integrated with the world market. The short-run parameters suggest that both markets are more affected by the world Robusta coffee series. For the Vietnamese and world Robusta markets, the causality runs in both directions; for the Indonesian and world Robusta markets, the causality runs toward the Indonesian market.

The results for Arabica suggest that cointegration exists between the Indonesian and world market as well as between the world and Costa Rican markets. However, no cointegration exists between grower prices in Indonesia and Costa Rica. The adjustment parameters indicate that Costa Rican Arabica prices adjust more rapidly to world Arabica prices than do Indonesian Arabica prices.

By implementing asymmetric price transmission using ECM, this study found little evidence of asymmetric price transmission in Robusta and Arabica coffee prices.

The absence of long-run equilibrium between Indonesia and other coffee-exporting markets implies that the market is integrated vertically rather than spatially. The vertical integration between domestic and world markets is typical, since it shares the same price information along the value chain. Therefore, price changes are transmitted along this chain. The absence may indicate that the coffee prices in those domestic markets do not influence each other because they do not share the same price information. Coffee trading from Indonesia to other coffee-exporting markets and vice versa is not significant, and the market chains are not adequately developed. This situation may constrain price transmission. Since this study used data on grower prices, the prices paid to Indonesian growers may not be correlated to the prices paid to Vietnamese or Costa Rican growers. In other words, the grower prices in each domestic market are affected by changes in global coffee prices.

In the literature, asymmetry in price transmission is considered to be caused by market power, adjustment cost, and policy intervention (Meyer and Cramon-Taubadel, 2004). Little of the evidence on the asymmetry between Indonesian and world coffee markets indicates that those factors are insignificant. No government policy interventions in coffee export such as via tariffs or price support occurred during the estimation period.

In 2014, however, the government set a 10 % tariff on coffee (VAT), providing an opportunity to observe asymmetric price transmission related to a specific tariff. Although imperfect competition is suspected in the processing and retailing markets, this suspicion should be followed by further identification along the coffee chain in Indonesia; likewise for the adjustment cost. This study clarifies that price changes in international markets are symmetrically transmitted to domestic markets.

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CHAPTER V
IMPACTS OF FOOD SAFETY STANDARDS ON INDONESIAN COFFEE EXPORTS

5.1 Introduction

Indonesia produced 12.73 million bags (60 kg/bag) of coffee in 2012 and 2013, of which 10.94 million were exported,[35] the highest level of production and export for the last 10 years. Although significantly trailing the production in Brazil and Vietnam, Indonesia plays an important role in the world coffee trade. Descriptive production and export statistics for selected producing countries are presented in Table 5.1.

Table 5.1. Exports Comparison Of Selected Coffee Producing Countries.

Year	Production (000 of 60kg bags)			Export (000 of 60kg bags)		
	Indonesia	Vietnam	Brazil	Indonesia	Vietnam	Brazil
2000/01	6,987	14,841	31,310	5,614	14,606	18,577
2001/02	6,833	13,093	31,365	5,173	11,966	23,767
2002/03	6,731	11,574	48,480	4,280	11,555	29,613
2003/04	6,404	15,337	28,820	4,821	14,497	24,909
2004/05	7,536	14,370	39,272	5,822	13,994	27,468
2005/06	9,159	13,842	32,944	6,795	13,122	25,078
2006/07	7,483	19,340	42,512	4,770	18,090	28,486
2007/08	4,474	16,405	36,070	4,418	15,774	28,044
2008/09	9,612	18,438	45,992	5,667	17,386	30,285
2009/10	11,380	17,825	39,470	7,990	14,591	30,215
2010/11	9,129	19,467	48,095	5,948	16,850	33,858
2011/12	7,287	24,058	43,484	6,185	23,475	31,888

Source: ICO (www.ico.org)

Volatility in production, prices, and export growth are, however, weaknesses in Indonesia's coffee performance. Annual growth in production has varied from 53% to -67% from 2001 to 2012, with a similar trend in annual export growth (varying from 29% to -42% over the same period). By contrast, Indonesia's share of world coffee production and export remained stationary at 5 to 6%.[36]

More restrictive food safety regulations on the world coffee trade will create another challenge for Indonesia's coffee, threatening growth in production and exports. The global coffee market is concerned about phytosanitary measures as well as pests and disease issues. As a result, regulations for the maximum residue levels in coffee have

35 http://www.ico.org/new_historical.asp, International Coffee Organization, 2014.8.8
36 Author's calculation based on the ICO's historical data.

been imposed. Codex currently maintains MRLs for 21 pesticides in coffee as of December 2012.[37] The ICO has also warned that Acrylamide, a pesticide found in coffee from several exporting countries, may be regulated in the future. However, it states that commercial measures for this pesticide are not yet available (CODEX, 2009).

In April 2011, Endosulfan was added to the Persistent Organic Pollutants list (POP) by the Stockholm POP Review Committee, followed by a global ban on this pesticide (POPRC, 2010). Indonesia has also declared that Endosulfan and Aldicard, two common pesticides used in coffee plantations, will be prohibited for all purposes (Ministry of Agriculture Republic of Indonesia, 2011). Japan set a uniform limit of 0.01 ppm for Carbaryl in 2005, causing several import rejections of coffee from Indonesia.[38] In addition to MRLs, the world coffee trade was also alarmed by the detection of OTA in some coffee exports. The evidence of OTA in coffee (Reddy *et al.*, 2010) and its link to cancer (IARC, 1993) forced the EU to impose maximum residue levels of 5 ppb and 10 ppb for roasted and soluble coffee respectively (EC, 2006).

The previous chapter on structural changes helped clarify the current situation in Indonesia's overall economy and the shifts in each sector. This discussion on market integration describes the market structure relationships between the domestic and regional markets. However, strong domestic production and an integrated market may still be influenced by other trade factors such as regulations, trade facilitations, barriers, and other trade policies. It is important to further analyze the factors that may influence, directly and indirectly, the development of trade in Indonesia.

Therefore, this chapter focuses on a trade analysis and its relationship with several determining factors and uses a gravity framework to explain that relationship. This discussion contributes empirical evidence on the relationship between the changes in food safety policy and Indonesian coffee exports. This study specifically examines

1. the extent to which food safety regulations (OTA) affect Indonesian coffee exports
2. the extent to which comparative advantage contributes to the export growth of Indonesian coffee
3. the geographical preference of coffee export destinations from Indonesia.

[37] http://dev.ico.org/documents/cy2012-13/icc-110-3-r2e-maximum-residue- limits.pdf, International Coffee Organization, 2014.8.8.
[38] http://www.mhlw.go.jp/english/topics/foodsafety/positivelist060228/dl/n01.pdf, Ministry of Health Labor and Welfare, 2014.8.8.

This chapter begins with the general concept of the gravity model and reviews previous research on it in section 5.2. Due to the importance of the concept panel data analysis in the gravity framework, the dynamic panel data analysis and several limitations of the estimation strategies are discussed.[39] Section 5.3 presents an empirical model of the gravity of coffee trade. Estimation results are presented in section 5.4, while section 5.5 provides conclusions and summarizes the policy implications.

5.2 Dynamic Trade Analysis using Gravity Framework

Different food safety regulations in each country and rapid changes in these standards may increase conflicts and reduce trade (Buzby, 2003). This phenomenon has focused attention on developing models to measure the impact of food safety policies on trade. Among these models, the gravity equation has proved popular in addressing this topic. The gravity model allows the freedom to include variables for food safety policies.

The gravity model is used to estimate the influence of food safety policies on trade in Koo *et al.* (1994), who examine the presence of foot and mouth disease and quotas in some countries to prevent trade with a large portion of the world (Koo *et al.* 1994). Otsuki *et al.* (2001) concluded that the implementation of the new Aflatoxin standard in the EU would have a negative impact on African exports of cereals, dried fruits, and nuts to Europe, reducing them by 64% or US$670 million. Another result also suggested that a 1% increase in the regulatory stringency for Chlorpyrifos would lead to a 1.63% decrease in banana imports (Wilson and Otsuki, 2004). Otsuki and Wilson (2001) also studied the implication of a more relaxed global regulatory standard (CODEX) and its positive impact on the beef trade. They found that global trade in beef would increase by over $3.2 billion.

The traditional static gravity model is as follows:[40]

$$F_{ij} = G(M_i^{\beta_1} M_j^{\beta_2} / D_{ij}^{\beta_3}) \tag{5.1}$$

or, in the normal double logs form,

$$\ln F_{ij} = \beta_0 + \beta_1 \ln(M_i) + \beta_2 \ln(M_j) - \beta_3 \ln(D_{ij}) + \varepsilon_{ij} \tag{5.2}$$

[39] The term "dynamic" here refers to the relationship between a dependent variable and its own past realization. It is different from "dynamic gravity" in the trade equation, in which trade is determined by current and past costs of trade (e.g., Campbell, 2010).

[40] The model was first used by Tinbergen (1962).

where F represents volume of trade from country *i* to country *j*, M typically represents the GDP for countries i and j, D denotes the distance between the two countries, ε represents an error term, and the constant G becomes β_0.

However, there are several flaws in this original static model when it confronts recent dynamic trade concepts such as trade creation and trade diversion (Shepherd, 2012). Those concepts suggest that any change in trade cost on one bilateral route will impact the other routes; these impacts are not captured in the explanatory variables. Bergstrand (1985) suggested that the original model omits certain price variables. Anderson and Wincoop (2003) also argued that the model does not have a theoretical foundation and that the estimation suffers from omitted variable bias. They suggested two additional variables for the model: inward and outward multilateral resistances. However, the widespread use of the gravity model to analyze trade policies is an indication that it is an important "workhorse." Several topics such as trade cost (Khan and Kalirajan, 2011), the impact of trade agreements (Koo *et al.*, 1994), and trading bloc formation (Okubo, 2007) have been addressed using this method.

The use of dynamic panel data analysis in the context of a gravity model is related to the implications of lagged dependent variables and other trade policy variables. Unlike the static model, dynamic panel analysis is useful when the dependent variable depends on its own past realization. A general Dynamic Panel Data (DPD) equation is as follows:

$$Y_{it} = \gamma W_{it} + X'_{it}\beta + \varepsilon_{it} \tag{5.3}$$

$$\varepsilon_{it} = u_i + v_{it}$$

$$Y_{it} = \gamma Y_{i,t-1} + X'_{it}\beta + u_i + v_{it} \tag{5.4}$$

$$E[u_i] = E[v_{it}] = E[u_i v_{it}] = 0$$

where W_{it} is a vector of predetermined but not strictly exogenous variables (for example, the lagged dependent variable, $Y_{i,t-1}$), and X'_{it} is a vector of a strictly exogenous variable. γ and β are parameters to be estimated. ε_{it} is a composite error term consisting of an unobserved group-level fixed effect (u_i) and idiosyncratic shocks (v_{it}), whose expected value is 0.

The OLS and Generalized Leased Square (GLS) estimators are biased and inconsistent when applied to the dynamic panel model in Equation 5.4, as the lagged dependent variable, $Y_{i,t-1}$, is correlated with the fixed effects, u_i. The effect will drive up the value of the coefficient of the lagged dependent variable (biased upward), which actually belongs to specific fixed effects. The fixed effect (within group) estimator can remove the fixed effects, u_i; however, it is also biased and inconsistent, since the transformation (deviation from the means) induces a correlation between that transformed lagged dependent variable and the transformed error term (Bond, 2002).[41] In a large sample, the standard result of the within group estimator is biased downward.

Alternatively, first-differencing transformation also removes the individual effects u_i from the model, yielding

$$\Delta Y_{it} = \gamma\, \Delta Y_{i,t-1} + \Delta X'_{it} + \Delta v_{it} \tag{5.5}$$

By construction, $\Delta Y_{i,t-1}$is correlated with Δv_{it}; therefore, OLS, GLS, and within group estimators are inappropriate. Anderson and Hsiao (1981, 1982) suggested a 2SLS estimator based on further lags of ΔY_{it} as instruments for $\Delta Y_{i,t-1}$(e.g., if v_{it} is IID across individuals and time, $\Delta Y_{i,t-2}$ or $Y_{i,t-2}$ would be a valid instrument for $\Delta Y_{i,t-1}$). Additional instruments are available when the panel has more than three time series observations. However, 2SLS is not asymptotically efficient since the model is overidentified with T>3 while maintaining the assumption that v_{it} are serially uncorrelated.

The Generalized Method of Moments (GMM), developed by Hansen (1982), provides a framework for obtaining asymptotically efficient estimators. Holtz-Eakin, Newey, and Rosen (1988) and Arellano and Bond (1991) later proposed how to construct estimators based on moment equations constructed from further lagged levels of Y_{it} and the first-differenced errors.[42] This proposed estimator is called the "Difference-GMM estimator." This estimator works in first-differenced equations and is instrumented by its own appropriate lagged level. The widely used first-difference GMM estimator confirmed that this estimator suffers from large finite sample bias and poor precision in a simulated study because lagged levels provide weak instruments for this estimator

[41] The transformed lagged dependent variable is $y_{i,t-1} - \frac{1}{T-1}(y_{i1} + \cdots + y_{it} + \cdots + y_{i,T-1})$, while the transformed error term is $v_{it} - \frac{1}{T-1}(v_{i,2} + \cdots + v_{i,t-1} + \cdots + v_{iT}$. The component $\frac{-y_{it}}{T-1}$ in the former is correlated with v_{it} in the latter, and the component $\frac{-v_{i,t-1}}{T-1}$ in the latter is correlated with $y_{i,t-1}$in the former.

[42] Difference GMM used the assumption that the errors are under homoscedasticity. When the errors are heteroscedastic, two-step GMM estimators are robust. To compensate for the downward bias in the standard errors, Windmeijer (2005) proposed a correction for this two-step GMM estimator.

(Alonso-Borrego and Arellano, 1996). Arellano and Bover (1995) and Blundell and Bond (1998) proposed an extended linear GMM estimator, a system of two equations (equation in level and equation in first differences) to improve efficiency. This extended linear GMM is called the "System-GMM" estimator. This estimator uses lagged levels of specified variables as instruments for equations in the first difference (similar to the Difference GMM), added by lags of their own first differences as an instrument for equation in levels.

5.3 Data and Modeling the Indonesian Coffee Trade

The proposed coffee trade model focuses on the impact of food safety policies related to OTA on Indonesian coffee exports. Variables for the Indonesian RCA Balassa index and geographical connections are added to the gravity model specification. In this study, Indonesia is treated as a single exporter, and is paired to 34 coffee-importing countries (N=34) in the inclusion of OTA and paired to 48 countries (N=48) with the exclusion of OTA. Both estimations use a 12-year period (2001–2012) of observation (T=12). Data on export quantity are taken from the ICO. Data on GDP are obtained from the World Bank's World Development Indicators (WDI). Data on the distance between two countries are available from the *Centre d'Études Prospectives et d'Informations Internationales* (CEPII). Data on OTA are obtained from various sources (e.g., Euro-Lex, European Mycotoxin Awareness Network). Data on the RCA index are calculated based on export data.

This study focuses on the impact of food safety policies related to OTA on Indonesian coffee exports in the autoregressive (AR[1]) process. Variables for the Indonesian RCA Balassa index and geographical connections are added to the gravity model specification. The general gravity equation in this study is as follows:

$$\ln X_{ijt} = \alpha_0 + b_1 \ln X_{ij,t-1} + b_2\, OTA_{jt} + b_3 \ln Y_{jt} + b_4 \ln Y_{it} + b_5 \ln D_{ij} + b_6 \ln RCA_{it} + b_7 C_z + \varepsilon_{it} \quad (5.6)$$

where X_{ijt} is bilateral export flows of coffee from Indonesia to country j in the period t and is measured as the quantity of exports. The lagged term of the dependent variable ($X_{ij,t-1}$) is included to observe how the past realization in coffee exports affects current exports. OTA_{jt} reflects the introduction of OTA-related regulations to the coffee trade and takes a value of 1 for the 2007–2012 period for EU countries.[43] This variable is used to capture the impact of food safety regulations on Indonesian coffee exports. Therefore, a negative sign on this variable is expected. Y_{jt} and Y_{it} stand for the GDP[44] of importing and exporting countries respectively and are used as proxies for the paired countries' economies of scale. Positive signs in these two variables are expected. D_{ij} measures the geographic distance between Indonesia and the importing country and is expected to have a negative sign, meaning that larger distances imply higher trade costs, thus reducing bilateral trade flows. RCA_{it} measures Indonesian coffee's comparative advantage using a Balassa index of RCA. This variable is expected to have a positive sign to support the argument that Indonesia has a strong comparative position in the coffee industry. Intuitively, if Indonesia has a strong comparative position in the coffee industry, its coffee industry can be said to be more competitive than the global average. This variable is used to draw a conclusion about Indonesian coffee competitiveness. The last variable, C_z[45], is a dummy variable reflecting the preferred export destination based on geographical location. The location may be positive or negative. ε_{it} is a composite error term consisting of unobserved group-level fixed effects (u_i) and an idiosyncratic shock/observation-specific error term (v_{it}).

Balassa's (1965) index of RCA has been widely used to measure the relative export performance of countries and industries/commodities; it is defined as a country's share of world exports of a commodity divided by its share of total world exports (Balassa, 1965). In this study, the index for Indonesian coffee is calculated as follows:

$$RCA_{ij} = (X_{ij}/ X_i)/ (X_{wj} /X_w) \qquad (5.7)$$

where,

X_{ij} = export of coffee from Indonesia

X_i = total Indonesian commodity exports

X_{wj} = world exports of coffee

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43 China (2010-2012=1), Singapore (2007-2012=1), Other importing countries (2001-2012=0).

44 A gravity equation typically uses GDP in the context of the whole commodity/sector. However, some previous studies (Anders and Caswell, 2009; Chen *et al.*, 2008) have shown that this variable can also be used in the context of a single commodity. One may expect statistical insignificance due to the small direct contribution to total GDP of this single commodity; however, a positive sign on this variable may indicate that the model is appropriate.

45 In this study, the variable C_z represents two model specifications: (1) for estimation using 34 countries (Asian and African countries [C_{AA}=0], European countries [C_{EU}=1], and American countries [C_{UC}=2]), and (2) for estimation using 48 countries (Geo_{Asia}=0, Geo_{Africa}=1, Geo_{Europe}=2, and $Geo_{America}$=3).

X_w = total world exports of all commodities

The interpretation is straightforward. If the index of the revealed comparative advantage (RCA_{ij}) has a value greater than unity, this indicates a comparative advantage for Indonesian coffee.

Although Balassa's RCA index is informative, Equation 5.7 suffers from an asymmetric property. It will produce RCA values distributed in three areas: $0 \leq RCA < 1$, $RCA=1$, and $1 < RCA < \infty$. It is easily shown that the lower bound is fixed, whereas the upper bound is not delimited. Thus, this study follows Yu *et al.* (2009) and applies the Normalized RCA to overcome this issue. The NRCA index measures the degree of deviation of a country's actual export from its comparative-advantage neutral level. NRCA can be written as

$$NRCA_{ij} = \Delta X_{ij} / X_w = X_{ij} / X_w - X_{wj}X_i / X_wX_w \quad (5.8)$$

Our interest is to observe the temporal comparison in the NRCA of a single commodity. Thus, the deviation in NRCA for each period measures the temporal change in Indonesian coffee's comparative advantage. The deviation in NRCA can be written as

$$\Delta NRCA_{ij} = NRCA_{ij,t+1} - NRCA_{ij,t} \quad (5.9)$$

Consequently, $\Delta NRCAij,\ t+1>0$ (or $\Delta NRCAij,\ t+1<0$) illustrates that country *i* has increased (or decreased) its comparative advantage in commodity *j* between time *t + 1* and *t*.

The RCA has been used in gravity models in some recent studies. Sheng and Song (2103) concluded that the RCA is positively correlated and has a significant effect on China–Australia bilateral trade. Schumacher (2003) studies how the home-market effect surfaces in the gravity equation using a model of monopolistic competition that accounts for traditional comparative advantage effects. Bahar (2012) built an Export Similarity Index from a traditional RCA index; by using the gravity equation, the study suggested that the probability that a product would be added to a country's export basket was, on average, 65% higher if a neighboring country were a successful exporter of that same product.

Theoretically, it can be predicted that Equation 5.6 contains several econometric issues. The RCA variable is assumed to be endogenous because causality may run in both directions between trade flow and the RCA. Therefore, this variable may be correlated with the error term. The second problem arises from the presence of the lagged dependent variable ($X_{ij,t-1}$), which may lead to autocorrelation. The third issue arises from the characteristics of time-invariant variables (fixed effects), such as distance and country location/geography, which may be correlated with the explanatory variables. Finally, a short-run observation (T=12) of a panel dataset may affect the estimation.

To avoid these problems, the Difference and System GMM estimator (Arellano and Bond 1991; Arellano and Bover, 1995; Blundell and Bond, 1998), designed for panel data analysis, can be applied. The estimator has the following characteristics: 1) a small T and large N; 2) a linear functional relationship; 3) a single left-hand-side variable that is dynamic, meaning that current value is influenced by previous realization; 4) the regressors are not strictly exogenous, meaning that it may have a correlation with the past and current realization of the errors; 5) fixed individual effects; 6) heteroskedasticity and autocorrelation within individuals but not across them; and 7) the available instruments may come from lagged or external variables (Roodman, 2006).

Problem 4 (small T panels) is addressed directly by the Difference and System GMM estimators. Problem 1 can be handled by using a lagged level of the endogenous variable (lagged $RCA_{it-l}, l \geq 2$) as instruments for RCA in first difference transformation. These available instruments are correlated with RCA_{it} but not with the error $\Delta\varepsilon_{it}$ term in Equation 5.6. Similarly, lagged differences of X_{ijt} $(\Delta X_{ij,t-l}, l \geq 2)$ can be used as instruments for the lagged dependent variable $(X_{ij,t-1})$ in level equation to handle problem 2 (Arellano and Bover, 1995; Blundell and Bond, 1998; Roodman, 2006). To cope with problem 3, GMM uses first difference transformation to transform Equation 5.6 into

$$\Delta X_{ijt} = \beta_1 \Delta X_{ij,t-1} + \beta_2 \Delta OTA_{jt} + \beta_3 \Delta Y_{j,t} + \beta_4 \Delta Y_{it} + \beta_5 \Delta RCA_{it} + \Delta\varepsilon_{it} \quad (5.10)$$

The error term in Equation 5.6 later becomes $\Delta\varepsilon_{it} = \Delta u_i + \Delta v_{it}$ or $(\varepsilon_{it} - \varepsilon_{i,t-1}) = (u_i - u_i) + (v_{it} - v_{i,t-1})$. The transformation removes time-invariant variables, including fixed country-specific effects (u_i).

Regarding the validity of the model, Arellano-Bond (1991) proposed a test to detect serial correlation in the disturbances. This violation in the disturbances will eventually affect the validity of some of the instruments.[46] It also reports a Sargan/Hansen test for overidentifying restrictions about whether the instruments as a group are exogenous.

5.4 Estimation Result and Discussion

This section provides the results of the gravity model in Equation 5.6 using GMM estimators. The results are summarized in Table 5.2, which contains two different estimations. Columns (1) and (2) were estimated using smaller number of countries (N1=34) for which data on OTA are available. The main objectives are to analyze the impact of food safety regulations on the Indonesian coffee trade, coffee competitiveness, and preferred destinations for coffee export. Since data on OTA in other countries are not available, the model needed to be relaxed by excluding this variable in the estimation. More observations (N2=48 countries) could be generated since the OTA variable was dropped. In this way, the geographical preference of Indonesian coffee exports in a more relaxed environment, without food safety policy intervention, can be identified. The result of this modified model is summarized in column (3). By comparing columns (2) and (3), the export destination pattern can be analyzed.

Table 5.2 contains two different techniques. Column (1) presents the results using the Difference-GMM estimator to handle the country fixed effects (u_i). As a consequence of first-difference transformation, time-invariant (i.e., distance and geographic dummy) variables were dropped. This column provides a basic intuition on the measurement of food safety regulations, coffee competitiveness, and other variables in the gravity model. An extended estimation using System-GMM was then applied to compensate for the limitation of the previous technique; the result is presented in columns (2) and (3). These columns also provide the coefficients of distance and geographic location, which were dropped from the first column.

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[46] To implement the Difference and System GMM, the STATA program *xtabond2* is used. It reports ab Arellano-Bond test for autocorrelation, which is applied to the first-difference equation residuals in order to eliminate the unobserved and perfectly autocorrelated u_i. AR(1) is expected in first differences because $\Delta v_{it} = v_{it} - v_{i,t-1}$ should correlate with $\Delta v_{i,t-1} = v_{i,t-1} - v_{i,t-2}$ since they share the $v_{i,t-1}$ term. However, higher-order autocorrelation indicates that some lags of the dependent variable, which might be used as instruments, are in fact endogenous and thus invalid instruments; that is, $y_{i,t-s}$,where s is the lag, would be correlated with $v_{i,t-s}$,,which would be correlated with $\Delta v_{i,t-s}$, which would be correlated with Δv_{it} if there were AR(s). It also reports a Sargan/Hansen test for overidentifying restrictions about whether the instruments as a group are exogenous. In robust estimation, *xtabond2* reports a Hansen J statistic instead of the Sargan test. See Roodman (2006). The STATA output of Table 5.2 is presented in Appendix 5.

Table 5.2. Estimation Result of Gravity Coffee Trades Equation [a)]

	Depvar: $\ln X_{ijt}$		
	Difference-GMM	System-GMM	System-GMM
	(1)[b]	(2)[b]	(3)[c]
$L.\ln X_{ijt}$	0.59***	0.86***	0.74***
	(0.11)	(0.08)	(0.06)
OTA	-0.46**	-0.39**	
	(0.23)	(0.19)	
$\ln Y_{jt}$	0.04	0.18	0.13**
	(0.30)	(0.18)	(0.06)
ln Yit	0.51***	0.37**	0.05
	(0.17)	(0.15)	(0.08)
ln RCA	0.76***	0.76***	0.44***
	(0.22)	(0.24)	(0.16)
ln D		-1.79***	-0.52***
		(0.39)	(0.18)
C_{EU}		2.42***	
		(0.74)	
C_{UC}		6.24***	
		(1.21)	
Geo_{Africa}			1.31***
			(0.33)
Geo_{Europe}			0.58**
			(0.27)
$Geo_{America}$			1.25***
			(0.46)
cons			0.61
			(2.39)
N	306	340	502
ar1p	0.00	0.00	0.00
ar2p	0.18	0.20	0.16
Hansen test of over-Identification (p-value)	1.000	1.000	1.000
Diff-in-Hansen test of exogeneity (p-value)	1.000	1.000	1.000

Source : Author's calculation

Standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note :

a)All columns are estimated in two-step GMM with option robust to obtain Windmeijer's corrected standard errors. AR(1) and AR(2) are tests for first-order and second-order serial correlation in the first-differenced residuals, under the null of no serial correlation. The Hansen test of over-identification is under the null that all instruments are valid. The Diff-in-Hansen test of exogeneity is under the null that instruments used for the equations in levels are exogenous

b) estimated using 34 countries data set and OTA variable is included.

c)estimated using 48 countries data set (without OTA variable).

In general, all columns of the GMM estimation result are well behaved. All the coefficients reported in Table 5.2 are in double log-log forms, so that elasticity can be directly estimated. The p-values of the Arellano-Bond autocorrelation test, significant in AR(1) but not in AR(2), are as expected, indicating that the second lags of the endogenous variables are appropriate instruments for their current values. The reported Hansen test of overidentification and the Difference-in-Hansen test of exogeneity indicate that the estimation seems to suffer from instrument proliferation.[47]

Columns (1) and (2) suggest that, all else being equal, the implementation of OTA regulations has had a statistically significant negative effect on the quantity of Indonesian coffee exports for both difference and system GMM estimators. These results confirm the hypothesis that more stringent regulations on trade will create a barrier to trade. From an elasticity point of view, a 1% increase in OTA will result in an annual loss of around 0.39% to 0.46% of exports. Our findings support the argument about the negative impact of non-tariff barriers to trade reported by Anders and Caswell (2009), Otsuki *et al.* (2001), and Wilson and Otsuki (2004).

Indonesian coffee exports are strongly related to past exports. A 1% increase over the past realization of coffee export will have an impact on current export realization of around 0.59% to 0.86%. This dynamic relationship with coffee exports confirms that any current shock will also have an impact on future export realization.

Since this study focuses on a single commodity, the statistical significance of GDP (in both paired countries) is less expected, although the positive sign is more so. The coefficients of importing countries' nominal GDP are positive and statistically significant only in column (3), whereas the coefficients of Indonesian nominal GDP are also positive and statistically significant in columns (1) and (2). Recent studies (e.g., Hummels and Klenow, 2005) suggest that trade expands both at the extensive margin (more products) and intensive margin (more volume in one product) as economies grow. Therefore, increasing i or j country's GDP may not necessarily increase trade flow in a certain commodity. In general, the results suggest that both paired countries' GDP may have effects on coffee trade flow depending on the model specification. The results suggest that a 1% increase in Indonesian GDP induces an approximately 0.31% to 0.51% increase in coffee exports. Regarding importing countries' GDP, the result suggests that a 1% change in this variable induces a 0.13% change in coffee exports.

[47] As discussed in Roodman (2006), the Hansen test may be weakened by putting too many instruments in the equation. If the reported Hansen tests in Table 5.2 are acceptable, this study may conclude that it failed to reject the null hypothesis that the instruments used in this estimation are valid and exogenous. This study does not conduct further testing on the strength of the instruments, as Wintoki *et al.* (2012) stated that there is no single criterion for evaluating the joint strength of instruments in the System GMM estimator.

The coefficient of Distance is also consistent with the hypothesis: a 1% increase in the unit of Distance reflects a 0.52% to 1.79% decrease in the total quantity of Indonesian coffee exports. In column 1, Distance is dropped due to time invariance. The comparative advantage of Indonesian coffee is positive and statistically significant in all columns. The results suggest that a 1% increase in Indonesia's RCA will have an impact on export quantity of between 0.44% and 0.76%. The estimation results, as well as the data presented in Figure 5-1, confirm the hypothesis that Indonesia has an adequate to strong comparative advantage in the coffee market relative to countries with average export volumes. As Figure 5-1 shows, the RCA index of Indonesian coffee never fell below unity but kept increasing from around 3 in 2001 to 5.2 in 2008. Although the index fell to 2.5 from 2009 to 2011, it rebounded to around 4 in 2013. Temporal comparative advantage levels are shown by the values of ΔNRCA; ΔNRCA > 0 in 2002, 2003, 2005, 2006, 2008, 2009, and 2011, while other periods had a negative ΔNRCA. The mean value of ΔNRCA[48] is calculated to be around 2.36x10.^{6} Since ΔNRCA reflects a positive comparative advantage, Indonesia can be said to have an adequate level of comparative advantage in coffee.

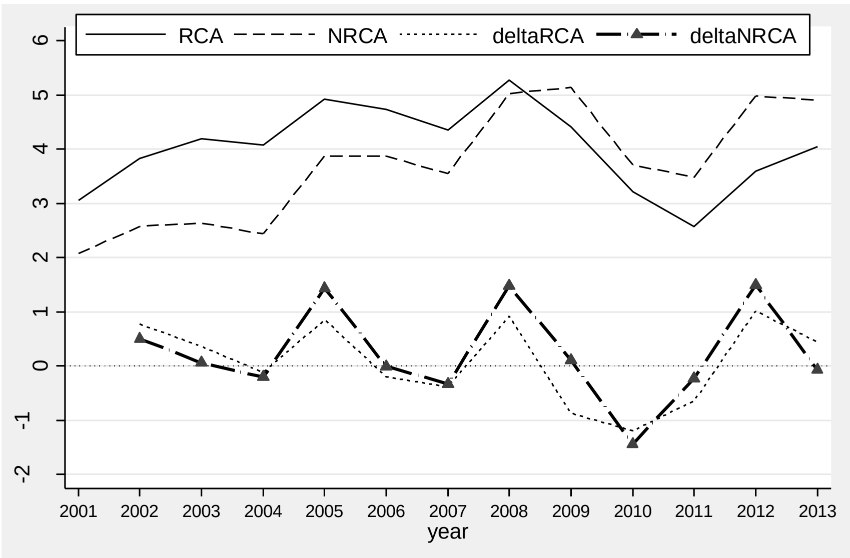

Figure 5-1. RCA and NRCA of Indonesian Coffee

Source: Author's Calculation

In columns (2) and (3), Continent dummy (C_Z) variables present the patterns of Indonesian coffee exports based on continent of destination. In column (2), variable C_Z is

48 The values of NRCA are typically very small. Therefore, Yu *et al.* (2009, p. 276) recommend scaling the values by 10,000, which does not affect the interpretation of the results. In this calculation, NRCA values were scaled by a constant of 100,000 to facilitate the presentation of the ΔNRCA figure.

denoted as C_{AA}, C_{EU}, and C_{UC} and is applied in the estimation using 34 countries;[49] in column (3), it is referred to as Geo_{Asia}, Geo_{Africa}, Geo_{Europe}, and $Geo_{America}$ and is used in the modified model (without OTA) using 48 countries.[50] In column (2), both coefficients C_{EU} and C_{UC} are positive and statistically significant, suggesting that Europe and America are important Indonesian trading partners and have a stronger connection to the Indonesian coffee trade than do Asia or Africa. In column (3), the coefficients of Geo_{Africa}, Geo_{Europe}, and $Geo_{America}$ are also positive and statistically significant, suggesting that a larger trade flow of coffee is directed to those three continents than to Asian countries.

Equation 5.6 shows that the short-run effect of OTA is equal to b2 and that the long-run effect is equal to b2/1-b1.[51] The adjustment coefficient of the partial adjustment process (1-b1) is equal to 0.41 or 0.14. The short-run effect of OTA is -0.46 (column [1]) or -0.39 (column [2]). Therefore, as Table 5.2 shows, the long-run effect of OTA is equal to -1.12 or -2.78 in the Diff-GMM and Sys-GMM respectively. The values of the long-run effect of OTA reported in this study are higher. This may be due to the relatively small dataset used in the estimation (N=34 and T=12), which does not allow the bias to be corrected optimally. Therefore, these values should be approached with caution. However, the results suggest that increased regulation stringency would negatively impact the coffee trade.

5.5 Conclusion

On the one hand, food safety standards are considered a means by which health risks can be reduced from the food products trade. On the other hand, the dissimilarities among the standards applied in bilateral trade can be considered as a trade barrier. This is true for developing countries, since their exports depend heavily on particular commodities. Indonesia, where coffee is an important export commodity, is also affected by this trade barrier. Risk to health is presumably uncertain, but it was empirically demonstrated that stricter food safety regulations have a negative impact on the coffee trade.

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[49] In the data on the 34 countries, Africa consists of Morocco and Egypt only; therefore, these countries are included among Asian countries as C_{AA}. Although C_{UC} consists of only the US and Canada, they are placed in a different category. C_{EU} refers to European countries.

[50] In the data on 48 countries, more countries are available; thus, they can be divided by region. The term *Geo* is used to distinguish between the two different model specifications.

[51] Consider a simple partial adjustment model: $Y_t = \alpha + \beta X_t + \gamma Y_{t-1} + \varepsilon_t$. The short-run effect of X on Y is β, and the long-run effect of X on Y is $\beta/(1-\gamma)$.

Using a panel data analysis of Indonesian coffee exports to 34 countries, this study provides further evidence on food safety and trade. By applying a gravity model, our findings suggest that more stringent food safety regulations such as those for OTA would have a negative impact on Indonesian coffee export quantities.

Our results also suggest that the presence of Indonesia's comparative advantage has a positive and significant effect on its coffee exports. This finding suggests that, on average, Indonesia has achieved optimal resource allocation and cost efficiency in the coffee industry. Finally, the results suggest that Europe and America are important trading partners for Indonesian coffee exports. Although the GMM estimator was able to predict effectively, further research using more countries and a longer time span should provide more robust results.

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CHAPTER VI
CONCLUSION AND POLICY IMPLICATIONS

Given Indonesia's long history of trade and its important role as a coffee-producing country, coffee has made a significant contribution to the economy. However, economic and econometric research on this commodity is limited. Therefore, this study explores the importance of the coffee trade in Indonesia using three analytical methods—the IO analysis, market integration analysis, and gravity of trade model—to obtain general conclusions on the Indonesian coffee trade.

Employing several methods provided in IO analysis identified the structural changes in coffee production and trade. The results indicate that the output of the coffee sector increased considerably from 2000 to 2010, although its share is insignificant compared to other agricultural sectors (e.g., paddy, oil palm). The results of the indexes of sensitivity and dispersion power suggest that the coffee sector has an adequately strong backward linkage, demanding inputs from other sector, but a weak forward linkage, as the sector is not strongly demanded by other sectors as input. Judging from the combinations of IPD and ISD, the results suggest that the coffee sector is not a key sector. However, similar findings are found in other agricultural sectors. This study also reveals that the coffee sector experienced a considerable increase in its intermediary inputs as well as in its intermediate demand, suggesting that the sector failed to move toward a growing position based on RAS analysis.

A skyline analysis explores self-sufficiency rates and the structure of trade. The shaded bars in exports and imports for the coffee sector indicate a larger net export than other sectors, suggesting that coffee is export-oriented. The coffee sector also shows a significant increase in its share of domestic production, indicating that coffee production grew from 2000 to 2010. Interestingly, the coffee sector's self-sufficiency rate rose significantly, almost doubling its total domestic demand in 2010. Though imports changed insignificantly, this study indicates that the coffee sector showed a strong export performance compared to other agricultural sectors. This conclusion provides a different perspective on the coffee sector.

Market integration analysis is used to identify the long-run equilibrium among markets. Since structural changes in coffee production and trade have been fully identified, this study attempted to identify the relationship between trades/export structures and market structures through the characteristics of coffee prices. For Robusta, this study found that global and Indonesian coffee prices are cointegrated in the long run. Similarly, this study found that long-run equilibrium exists between world and Vietnamese Robusta prices, with a more rapid adjustment towards equilibrium compared to Indonesian prices. However, no cointegration is found between Indonesian and Vietnamese markets. For Arabica, cointegration is found between world and Indonesian coffee prices as well as between Costa Rican and world prices. These findings show that Costa Rica adjusted more rapidly toward equilibrium than did Indonesian prices. Finally, this study found little evidence of asymmetry between the Indonesian and world coffee markets, indicating that prices are transmitted symmetrically in the long run.

Based on the measurement of the two types of Indonesian coffee market, this study suggests that the Indonesian market is less integrated than the other exporting markets. Thus, shocks in world coffee prices will be neither fully nor quickly transmitted into domestic markets. Rapsomanikis and Mugera (2011) found a similarly slow transmission in developing markets, although the markets were integrated in the long run. This finding also suggests that Indonesian coffee farmers (including traders) face greater risks of price volatility since the Indonesian market structures cannot absorb information on coffee prices efficiently. This volatility causes uncertainty among market actors, thus preventing the market from functioning properly (Rapsomanikis and Mugera, 2011). This study indicates market inefficiency (i.e., Conforti, 2004) since changes in coffee prices are not fully transmitted from the international market.

According to a World Bank report (Giovannucci *et al.*, 2004), Vietnam has the lowest production cost and among the highest average yield levels per hectare. The report found a positive correlation between fertilizer usage and increasing productivity. Generous credit programs and low import taxes on fertilizer allowed the farmers to afford the input at lower costs.

Its marketing channels are reasonably transparent and efficient. Farmers received price information through TV, radio, coffee collection centers, and traders, and most of the channels are well-developed. As a result, farmers received the highest share of FOB prices, at 94 %, and farm gate prices are sometimes higher than spot prices. The remaining thin shares reflect the margin for intermediaries and transaction costs. Farmers learnt how to calculate farm gate prices from exchange listings or FOB prices. Search costs are low; therefore, price differences between different potential buyers are reported to be no more than 0.05 %. Farmers also have clear ideas about their selling price expectations. Furthermore, Vietnam's domestic markets are strong, which helps buffer the coffee sector from international volatility. There are no excessive stocks, and there is also an increasing demand for soluble coffee, indicating that product diversification has been well-developed.

Governments diminished their active participation in coffee sector policymaking through nationwide reforms. For instance, they removed restrictions and allowed private firms to participate more fully in the estates and market. They provided generous credit, froze debt repayments, and encouraged credit for successful coffee businesses. Farmers incur few formal costs to comply with government regulations. The import taxes on fertilizer have been reduced to five percent or less.

The Indonesian coffee market is fully liberalized; however, there are indications that the market chains are not efficient. The farm gate price share in Indonesia is around 76 % of FOB prices, much lower than in Vietnam. This large price discrepancy indicates three situations: less educated farmers in terms of price information, poor marketing channels, and high transactional costs. Farmers may still rely on traders or cooperatives to obtain information on coffee prices. Use of mass media such as TV, radio, newspapers, and the Internet has not been maximized. Additionally, the marketing chains are quite long, defined by farmers–collectors–traders–exporters. Finally, the transactional cost is around 14.7 % of FOB prices, while intermediaries' margins are around 9.4 %.

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Risk in the coffee trade arises from various sources, such as price volatility and inefficient policies. Another risk is food safety regulation. Although regulation provides benefits for health and safety, it also acts as a non-tariff barrier. Its importance to the coffee trade is undeniable. Therefore, this study explored the impact of food safety regulations on Indonesian coffee exports using the gravity of trade framework. The gravity model is a well-known method of identifying the factors influencing trade such as GDP, distance, trade facilitation policy, and trade costs. This study found that coffee is subjected to several food safety requirements and that the implementation of the regulations varies depending on the trading partner. Regulations also change rapidly and are becoming more stringent. This study found that the regulation of OTA has negative effects on Indonesian coffee exports. Furthermore, the GDP of both exporting and importing countries, distance, and Indonesia's comparative advantage also have impacts on the coffee trade. The gravity model in this study also identified the preferred destination markets for Indonesian coffee. The findings imply potential future gain through trade facilitation policies among the identified markets (e.g., Europe and America) to reduce the negative impacts of food safety regulations on Indonesian coffee.

Several policy implications and recommendations can be drawn from this study. To address the low importance of the coffee sector in Indonesia, policies regarding productivity, value added, and quality assurance in coffee production are required. Coffee productivity in Vietnam and Brazil is much higher than in Indonesia. At least ninety percent of Indonesia's coffee plantations are owned by small farmers. Therefore, the way to improve productivity is by addressing these small estates. Vietnam's government allows private business to help run coffee estates; this strategy has improved productivity significantly. Private businesses have replaced the heavily subsidized and unprofitable government-owned estates, since private estates can bear more competitive markets. However, there is a debate in Indonesia about whether a similar strategy would improve farmer welfare. Small farmers are not able to compete with private business in terms of financial resources. Therefore, a more integral approach needs to be considered, such as by strengthening coffee farmers' institutions.

Crop area expansion and government support for agricultural inputs to the coffee sector should be considered. In the case of Robusta coffee, fertilizer and pesticides are important for boosting productivity. Therefore, government support for these inputs is required. Indirectly, the government may provide soft loans that could be allocated to purchase these inputs or hire additional labor. However, this strategy may face challenges since demand for organic coffee is increasing. Furthermore, Indonesian Robusta faces competition from Vietnam, since both countries produce the same coffee. Therefore, increasing Robusta productivity will not be a good strategy for Indonesia. Robusta coffee is sometimes considered low-quality, as roaster companies normally blend it with other coffees to reduce costs. By contrast, Indonesia has a competitive advantage in Arabica coffee. Some of its Arabica coffees, such as Gayo, Mandheling, Kintamani, and Kalosi, are quite well-known in international markets. Therefore, the government should step up the development of higher value-added coffees to improve its position in the international coffee trade. This approach has also been suggested by Li and Siaghian (2013) in regards to Vietnam Robusta and Columbian Mild coffees. They suggest that Columbia should maintain its reputation while exploring new niche specialty markets, whereas Vietnam should maintain its low-cost production while improving Robusta quality.

Regarding the interconnectedness between coffee and other industries, the government should increase the value added of coffee products. The objective is to increase the export of coffee in more developed products. Product development and diversification along the coffee value chain are expected to create more value in coffee products, create new markets, and induce higher employment. The implementation of a VAT on coffee exports triggered debates. In 2015, the government started to impose a VAT on coffee exports of around 10 % in order to boost the export of processed coffee. The motivation was to induce more investment in coffee processing chains and to penetrate new markets. However, domestic coffee processing companies sometimes cannot fully absorb the coffee production. Therefore, this situation may reduce green coffee export quantities.

To address the market structure issues, several components of development are suggested. Improving efficiency in the domestic market structures along the coffee value chain is necessary because this is related to transaction costs. As efficiency improves, market actors will have less power over coffee price formation. Therefore, the degree of inertia in price transmission is reflected by trade costs only.

Price information channels must also be improved. Because small farming is dominant in coffee production, price information channels and the capacity to absorb that information are important to price formation. Coffee farmers tend to be price takers and thus have little bargaining power. When the information cannot be fully absorbed, any gain or loss in trading is less predictable. For instance, according to an FAO report (Susila, 2006), a decrease in FOB will cause farmer gate shares to fall from 75 % to 66 %. The government should invest in communication infrastructure and develop information channels such as access to the Internet, radio, and local newspapers. They have to provide education on how to calculate farm prices based on available information such as exchange listings or FOB prices, which are available online. This is important, as it will allow farmers to predict future prices based on the availability of future harvest and data on demand. Vietnamese farmers have already developed this ability. The farmers can obtain full information on prices so that the differences in prices among buyers are not significant, meaning that markets can compete in a relatively perfect environment.

The third factor is the infrastructure along the production channels. This is related to the physical risk that can influence prices due to transportation costs. It is well-known in the coffee sector that fuel costs are the dominant costs when coffee is transported from a farmer to the nearest ports. There are only three ports available in Indonesia for coffee to be exported, and the distances from coffee-producing regions to these three ports are long.

Finally, the domestic markets need to be improved. The experiences of other countries such as Vietnam and Brazil show that strong domestic markets will help farmers to buffer the domestic coffee sector from price volatility in the international markets. For instance, if there is a decrease in the international price, farmers may push coffee into domestic markets since it may obtain better prices than in international markets. The government can support this by establishing a program or stimulus for increasing domestic coffee consumption such as via a coffee promotion or advertising through marketing channels or mass media. The government could encourage businesspeople to establish new cafes or coffee shops. The government could also support domestic or foreign investment in coffee diversification activities such as in soluble coffee since demand is shifting from ground coffee to soluble/instant coffee.

Regarding the food safety challenge to the coffee trade, improving coffee quality is important. Regarding OTA risk mitigation, Vietnam was involved in a technical cooperation program, assisted by the FAO, designed to educate farmers about OTA and to reduce the risk of its occurrence. The FAO independently agreed to support a TCP project (TCP/VIE/2903 A) through its own funding called the Improvement of Coffee Quality and Prevention of Mould Formation and *Ochratoxin A* (OTA) Contamination of Coffee in Vietnam (Yoovatana *et al.*, 2006). Foreign and domestic investments have significantly improved the quality of equipment used by processors to provide more efficient and higher-quality coffee processing. Many foreign technologies have been imported and adapted by local manufacturers. From 1995 to 2003, the monthly pass–fail rates show a dramatic improvement in Vietnamese coffee, representing a significant reduction in contract rejection rates.

A similar project, the Enhancement of Coffee Quality through the Prevention of Mould Formation (GCP/INT/743/CFC), was implemented in Indonesia (FAO, 2006). Together with Brazil, Colombia, Côte d'Ivoire, India, Kenya, and Uganda, the FAO offered technical assistance from 2000 to 2005 in order to enhance knowledge of OTA in coffee, to provide guidelines for the hygienic production of coffee, to foster capacity building at national coffee institutes on specific technical issues, to strengthen policymaking for and regulation of the sector, and to develop regional and international collaboration.

Afterward, several strategies were proposed for improving Indonesian coffee quality based on the project (Susila, 2006). For instance, one option is raising the issue of low-quality coffee onto the national level. Farmers must be convinced that improved coffee will lead to better prices. Additionally, Nestle, an Indonesian coffee buyer, can accommodate only around 3,000 tons of better-quality coffee. Therefore, markets for better coffee need to be expanded. The provision of credit will also help farmers to cultivate better-quality coffee since the fund can be allocated for additional fertilizer and labor. The credit can also be used to rejuvenate coffee processing technology to improve coffee quality and minimize defects. Farmer organizations also need to be empowered to guarantee that the strategies will be implemented well.

Regulations on banned pesticides or their inappropriate use on coffee should be communicated clearly to farmers. The government should regulate the distribution of particular chemicals that may lead to coffee export rejection. Additionally, to prevent future export rejection, the government should pursue trade agreements. A penetration into emerging coffee markets, where the regulations or export requirements are not strict, is another recommendation. In regards to global initiatives on coffee certifications, the government could initiate a unification of certification in regional markets such as the ASEAN. An ASEAN coffee standard may also enlarge the capability among ASEAN countries to reduce the impacts of food safety regulations on the coffee trade. Finally, trade facilitation and negotiations among loyal trading partners should be promoted—for instance, joint cooperation between importers and domestic farmers regarding the sustainability of codes of conduct for coffee farming. Most coffee exporters in Indonesia are members of AEKI (*Asosiasi Eksporter Kopi Indonesia*). This organization plays an important role in promoting Indonesian coffee in international markets. This organization can also improve the quality of coffee by providing services to farmers, since this association is well informed regarding the buyers' requirements.

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Appendix 3.1. Mathematical Transformation of Leontief Inver Matrix and RAS

3.1.1 Leontief Inverse Matrix of 20 Sector

The "ready to use" I-O tables of the year 2000; 2005 and 2010 are composed of 20 sectors. Based on this 20 aggregated sectors of the Indonesian IO tables, the equilibrium between total demand and total supply for each good i is as follow:

$$x_i + m_i = z_{i1} + z_{i2} + \ldots + z_{i20} + y_i \tag{1}$$

where x_i is the output of sector i, m_i denotes imports of product i, z_{ij} is sector i's product absorbed by sector j whether it comes from domestic production or is imported $\left(z_{ij} = z_{ij}^d + z_{ij}^m\right)$, y_i is the total final demand for sector i's product, which includes both domestic and imported final demand $\left(y_i = y_i^d + y_i^m\right)$ then equation (1) can be written as

$$x_i = z_{i1} + z_{i2} + \ldots + z_{in} + y_i + m_i \tag{2}$$

Let assume that $y_i^* = y_i + m_i$ thus for the whole sectors there would be a set of 20 equations

$$\begin{aligned} x_1 &= z_{11} + z_{12} + \ldots + z_{1,20} + y_1^* \\ x_2 &= z_{21} + z_{22} + \ldots + z_{2,20} + y_2^* \\ &\vdots \\ x_{20} &= z_{20,1} + z_{20,2} + \ldots + z_{20,20} + y_{20}^* \end{aligned} \tag{3}$$

Define a_{ij} is the direct input coefficient, as

$$a_{ij} = \frac{z_{ij}}{x_j}$$

and substitute (2) into (3),

$$\begin{aligned} x_1 &= a_{11} x_1 + a_{12} x_2 + \cdots + a_{1,20} x_{20} + y_1^* \\ x_2 &= a_{21} x_1 + a_{22} x_2 + \ldots + a_{2,20} x_{20} + y_2^* \\ &\vdots \\ x_{20} &= a_{20,1} x_1 + a_{20,2} x_2 + \cdots + a_{20,20} x_{20} + y_{20}^* \end{aligned} \tag{4}$$

In matrix term, (4) can be written as

$$X = A X + Y^* \tag{5}$$

with

$$A = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1,20} \\ a_{21} & a_{22} & & a_{2,20} \\ \vdots & \vdots & \ddots & \vdots \\ a_{20,1} & a_{20,2} & \cdots & a_{20,20} \end{bmatrix}; \quad X = \begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_{20} \end{bmatrix}; \quad Y^* = \begin{bmatrix} y_1 \\ y_2 \\ \vdots \\ y_{20} \end{bmatrix} \tag{6}$$

By using an n x n Identity matrix (I) manipulation in (6), I can obtain

$$X = (I - A)^{-1} Y^* \tag{7}$$

where $(I - A)^{-1}$ is known as Leontief inverse matrix. Let B represent the elements of Leontief inverse matrix $(B = (I - A)^{-1})$ thus (7) can be written as

$$\begin{aligned} x_1 &= b_{11} y_1^* + b_{12} y_2^* + \ldots + b_{1,20} y_{20}^* \\ x_2 &= b_{21} y_1^* + b_{22} y_2^* + \ldots + b_{2,20} y_{20}^* \\ &\vdots \\ x_{20} &= b_{20,1} y_1^* + b_{20,2} y_2^* + \ldots + b_{20,20} y_{20}^* \end{aligned} \tag{8}$$

The coefficient b_{ij} indicates by how much the output of the i^{th} sector, x_i, would increase as a result of one unit increase in the final demand y_j $\left(b_{ij} = \partial x_i / \partial y_j\right)$.

Provided that the number of employment (e) in each sector is available, the a vector of employment coefficients can be denoted as

$$\hat{e_j} = [e_1/x_1 \;\; e_2/x_2 \; \ldots \; e_{20}/x_{20}] = [\hat{e_1} \;\; \hat{e_2} \; \ldots \; \widehat{e_{20}}\,]$$

Then $\in_j = \hat{e_j}\, X = \hat{e_j}\, (I - A)^{-1}\, Y^*$ produces a vector whose elements are the total employment in each sector as a result of a new exogenous final demand,

$$\in_j = \begin{bmatrix} \hat{e}_1 & 0 & \cdots & 0 \\ 0 & \hat{e}_2 & & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & \hat{e}_{20,20} \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_{20} \end{bmatrix} = \begin{bmatrix} \in_1 \\ \in_2 \\ \vdots \\ \in_{20} \end{bmatrix} \qquad (9)$$

3.1.2 RAS Method

RAS is a method to estimate the new input coefficient matrix in time t ($A_{(t)}$) using the information from input coefficient in basic year ($A_{(0)}$). Suppose the input coefficient matrix in the base year is $A_{(0)} = [a_{ij}]_0$ and the total rows and columns of intermediary input in the projection year be $X_{\blacksquare j}$ and $X_{i\blacksquare}$ respectively then using the multiplier R and S to satisfy the following condition:

$$\hat{R} \bullet A_{(0)} \bullet \hat{S} = A_{(t)}$$

$$\begin{bmatrix} r_1 & 0 & 0 & 0 \\ 0 & r_2 & 0 & 0 \\ 0 & 0 & \ddots & 0 \\ 0 & 0 & 0 & r_n \end{bmatrix} m \bullet \begin{bmatrix} a_{11} & \cdots & \cdots & a_{1n} \\ \vdots & a_{22} & & \vdots \\ \vdots & & \ddots & \vdots \\ a_{n1} & \cdots & \cdots & a_{nn} \end{bmatrix} t = T \bullet \begin{bmatrix} s_1 & 0 & 0 & 0 \\ 0 & s_2 & 0 & 0 \\ 0 & 0 & \ddots & 0 \\ 0 & 0 & 0 & s_n \end{bmatrix} m = \begin{bmatrix} a`_{11} & \cdots & \cdots & a`_{1n} \\ \vdots & a`_{22} & & \vdots \\ \vdots & & \ddots & \vdots \\ a`_{n1} & \cdots & \cdots & a`_{nn} \end{bmatrix} t = T + m$$

where $\hat{R}$ = a diagonal matrix whose elements indicate the effect of substitution and $\hat{S}$ = diagonal matrix whose elements describe the effect of fabrication (Kaneko,1988). Effect of substitution shows how much of a commodity (by row in the IO tables) can be replaced by another commodity in the production process. While the effect of fabrication shows how much a sector (by column in the IO table) can absorb the intermediary input out of the total input.

Appendix 3.2. IO Table of Indonesia (2000-2005-2010)

Appendix 3.2a. IO Table of Indonesia (2000)

Code	Sector	1	2	3	4	5	6	7
1	Paddy	2498744	0	0	0	0	0	0
2	Beans and Corn	0	958424	0	1924	0	0	0
3	Root crops	0	0	285079	0	0	0	0
4	Vegetables, Fruits, other food crops	0	0	0	666636	0	0	0
5	Rubber	17	0	0	0	1970925	0	0
6	Oil Palm	0	0	0	0	0	58108	0
7	Coffee	0	0	0	0	0	0	234963
8	Other estate crops	0	0	0	4880	0	0	0
9	Other crops	2885855	141857	30899	17073	256995	555034	12550
10	Livestock and Poultry	204149	213959	131519	557101	1551	12165	3451
11	Forestry and Fisheries	742	3497	855	776	5506	431	2790
12	Mining and Quarrying	0	0	0	0	0	0	0
13	Agricultural related Manufacturing Industries	2474278	604983	127782	312472	149636	348979	210516
14	Non-agricultural related Manufacturing Industries	23402	6574	7672	35262	557082	124131	7047
15	Electricity, gas and water supply	0	0	2066	0	1587	2270	813
16	Construction	102784	99853	5571	26451	136627	207522	42109
17	Trade and Restaurant and Hotel	336759	459036	231939	1311610	217909	247293	75349
18	Transport and Communication	219599	107184	44191	134491	114563	103997	25098
19	Finance, Real Estate and Business Services	595811	110158	17016	20383	42317	84054	15204
20	Unspecified sector	14	0	0	0	0	0	0
190	**Total Intermediary Input**	9,342,154	2,705,525	884,589	3,089,059	3,454,698	1,743,984	629,890
201	Wage and salary	7006292	1969452	1600388	7569505	5113842	1165384	340479
202	Margin/Surplus	38894180	12683729	11916224	25796832	2776321	2099733	868251
203	Depreciation	886578	131415	171404	116199	475696	221125	67411
204	Indirect tax-Indirect Tax	720882	245438	109904	273796	151524	68538	37857
209	**Primary Input /Gross Value Added**	47507932	15030034	13797920	33756332	8517383	3554780	1313998

Appendix 3.2a.(cont.)

8	9	10	11	12	13	14	15	16	17	18
0	142720	241033	0	0	52498731	44571	0	0	2603	0
0	32377	144006	13910	0	9685938	238	0	0	302410	7870
0	5852	60518	572	0	1495626	1	0	0	928420	40057
0	0	31108	1037	0	5054004	31609	0	0	1831588	0
0	0	0	0	0	2797513	7201923	0	0	0	0
0	0	0	0	0	4329636	908602	0	0	0	0
0	0	0	0	0	1578587	0	0	0	1986	0
671549	338	111835	0	0	18780652	988255	0	0	403630	8489
432982	15982	143712	1715157	0	30153	88217	0	0	4177	604
72980	226623	707923	7437	0	14070672	342190	0	0	6179605	203779
16630	8599	4691	1145540	19908	20205025	229970	4	4252556	1644985	41869
0	11	494	0	18264509	4212639	90986260	14228354	14259429	2108	15875
1666006	434612	17025921	2222582	70711	122295484	5431495	35759	7477263	28494888	4083099
175704	307650	245737	3298779	3593972	32994789	140781393	3130991	81341250	28193279	30798622
8639	16378	14749	44780	55858	4271456	5266887	2360872	158812	6242983	723786
908164	20279	20289	809327	1918900	231702	535099	278248	173327	3100861	3377213
474901	275483	2649675	2345273	1559363	60530136	28522538	974490	20018859	36974652	16798443
294699	84069	691775	665328	1782900	16403861	15067447	347729	6676956	15134547	17154849
259209	95374	56132	954174	1856834	9768272	14562624	887517	16737913	40552732	13003767
7690	0	1234	0	0	333637	1020032	4	7306	548590	1716
4,989,153	1,666,347	22,150,832	13,223,896	29,122,955	381,568,513	312,009,351	22,243,968	151,103,671	170,544,044	86,260,038
4242956	1717651	10788220	8972011.00	25590708	59006474	49336807	2279382	37132511	61084802	16877567
13003601	3518447	13060366	33484651.00	127536529	99913965	102235278	4703542	29228340	134564418	26793354
286480	159020	411639	2303644.00	8010781	17930689	22707927	4044105	6723107	14562257	19093239
186329	146969	135296	935759.00	6554177	22982891	11483838	-2633302	3489434	15458757	2247971
17719366	5542087	24395521	45696065	167692195	199834019	185763850	8393727	76573392	225670234	65012131
22708519.00	7208434.00	46546353.00	58919961.00	196815150.00	581402532.00	497773201.00	30637695.00	227677063.00	396214278.00	151272169.00

Appendix 3.2a.(cont.)

		Total Intermediate demand	Final consumption expenditure by households	Final consumption expenditure by government	GFCF+ change I	Total Export	Total Final Demand	Total Demand	Total Import	Total Output
19	20	180	301	302	303+304	307	309	310	409	600
27027	0	55455429	0	0	1398706	371	1399077	56854506	4420	56850086
82144	0	11229241	9279736	0	404112	91970	9775818	21005059	3269500	17735559
175102	0	2991227	11310962	0	364652	37425	11713039	14704266	21757	14682509
1150188	0	8766170	34618062	0	-152955	121159	34586266	43352436	6507045	36845391
0	0	11970378	0	0	4035	76063	80098	12050476	78395	11972081
0	0	5296346	0	0	4694	10079	14773	5311119	12355	5298764
0	0	1815536	125441	0	2911	0	128352	1943888	0	1943888
35947	109236	21114811	3522107	0	347748	4600592	8470447	29585258	6876739	22708519
154450	7162	6492859	807867	0	-117161	34033	724739	7217598	9164	7208434
652219	0	23587323	24503817	0	-710574	273521	24066764	47654087	1107734	46546353
299117	0	27883491	28208932	0	1044075	2216992	31469999	59353490	433529	58919961
350202	0	142319881	2730	0	3124027	77225464	80352221	222672102	25856952	196815150
15451034	3591	208921091	262461865	0	2238052	166421505	431121422	640042513	58639981	581402532
15148502	184739	340956577	124559891	0	61357582	214149343	400066816	741023393	243250192	497773201
2771744	4397	21948077	8689618	0	0	0	8689618	30637695	0	30637695
7292850	0	19287176	0	0	208389887	0	208389887	227677063	0	227677063
24976614	125719	199106041	148190688	0	10404567	57094906	215690161	414796202	18581924	396214278
11167467	29665	86250415	66454654	0	2717875	26567818	95740347	181990762	30718593	151272169
37638266	6346	137264103	135016841	90779600	597924	20491748	246886113	384150216	46534170	337616046
14703	8443	1943369	-954903	0	498	77189	-877216	1066153	85996	980157
117,387,576	479,298	1334599541	856798308	90779600	291420655	569490178	1808488741	3143088282	441988446	2701099836
106252844	134534	408181809								
96755636	344820	780178217								
13231294	6355	111540365								
3988696	15150	66599904								
220228470	500859	1366500295								
337616046.00	980157.00	2701099836.00								

Appendix 3.2b. IO Table of Indonesia (2005)

Code	Sector	1	2	3	4	5	6	7
1	Paddy	5575315	0	0	0	0	0	0
2	Beans and Corn	0	2210700	0	9320	0	0	0
3	Root crops	0	0	1221814	0	0	0	0
4	Vegetables, Fruits, other food crops	0	0	0	2586335	0	0	0
5	Rubber	0	0	0	0	3401376	0	0
6	Oil Palm	0	0	0	0	0	324664	0
7	Coffee	0	0	0	0	0	0	1181361
8	Other estate crops	0	0	0	14828	0	645	0
9	Other crops	4550795	1525100	361502	198002	122452	296176	19523
10	Livestock and Poultry	846754	342017	161619	1321191	10379	57767	3607
11	Forestry and Fisheries	2617	3228	736	2409	9681	495	3099
12	Mining and Quarrying	0	0	0	0	0	0	0
13	Agricultural related Manufacturing Industries	6776667	2307007	610478	4109919	1223899	1596897	938135
14	Non-agricultural related Manufacturing Industries	97362	38790	26384	311862	1168432	701192	189126
15	Electricity, gas and water supply	0	0	632	377	3518	2721	1107
16	Construction	604829	267403	8113	73943	303654	1010817	71053
17	Trade and Restaurant and Hotel	956503	543836	165821	1386779	377976	313094	276857
18	Transport and Communication	596895	415001	233756	625340	271013	260645	93587
19	Finance, Real Estate and Business Services	2402215	401876	73916	269094	283069	2668578	692506
20	Unspecified sector	45	0	0	0	0	0	0
190	**Total Intermediary Input**	22,409,997	8,054,958	2,864,771	10,909,399	7,175,449	7,233,691	3,469,961
201	Wage and salary	10726885	3896443	2150301	13820260	8420393	3869564	1492157
202	Margin/Surplus	49605483	23306102	16101407	58530642	6904202	7585641	4039034
203	Depreciation	1121033	203443	197910	282949	910876	774426	323727
204-20	Indirect tax-subsidy	780963	298438	177047	970772	183263	206628	192587
209	**Primary Input /Gross Value Added**	62234364	27704426	18626665	73604623	16418734	12436259	6047505
210	**Total Input**	84644361.00	35759384.00	21491436.00	84514022.00	23594183.00	19669950.00	9517466.00

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Appendix 3.2b.(cont.)

8	9	10	11	12	13	14	15	16	17	18
0	96800	208971	0	0	77113643	46059	0	0	4154	0
0	45257	236427	84337	0	17624804	0	0	0	736650	3313
0	1844	86317	3100	0	2531186	6	0	0	2003948	28382
0	0	95207	708	0	13441484	130952	0	0	8986479	0
0	0	0	0	0	1741313	18168737	0	0	0	0
0	0	0	0	0	17230083	1778554	0	0	0	0
0	0	0	0	0	3853262	0	0	0	6088	0
1102566	462	101079	0	0	25591741	2022527	0	0	1029210	2637
267481	19144	198780	647038	0	6875	99415	0	0	3131	506
92637	210879	206695	12244	0	20143162	69352	0	0	14650536	17618
19677	10323	6494	2787469	48839	28823512	703261	15	9254685	5214597	20283
0	11	231	0	36900296	10659137	172784219	12654459	31563257	21113	28389
3111687	529546	18230534	3603063	280579	212183846	11936272	203874	22630845	69445916	3911211
489603	566868	411546	4667253	12271018	60616535	356028666	26842751	205267436	19807788	78116844
10233	19433	111212	119959	277152	10392137	13791921	13503992	248125	10812620	4010109
1321274	23606	20881	636289	4013352	765959	1680695	847949	589417	9272367	6377923
661671	180558	3433434	2835492	2952830	56926439	51411159	3229815	49423947	33004734	13518615
455552	95190	985761	1250331	4608363	31593190	33456166	1087409	16260769	38151281	36287058
1013468	330381	296254	1184066	8729287	31857931	43444543	3612472	36311987	83192249	61678309
9183	0	0	0	0	662452	1151883	17	29151	1406221	1835
8,555,032	2,130,302	24,629,823	17,831,349	70,081,716	623,758,691	708,704,387	61,982,753	371,579,619	297,749,082	204,003,032
5633114	2311205	16024133	16383977.00	43670526	96649782	130739002	8688614	76881831	129859534	64154069
18865347	4795781	25370284	61197801.00	243517067	189374060	289147749	13504337	103773710	250073524	67930872
464391	192662	1480335	2777971.00	16855751	30260879	60899015	12065215	18722142	36438008	59778492
410822	161070	803469	1669993.00	13126269	35733698	-37123340	-7347417	7484509	16814493	2559046
25373674	7460718	43678221	82029742	317169613	352018419	443662426	26910749	206862192	433185559	194422479
33928706.00	9591020.00	68308044.00	99861091.00	387251329.00	975777110.00	1152366813.00	88893502.00	578441811.00	730934641.00	398425511.00

Appendix 3.2b.(cont.)

		ID	C	G	I	X	C+G+I+X	ID+FD	M	(ID+FD)-M
		Total Intermediate demand	Final consumption expenditure by households	Final consumption expenditure by government	GFCF+ change I	Total Export	Total Final Demand	Total Demand	Total Import	Total Output
19	20	180	301	302	303+304	307	309	310	409	600
38341	0	83083283	0	0	1561746	11	1561757	84645040	679	84644361
208249	0	21159057	18874774	0	-438361	97293	18533706	39692763	3933379	35759384
363094	0	6239691	15843211	0	-586207	71612	15328616	21568307	76871	21491436
6961101	0	32202266	67122192	0	-1047847	365122	66439467	98641733	14127711	84514022
0	0	23311426	0	0	283763	43614	327377	23638803	44621	23594182
0	0	19333301	0	0	211246	167904	379150	19712451	42501	19669950
0	0	5040711	512558	0	618	3984775	4497951	9538662	21196	9517466
74498	356393	30296586	4888913	0	332467	6234209	11455589	41752175	7823468	33928707
183220	8429	8507569	930510	0	30703	138897	1100110	9607679	16659	9591020
1120257	0	39266714	32400700	0	-2053405	281718	30629013	69895727	1587683	68308044
987905	0	47899325	47243403	0	-787954	5998631	52454080	100353405	492314	99861091
673697	0	265284809	12823	0	6289341	191707498	198009662	463294471	76043142	387251329
37254111	9666	400894152	434102178	0	3583898	228793297	666479373	1067373525	91596415	975777110
95450377	503912	863573745	283065369	0	152235997	338283754	773585120	1637158865	484792052	1152366813
8024874	10715	61340837	27552638	0	0	27	27552665	88893502	0	88893502
21570950	0	49460474	0	0	528981337	0	528981337	578441811	0	578441811
35884375	99953	257583888	365276485	0	21397041	100965575	487639101	745222989	14288348	730934641
30943532	47511	197718350	183557672	0	7015192	59285197	249858061	447576411	49150900	398425511
117436827	15384	395894412	305128042	224980540	12336584	40674100	583119266	979013678	96076090	882937588
11309	19955	3292051	-920464	0	0	12233	-908231	2383820	17503	2366317
357,186,717	1,071,918	2811382647	1785591004	224980540	729346159	977105467	3717023170	6528405817	840131532	5688274285
246522690	323507	882217987								
222110373	907664	1656641080								
48018425	26797	291794447								
9099383	36431	46238124								
525750871	1294399	2876891638								
882937588.00	2366317.00	5688274285.00								

Appendix 3.2c. IO Table of Indonesia (2010)

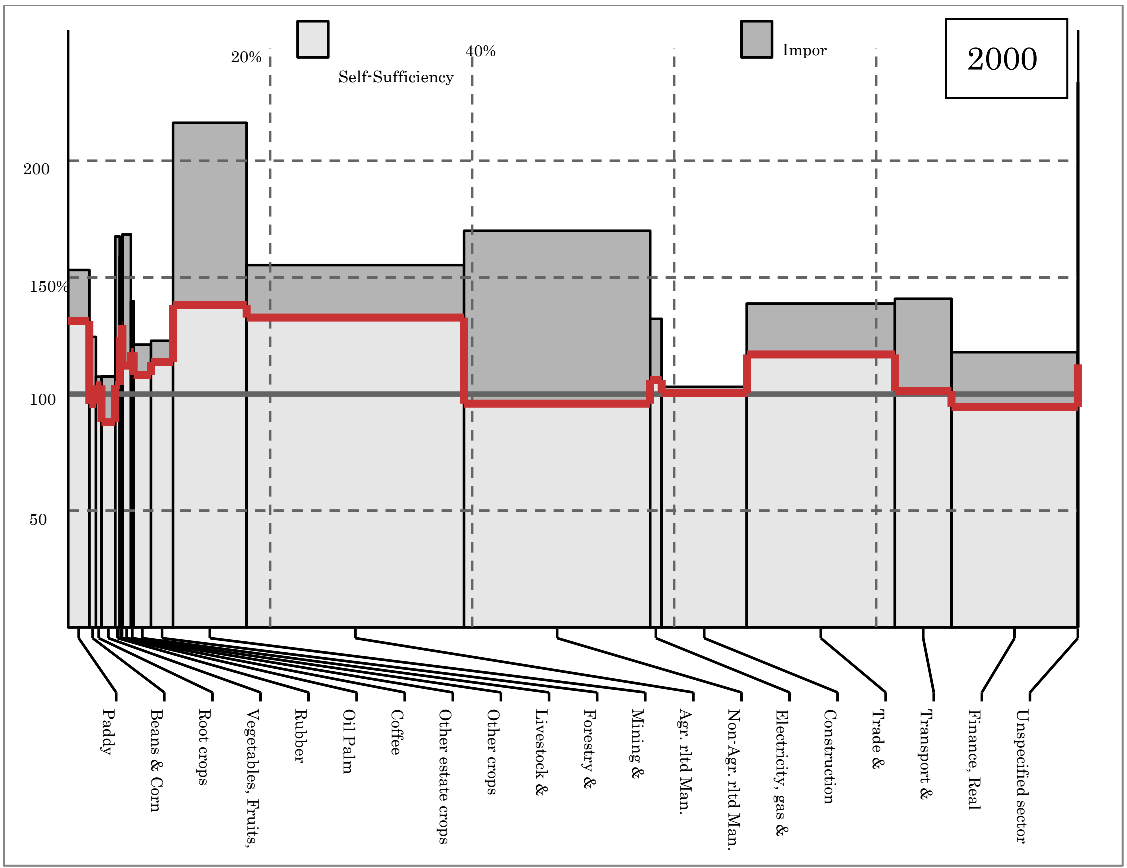
Code	Sector	1	2	3	4	5	6	7
1	Paddy	23313372	0	0	0	0	0	0
2	Beans and Corn	0	5518996	0	23909	0	0	0
3	Root crops	0	0	5299510	338782	0	0	0
4	Vegetables, Fruits, other food crops	0	7691	253107	8556928	0	0	0
5	Rubber	0	0	0	0	5549645	0	0
6	Oil Palm	0	0	0	0	0	9604102	0
7	Coffee	0	0	0	0	0	0	4121441
8	Other estate crops	82	115	5	7076	718	6356	0
9	Other crops	7374670	1694760	356109	216500	555954	2098386	30820
10	Livestock and Poultry	7164157	1954629	576838	4688167	242327	2137917	29692
11	Forestry and Fisheries	521	574	77	873	6004	431	597
12	Mining and Quarrying	0	0	0	0	0	0	0
13	Agricultural related Manufacturing Industries	17362099	3983438	749437	5163167	8489273	16702808	2354399
14	Non-agricultural related Manufacturing Industries	33404	8027	3405	36394	1194987	827017	60609
15	Electricity, gas and water supply	5	0	23	359	4871	5935	482
16	Construction	652308	199144	987	53171	792407	4215428	74659
17	Trade and Restaurant and Hotel	2817193	977165	728124	2348190	777157	1810703	698553
18	Transport and Communication	719894	276615	183077	561958	354931	698074	157128
19	Finance, Real Estate and Business Services	1205260	105166	16382	43070	403827	4836200	162985
20	Unspecified sector	23	0	0	0	0	0	0
190	**Total Intermediary Input**	60,642,988	14,726,320	8,167,081	22,038,544	18,372,101	42,943,357	7,691,365
201	Wage and salary	30521894	7851774	5209105	30607766	21467602	14788143	3356478
202	Margin/Surplus	142316273	47761823	45145657	125273234	17567662	42131498	9053518
203	Depreciation	3189746	362845	141699	921397	2322258	2959590	728196
204-20	Indirect tax-subsidy	1051513	230952	582783	2129788	501670	847877	465145
209	**Primary Input /Gross Value Added**	177079426	56207394	51079244	158932185	41859192	60727108	13603337
210	**Total Input**	237722414.00	70933714.00	59246325.00	180970729.00	60231293.00	103670465.00	21294702.00

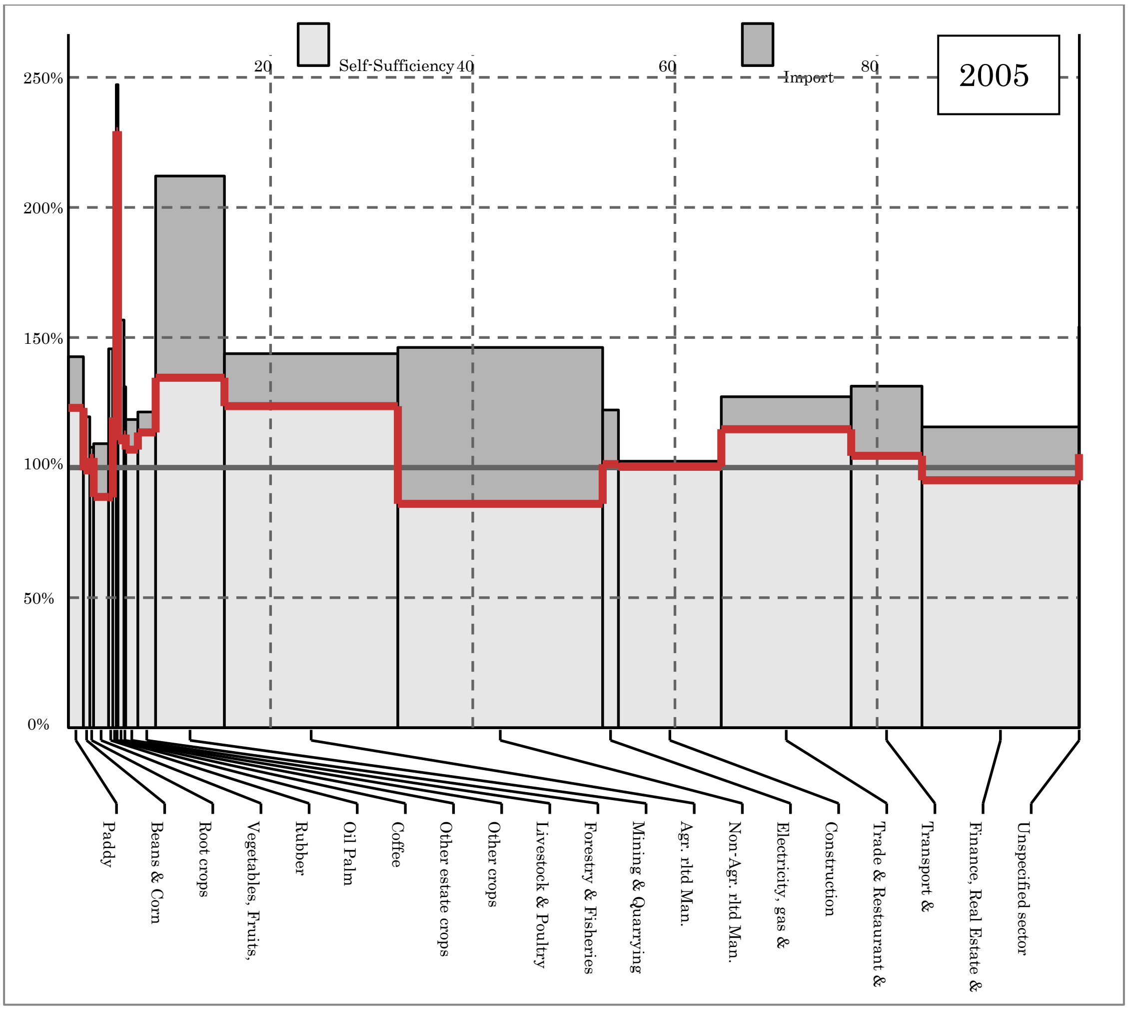
Appendix 3.2c. (cont.)

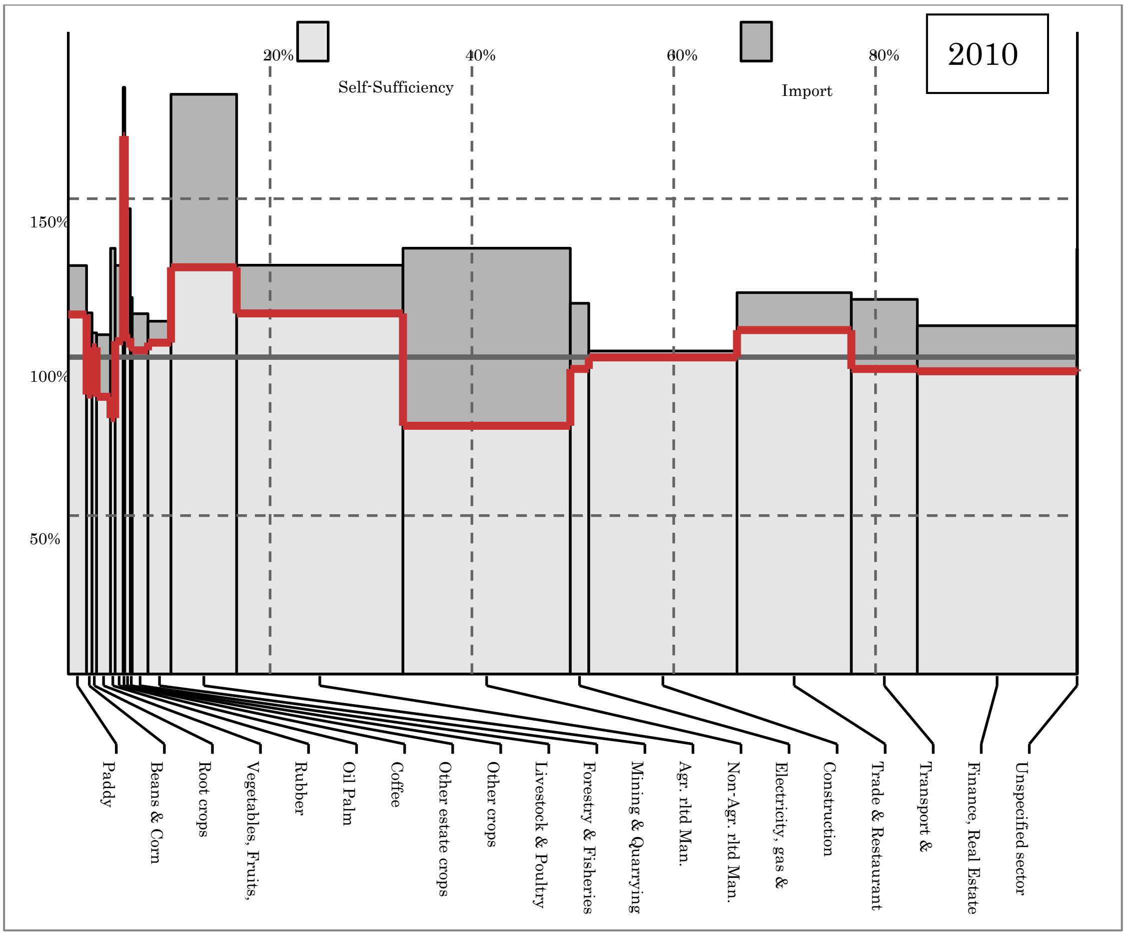
8	9	10	11	12	13	14	15	16	17	18
0	399344	2853377	0	0	211470649	491636	0	0	91025	0
0	183234	3407913	336652	0	37303818	0	0	0	656438	28229
0	29332	2447479	45649	0	11782469	4	0	0	2503468	68766
0	0	1969497	2719	0	32689034	702337	0	0	11487640	282714
0	0	0	0	0	4855219	49521773	0	0	0	0
0	0	0	0	0	74114379	15988603	0	0	0	0
0	0	0	0	0	9935052	0	0	0	4905	0
2474844	5191	76763	0	0	46849802	8105972	0	0	436641	7673
976879	152884	1117168	3676133	0	47409	462683	0	0	4697	6404
887533	2077996	6483882	65979	0	60806402	967914	2151852.406	0	27842357	193764
6832	33096	4098	24136470	83298	74267669	4972317	0	31240524	15394245	495824
1	12	193	0	69248300	28508939	300637502	55175132	130716443	17193	31558
11240179	1508064	50577333	3623656	706920	442342073	23321639	399826.9404	88751544	145565651	29614564
205656	165375	1344886	1870111	13619643	74935903	681037436	48647332.96	624282935	21937033	91161958
7185	14163	198060	85025	1066528	21842567	39606988	51822942.42	7519629	25491726	7732429
2272532	54612	61449	1651014	17956869	2183119	5706805	3567249.893	6277506	28914875	15670464
1248435	440717	12111742	9140087	5311249	118094323	90725688	11193308.6	158934275	67128515	29942697
470802	117958	2629886	2587029	21408745	64211925	60549497	3666239.196	76818603	84036881	72278093
550957	152069	427958	1685236	23480666	52912420	73998183	9140283.59	179092346	162415237	164475017
13330	0	0	0	0	2084124	2593091	74	287986	3769102	5773
20,355,165	5,334,047	85,711,684	48,905,760	152,882,218	1,371,237,295	1,359,390,068	185,764,242	1,303,921,791	597,697,629	411,995,927
10615198	6121745	41958057	50127622.00	114532858	216333231	241460221	14359366	226964635	261809417	139144544
38917759	12730969	70516738	186667832.00	511428218	428777086	480961641	72657043	312354800	514912475	166367881
950760	480037	4020141	8007860.00	41683275	63085304	112122255	19465205	57729315	73894398	133272390
866977	454200	2319942	4831886.00	32231129	80444655	-21009792	-52468081	23953850	36444103	6471179
51350694	19786951	118814878	249635200	699875480	788640276	813534325	54013533	621002600	887060393	445255994
71705859.00	25120998.00	204526562.00	298540960.00	852757698.00	2159877571.00	2172924393.00	239777775.00	1924924391.00	1484758022.00	857251921.00

Appendix 3.2c. (cont.)		ID	C	G	I	X	C+G+I+X	ID+FD	M	(ID+FD)-M
		Total Intermediate demand	Final consumption expenditure by households	Final consumption expenditure by government	GFCF+ change I	Total Export	Total Final Demand	Total Demand	Total Import	Total Output
19	20	180	301	302	303+304	307	309	310	409	600
115901	0	238735304	0	0	-858629	0	-858629	237876675	154261	237722414
702623	0	48161812	36173224	0	-13655	120491	36280060	84441872	13508158	70933714
1016731	0	23532190	35677676	0	-11220	51324	35717780	59249970	3645	59246325
22945598	0	78897265	130409817	0	-26458	439666	130823025	209720290	28749561	180970729
0	0	59926637	0	0	224678	275484	500162	60426799	195506	60231293
0	0	99707084	0	0	4005259	221	4005480	103712564	42099	103670465
0	0	14061398	1202976	0	178739	6077583	7459298	21520696	225994	21294702
216348	2224622	60412208	10415331	0	318118	14172896	24906345	85318553	13612694	71705859
1960398	76517	20808371	4320165	0	-99187	116404	4337382	25145753	24755	25120998
5551869.594	0	123823276	74661105	0	10944740	386406	85992251	209815527	5288965	204526562
10394489	0	161037939	129514353	0	4307192	3901795	137723340	298761279	220319	298540960
312425	0	584647698	74969	0	12980668	354777931	367833568	952481266	99723568	852757698
97631503.06	9644	950097218	1000658130	0	2554088	355107824	1358320042	2308417260	148539689	2159877571
206370123	334225	1768076460	549233723	0	266308228	561817780	1377359731	3145436191	972511798	2172924393
22420583.58	18965	177838466	60640813	0	1155421	757908	62554142	240392608	614833	239777775
63946242.11	0	154250841	0	0	1773817827	4080273	1777898100	1932148941	7224550	1924924391
93493938.4	281324	608203384	706819130	0	43312970	166341083	916473183	1524676567	39918545	1484758022
73548159.8	99274	465374769	412230548	0	9023607	64702996	485957151	951331920	94079999	857251921
259729097.4	13223	934845583	620545891	594460338	3245275	57890180	1276141684	2210987267	139918155	2071069112
205102	34246	8992851	-2069666	0	0	75	-2069591	6923260	97418	6825842
860,561,132	3,092,040	6581430754	3770508185	594460338	2131367661	1591018320	8087354504	14668785258	1564654512	13104130746
619544268	933184	2057707108								
451944742	2610487	3680097336								
115748370	77298	641162339								
23270600	112833	143733209								
1210507980	3733802	6522699992								
2071069112.00	6825842.00	13104130746.00								

Appendix 3.3. Skyline Charts of Indonesian Economy




2005
Self-Sufficiency
Import
20
40
60
80
250%
200%
150%
100%
50%
0%
Paddy
Beans & Corn
Root crops
Vegetables, Fruits,
Rubber
Oil Palm
Coffee
Other estate crops
Other crops
Livestock & Poultry
Forestry & Fisheries
Mining & Quarrying
Agr. rltd Man.
Non-Agr. rltd Man.
Electricity, gas &
Construction
Trade & Restaurant &
Transport &
Finance, Real Estate &
Unspecified sector



2010
Self-Sufficiency
Import
20%
40%
60%
80%
150%
100%
50%
Paddy
Beans & Corn
Root crops
Vegetables, Fruits,
Rubber
Oil Palm
Coffee
Other estate crops
Other crops
Livestock & Poultry
Forestry & Fisheries
Mining & Quarrying
Agr. rltd Man.
Non-Agr. rltd Man.
Electricity, gas &
Construction
Trade & Restaurant
Transport &
Finance, Real Estate
Unspecified sector

Appendix 4.1. Coffee Producing Countries Based on Quality Groups

Quality Group	Producers
Colombian mild arabicas	Colombia, Kenya, United Republic of Tanzania
Other mild arabicas	Bolivia, Burundi, Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, Guatemala, Haiti, Honduras, India, Jamaica, Malawi, Mexico, Nicaragua, Panama, Papua New Guinea, Peru, Rwanda, Venezuela, Zambia, Zimbabwe
Brazilian and other natural arabicas	Brazil, Ethiopia, Paraguay
Robustas	Angola, Benin, Cameroon, Central African Republic, Congo, Côte d'Ivoire, Democratic Republic of the Congo, Equatorial Guinea, Gabon, Ghana, Guinea, Indonesia, Liberia, Madagascar, Nigeria, Philippines, Sierra Leone, Sri Lanka, Thailand, Togo, Trinidad and Tobago, Uganda, Viet Nam

Appendix 4.2 Stata Comands In Market Integration Analysis

4.2.1 Robusta Series

```
. varsoc lnidn lnivnm lnico if t>=tm(1994m1)

   Selection-order criteria
   Sample:  1994m1 - 2007m9                 Number of obs     =      165
  +---------------------------------------------------------------------------------+
  |lag |    LL      LR     df    p     FPE        AIC        HQIC       SBIC        |
  |----+----------------------------------------------------------------------------|
  |  0 |  70.9175                      .000088    -.823243    -.800319    -.766771   |
  |  1 |  567.844  993.85    9  0.000  2.4e-07    -6.7375     -6.6458     -6.51161   |
  |  2 |  603.061  70.436    9  0.000  1.7e-07    -7.05529    -6.89482*   -6.65999*  |
  |  3 |  612.436  18.749*   9  0.027  1.7e-07*   -7.05983*   -6.83059    -6.49512   |
  |  4 |  616.919  8.9655    9  0.440  1.8e-07    -7.00508    -6.70707    -6.27095   |
  +---------------------------------------------------------------------------------+
   Endogenous:  lnidn lnivnm lnico
    Exogenous:  _cons

. vecrank lnidn lnivnm lnico if t>=tm(1994m1),lags(2)

                   Johansen tests for cointegration
Trend       : constant                               Number of obs    =    165
Sample      :  1994m1 - 2007m9                       Lags             =      2
-------------------------------------------------------------------------------
maximum                               trace         5% critical
  rank   parms      LL      eigenvalue statistic     value
    0     12     584.57017        .     36.9827      29.68
    1     17     594.56603    0.11411   16.9909      15.41
    2     20     602.12972    0.08760   1.8635*      3.76
    3     21     603.06149    0.01123
-------------------------------------------------------------------------------

. vec lnidn lnivnm lnico if t>=tm(1994m1),lags(3) rank(2) bconstraints(1/4)


Vector error-correction model

Sample:  1994m1 - 2007m9                       No. of obs  =      165
                                               AIC         = -7.061792
Log likelihood    =  611.5979                  HQIC        = -6.840195
Det(Sigma_ml)     =  1.21e-07                  SBIC        = -6.515899

Equation          Parms     RMSE    R-sq        chi2        P>chi2
----------------------------------------------------------------
D_lnidn           9    .099851      0.1852      35.45654    0.0000
D_lnivnm          9    .075589      0.3593      87.49155    0.0000
D_lnico           9    .073063      0.1958      37.9765     0.0000
----------------------------------------------------------------

------------------------------------------------------------------------------
            |     Coef.       Std. Err.    z    P>|z|       [95% Conf. Interval]
----------- +-----------------------------------------------------------------
D_lnidn     |
       _ce1 |
        L1. |     .0062089    .0793487    0.08  0.938       -.1493117   .1617295
            |
       _ce2 |
        L1. |     -.1384352  .0797296   -1.74  0.083       -.2947023   .0178319
            |
      Lnidn |
        LD. |     -.1910329   .1011904    -1.89 0.059       -.3893625   .0072967
       L2D. |     -.3128128   .095771     -3.27 0.001       -.5005204  -.1251052
            |
     Lnivnm |
        LD. |     .0756196    .1314449    0.58  0.565       -.1820076   .3332469
       L2D. |     .0487347    .1168839    0.42  0.677       -.1803535   .277823
            |
      Lnico |
        LD. |     .527233     .15166      3.48  0.001       .2299849    .8244812
       L2D. |     .1890544    .1578736    1.20  0.231       -.1203722   .498481
            |
      _cons |     -.000117    .0078902    -0.01 0.988       -.0155814   .0153474
----------- +-----------------------------------------------------------------
D_lnivnm    |
```

```
       _ce  |
        L1. |     -.1641223   .0600683    -2.73 0.006       -.2818541   -.0463905
            |
      _ce2  |
        L1. |     .1309557    .0603567    2.17  0.030       .0126588    .2492526
            |
     Lnidn  |
        LD. |     -.0426657   .0766029    -0.56 0.578       -.1928046   .1074733
       L2D. |     .0117347    .0725003    0.16  0.871       -.1303632   .1538326
            |
    Lnivnm  |
        LD. |     .1603177    .099506     1.61  0.107       -.0347106    .3553459
       L2D. |     .0850309    .0884831    0.96  0.337       -.0883929    .2584546
            |
     Lnico  |
        LD. |     .5418407    .1148092    4.72  0.000       .3168187    .7668627
       L2D. |     -.0659603   .1195131   -0.55  0.581       -.3002016   .168281
            |
     _cons  |     -.0000976   .005973     -0.02 0.987       -.0118044   .0116093
----------- +-----------------------------------------------------------------
D_lnico     |
      _ce1  |
        L1. |     -.204477    .0580611    -3.52 0.000       -.3182746   -.0906794
            |
      _ce2  |
        L1. |     -.045725    .0583397    -0.78 0.433       -.1600688   .0686187
            |
     Lnidn  |
        LD. |     -.0723005   .0740431   -0.98  0.329       -.2174223   .0728213
       L2D. |     -.1009908   .0700775   -1.44  0.150       -.2383402   .0363587
            |
    Lnivnm  |
        LD. |     .0479129    .0961809    0.50  0.618       -.1405982   .2364239
       L2D. |     .1708956    .0855263    2.00  0.046       .0032671    .3385241
            |
     lnico  |
        LD. |     .3141319    .1109727    2.83  0.005       .0966294    .5316343
       L2D. |     .0295531    .1155193    0.26  0.798       -.1968606   .2559668
            |
     _cons  |     .0000748    .0057734    0.01  0.990       -.0112409    .0113904
-------------------------------------------------------------------------------

Cointegrating equations

Equation         Parms    chi2     P>chi2
------------------------------------------
_ce1               1   396.3797   0.0000
_ce2               1   353.5441   0.0000
------------------------------------------

Identification:  beta is exactly identified

 ( 1)  [_ce1]lnico      = 1
 ( 2)  [_ce1]lnivnm     = 0
 ( 3)  [_ce2]lnico      = 1
 ( 4)  [_ce2]lnidn      = 0
------------------------------------------------------------------------------
      beta |     Coef.   Std. Err.     z    P>|z|     [95% Conf. Interval]
----------- +-----------------------------------------------------------------
_ce1        |
     Lnidn |  -.7368173   .0370087   -19.91   0.000    -.8093531   -.6642815
    Lnivnm |  (omitted)
     Lnico |          1          .        .         .           .          .
     _cons |  -1.400041          .        .         .           .          .
----------- +-----------------------------------------------------------------
_ce2        |
     lnidn |  (omitted)
    lnivnm |  -.8548596   .0454646  -18.80   0.000    -.9439685   -.7657507
     lnico |          1          .        .      .          .          .
     _cons |  -.8657526          .        .      .          .          .
-----------------------------------------------------------------------------
  Jarque-Bera test
  +-----------------------------------------------------+
  |         Equation    |          chi2   df  Prob > chi2   |
  |-------------------- +-------------------------------- |
  |          D_lnidn    |         16.100   2    0.00032     |
  |         D_lnivnm    |         33.723   2    0.00000     |
  |          D_lnico    |          0.326   2    0.84968     |
  |              ALL    |         50.149   6    0.00000     |
```

Skewness test

Equation	Skewness	chi2	df	Prob > chi2
D_lnidn	-.1837	0.928	1	0.33539
D_lnivnm	.434	5.180	1	0.02285
D_lnico	-.02797	0.022	1	0.88340
ALL		6.129	3	0.10549

Kurtosis test

Equation	Kurtosis	chi2	df	Prob > chi2
D_lnidn	4.4855	15.172	1	0.00010
D_lnivnm	5.0376	28.544	1	0.00000
D_lnico	3.2104	0.304	1	0.58121
ALL		44.020	3	0.00000

vargranger

Granger causality Wald tests

Equation	Excluded	chi2	df	Prob > chi2
D_lnidn	D.lnivnm	2.1983	3	0.532
D_lnidn	D.lnico	10.143	3	0.017
D_lnidn	ALL	30.656	6	0.000
D_lnivnm	D.lnidn	1.107	3	0.775
D_lnivnm	D.lnico	26.205	3	0.000
D_lnivnm	ALL	33.654	6	0.000
D_lnico	D.lnidn	.94136	3	0.815
D_lnico	D.lnivnm	8.6716	3	0.034
D_lnico	ALL	9.4542	6	0.150

. varstable

Eigenvalue stability condition

Eigenvalue		Modulus
-.03909549	+.5871381i	.588438
-.03909549	-.5871381i	.588438
.5618262		.561826
.1437841	+.528557i	.547765
.1437841	-.528557i	.547765
-.5025592		.502559
-.1752887	+.145142i	.227579
-.1752887	-.145142i	.227579
.1478318		.147832

All the eigenvalues lie inside the unit circle.
VAR satisfies stability condition.

vargranger

Granger causality Wald tests

Equation	Excluded	chi2	df	Prob > chi2
D_lnidn	D.lnivnm	2.1983	3	0.532
D_lnidn	D.lnico	10.143	3	0.017
D_lnidn	ALL	30.656	6	0.000
D_lnivnm	D.lnidn	1.107	3	0.775
D_lnivnm	D.lnico	26.205	3	0.000
D_lnivnm	ALL	33.654	6	0.000
D_lnico	D.lnidn	.94136	3	0.815
D_lnico	D.lnivnm	8.6716	3	0.034
D_lnico	ALL	9.4542	6	0.150

. varstable

```
 Eigenvalue stability condition
+-------------------------------------- +
|       Eigenvalue          |  Modulus |
|-------------------------- +---------- |
| -.03909549    +.5871381i  |   .588438 |
| -.03909549    -.5871381i  |   .588438 |
|   .5618262                |   .561826 |
|   .1437841    +.528557i   |   .547765 |
|   .1437841    -.528557i   |   .547765 |
|  -.5025592                |   .502559 |
|  -.1752887    +.145142i   |   .227579 |
|  -.1752887    -.145142i   |   .227579 |
|   .1478318                |   .147832 |
+-------------------------------------- +
 All the eigenvalues lie inside the unit circle.
 VAR satisfies stability condition.
```

4.2.2 Arabica Series

```
. constraint define 1[_ce1]lnaraico      =1
. constraint define 2[_ce1]lnaracosta    =0
. constraint define 3[_ce2]lnaracosta    =1
. constraint define 4[_ce2]lnaraidn      =0

. vec lnaraidn lnaraico lnaracosta if t>=tm(2000m1),lags(3) rank(2) bconstraints(1/4)
Iteration 1:    log likelihood = 340.92487
Iteration 2:    log likelihood = 344.12696
Iteration 3:    log likelihood = 344.26723
Iteration 4:    log likelihood = 344.27084
Iteration 5:    log likelihood = 344.27095
Iteration 6:    log likelihood = 344.27095
Iteration 7:    log likelihood = 344.27095
Iteration 8:    log likelihood = 344.27095
Iteration 9:    log likelihood = 344.27095
Iteration 10:   log likelihood = 344.27095
Iteration 11:   log likelihood = 344.27095

Vector error-correction model

Sample:  2000m4 - 2007m9                       No. of obs        =       90
                                               AIC               = -7.006021
Log likelihood    =   344.271                  HQIC              = -6.681199
Det(Sigma_ml)     =  9.55e-08                  SBIC              = -6.200527

Equation         Parms     RMSE    R-sq     chi2     P>chi2
----------------------------------------------------------------
D_lnaraidn        9     .099112    0.1444  13.66719   0.1347
D_lnaraico        9     .05214     0.3077  35.99897   0.0000
D_lnaracosta      9     .073908    0.1089  9.900607   0.3586
----------------------------------------------------------------

------------------------------------------------------------------------------
                 |     Coef.  Std. Err.     z    P>|z|    [95% Conf. Interval]
----------------- +-------------------------------------------------------------
D_lnaraidn       |
      _ce1       |
       L1.       |  .0995588  .1031142    0.97  0.334   -.1025413   .3016588
                 |
      _ce2       |
       L1.       |  .2297658  .1422719    1.61  0.106   -.0490821   .5086137
                 |
   lnaraidn      |
       LD.       | -.1014844  .1319056   -0.77  0.442   -.3600146   .1570458
      L2D.       | -.1658443  .1300389   -1.28  0.202   -.4207159   .0890274
                 |
   lnaraico      |
       LD.       |  .4436648  .2068139    2.15  0.032    .0383171   .8490125
      L2D.       |  .1571744  .1998398    0.79  0.432   -.2345044   .5488532
                 |
  lnaracosta     |
       LD.       |  .0714125  .1739859    0.41  0.681   -.2695936   .4124186
      L2D.       | -.1125748  .1633392   -0.69  0.491   -.4327139   .2075642
                 |
     _cons       |  .0033902  .0105285    0.32  0.747   -.0172453   .0240256
----------------- +-------------------------------------------------------------
```

```
D_lnaraico        |
       _ce1       |
        L1.       |  -.1567426   .0542456   -2.89   0.004   -.2630619   -.0504232
                  |
       _ce2       |
        L1.       |   .3001524   .0748454    4.01   0.000    .1534581    .4468466
                  |
   lnaraidn       |
        LD.       |  -.0731745   .0693919   -1.05   0.292   -.2091802    .0628312
       L2D.       |  -.0008013   .0684099   -0.01   0.991   -.1348823    .1332798
                  |
   lnaraico       |
        LD.       |   .2763922   .1087991    2.54   0.011    .0631498    .4896347
       L2D.       |   .0848357   .1051303    0.81   0.420   -.1212159    .2908872
                  |
  lnaracosta      |
        LD.       |  -.0245608   .0915293   -0.27   0.788   -.2039548    .1548333
       L2D.       |  -.0134239   .0859283   -0.16   0.876   -.1818404    .1549925
                  |
      _cons       |   .0007537   .0055388    0.14   0.892   -.0101021    .0116094
----------------  +----------------------------------------------------------------
D_lnaracosta      |
       _ce1       |
        L1.       |  -.0511777   .0768931   -0.67   0.506   -.2018853    .0995299
                  |
       _ce2       |
        L1.       |  -.2344745   .1060933   -2.21   0.027   -.4424136   -.0265355
                  |
   lnaraidn       |
        LD.       |  -.0014377    .098363   -0.01   0.988   -.1942257    .1913504
       L2D.       |  -.0548134   .0969711   -0.57   0.572   -.2448732    .1352465
                  |
   lnaraico       |
        LD.       |   .1128782   .1542227    0.73   0.464   -.1893928    .4151493
       L2D.       |   .0782443   .1490221    0.53   0.600   -.2138337    .3703223
                  |
  lnaracosta      |
        LD.       |   .1145959   .1297427    0.88   0.377    -.139695    .3688869
       L2D.       |   .0512393   .1218034    0.42   0.674   -.1874909    .2899695
                  |
      _cons       |   .0042868   .0078512    0.55   0.585   -.0111012    .0196749
-------------------------------------------------------------------------------

Cointegrating equations

Equation         Parms    chi2     P>chi2
-------------------------------------------
_ce1                1   65.06021   0.0000
_ce2                1   224.3433   0.0000
-------------------------------------------

Identification:  beta is exactly identified

 ( 1)  [_ce1]lnaraico   = 1
 ( 2)  [_ce1]lnaracosta = 0
 ( 3)  [_ce2]lnaracosta = 1
 ( 4)  [_ce2]lnaraidn   = 0
---------------------------------------------------------------------------------
       beta       |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
----------------- +---------------------------------------------------------------
_ce1              |
   lnaraidn       |  -.7702434   .0954927   -8.07   0.000   -.9574056   -.5830811
   lnaraico       |          1          .       .       .           .           .
  lnaracosta      |  (omitted)
      _cons       |  -1.095782          .       .       .           .           .
----------------- +---------------------------------------------------------------
_ce2              |
   lnaraidn       |  (omitted)
   lnaraico       |  -.9893908   .0660559  -14.98   0.000   -1.118858   -.8599237
  lnaracosta      |          1          .       .       .           .           .
      _cons       |   .2108624          .       .       .           .           .
---------------------------------------------------------------------------------

. vecstable

   Eigenvalue stability condition
  +---------------------------------------+
  |      Eigenvalue          |  Modulus   |
  |------------------------- +------------|
```

```
|        1                 |        1    |
|   .8213167               |   .821317   |
|   .4018637    +.2922324i |   .496885   |
|   .4018637    -.2922324i |   .496885   |
| -.03410024    +.4749806i |   .476203   |
| -.03410024    -.4749806i |   .476203   |
|   .4568879               |   .456888   |
|  -.2445487    +.03961929i|   .247737   |
|  -.2445487    -.03961929i|   .247737   |
+----------------------------------------+
 The VECM specification imposes a unit modulus.


. veclmar

 Lagrange-multiplier test
+-----------------------------------   +
| lag    |     chi2    df   Prob > chi2  |
|------- +---------------------------- |
|   1    |  11.8410     9    0.22242     |
|   2    |  16.1711     9    0.06339     |
+--------------------------------------+
 H0: no autocorrelation at lag order

. vecnorm

 Jarque-Bera test
+--------------------------------------------------------------+
|         Equation    |          chi2        df  Prob > chi2   |
|-------------------- +----------------------------------------|
|       D_lnaraidn    |        122.566       2   0.00000       |
|       D_lnaraico    |          0.079       2   0.96140       |
|     D_lnaracosta    |        992.133       2   0.00000       |
|            ALL      |        1114.777      6   0.00000       |
+--------------------------------------------------------------+

 Skewness test
+--------------------------------------------------------------+
|         Equation    | Skewness  chi2       df  Prob > chi2   |
|-------------------- +----------------------------------------      |
|       D_lnaraidn    |  .13311   0.266       1   0.60619       |
|       D_lnaraico    |  .04078   0.025       1   0.87450       |
|     D_lnaracosta    |  .81733   10.020      1   0.00155       |
|            ALL      |           10.311      3   0.01610       |
+--------------------------------------------------------------+

 Kurtosis test
+--------------------------------------------------------------+
|         Equation    | Kurtosis  chi2       df  Prob > chi2   |
|---------------------+----------------------------------------|
|       D_lnaraidn    |  8.7108   122.300     1   0.00000       |
|       D_lnaraico    |  2.8802    0.054     1   0.81662       |
|     D_lnaracosta    |  19.183   982.112     1   0.00000       |
|            ALL      |           1104.466    3   0.00000       |
+--------------------------------------------------------------+


. qui var d.lnaraidn d.lnaraico d.lnaracosta if t>=tm(2000m1),lags(3)

. vargranger
 Granger causality Wald tests
+--------------------------------------------------------------------+
|        Equation         Excluded      |  chi2     df Prob > chi2   |
|-------------------------------------- +--------------------------- |
|      D_lnaraidn       D.lnaraico      | .03794   1    0.846        |
|      D_lnaraidn     D.lnaracosta      |  3.183   1    0.074        |
|      D_lnaraidn            ALL        | 3.2404   2    0.198        |
|-------------------------------------- +--------------------------- |
|      D_lnaraico       D.lnaraidn      | .16538   1    0.684        |
|      D_lnaraico     D.lnaracosta      | 2.1729   1    0.140        |
|      D_lnaraico            ALL        | 2.3274   2    0.312        |
|-------------------------------------- +--------------------------- |
|    D_lnaracosta       D.lnaraidn      | .04878   1    0.825        |
|    D_lnaracosta       D.lnaraico      | 2.0515   1    0.152        |
|    D_lnaracosta            ALL        | 2.1282   2    0.345        |
+--------------------------------------------------------------------+
```

4.2.3 Asymmetric Test of Robusta and Arabica Coffee

```
 varsoc  lnrobidn lnrobico


   Selection-order criteria
   Sample:  1990m5 - 2007m9                    Number of obs     =      209
  +---------------------------------------------------------------------------+
  |lag |    LL      LR     df    p      FPE       AIC       HQIC      SBIC     |
  |----+----------------------------------------------------------------------- |
  |  0 | -90.8633                      .008337    .888644    .901575    .920628   |
  |  1 |   459.53  1100.8   4  0.000  .000045    -4.34      -4.3012   -4.24405   |
  |  2 |  474.672  30.285   4  0.000  .00004     -4.44662   -4.38197   -4.2867*   |
  |  3 |  482.053  14.762*  4  0.005  .000039*   -4.47898*  -4.38846*  -4.25509   |
  |  4 |  483.744  3.3822   4  0.496  .00004     -4.45688   -4.3405    -4.16903   |
  +---------------------------------------------------------------------------+
   Endogenous:  lnrobidn lnrobico
    Exogenous:  _cons

. vecrank lnrobidn lnrobico if t>tm(1994m1), lags(3)
                   Johansen tests for cointegration
Trend: constant                                    Number of obs =    164
Sample:  1994m2 - 2007m9                                    Lags =      3
-------------------------------------------------------------------------------
maximum                                         trace          5% critical
  rank   parms     LL           eigenvalue      statistic      value
    0     10     360.80188          .           18.5669        15.41
    1     13     369.33968      0.09888         1.4913*        3.76
    2     14     370.08533      0.00905
-------------------------------------------------------------------------------

. vecrank lnrobidn lnrobico if t>tm(1994m1), lags(2)

                   Johansen tests for cointegration
Trend      : constant                               Number of obs   =    164
Sample     :  1994m2 - 2007m9                       Lags            =      2
-------------------------------------------------------------------------------
maximum                                         trace          5% critical
  rank   parms     LL           eigenvalue      statistic      value
    0     6       353.7325          .           20.3273        15.41
    1     9      363.18037      0.10883         1.4315*        3.76
    2     10     363.89613      0.00869
-------------------------------------------------------------------------------

. vecrank lnrobidn lnrobico if t>tm(1994m1), lags(4)

                   Johansen tests for cointegration
Trend      : constant                               Number of obs   =    164
Sample     :  1994m2 - 2007m9                       Lags            =      4
-------------------------------------------------------------------------------
maximum                                         trace          5% critical
  rank   parms     LL           eigenvalue      statistic      value
    0     14      361.5532          .           20.1144        15.41
    1     17     370.74746      0.10607         1.7259*        3.76
    2     18     371.61042      0.01047
-------------------------------------------------------------------------------

. var d.lnrobidn d.lnrobico if t>tm(1994m1), lags(1/3)
Vector autoregression

Sample:  1994m2 - 2007m9                        No. of obs      =      164
Log likelihood  =  361.5532                     AIC             = -4.238454
FPE             =  .0000495                     HQIC            = -4.131027
Det(Sigma_ml)   =  .0000417                     SBIC            = -3.973831

Equation          Parms     RMSE    R-sq     chi2    P>chi2
----------------------------------------------------------------
D_lnrobidn          7    .100617   0.1661   32.65637   0.0000
```

```
D_lnrobico          7    .077242   0.0929   16.79921   0.0101
----------------------------------------------------------------
------------------------------------------------------------------------------
               |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
--------------- +--------------------------------------------------------------
D_lnrobidn     |
   lnrobidn    |
       LD.     | -.1914536   .0918158   -2.09 0.037      -.3714092 -.011498
      L2D.     | -.3302913   .0939015   -3.52 0.000      -.5143349 -.1462477
      L3D.     | -.0543583   .0970169   -0.56 0.575      -.244508   .1357914
               |
   lnrobico    |
       LD.     |  .5402221   .1171759    4.61 0.000      .3105617   .7698826
      L2D.     |  .2649823   .1235666    2.14 0.032      .0227961   .5071684
      L3D.     |  .1466019   .1239286    1.18 0.237      -.0962937  .3894975
               |
      _cons    | -.0011499   .0077053   -0.15 0.881      -.016252   .0139523
--------------- +--------------------------------------------------------------
D_lnrobico     |
   lnrobidn    |
       LD.     |  .0535002   .0704853    0.76 0.448      -.0846484  .1916488
      L2D.     | -.0161404   .0720865   -0.22 0.823      -.1574272  .1251465
      L3D.     | -.0006057   .0744781   -0.01 0.994      -.1465801  .1453687
               |
   Lnrobico    |
       LD.     |  .2335934   .0899537    2.60 0.009      .0572874   .4098995
      L2D.     |  .0600681   .0948598    0.63 0.527      -.1258537  .2459899
      L3D.     |  .0378454   .0951377    0.40 0.691      -.1486211  .2243119
               |
      _cons    |  .0020511   .0059152    0.35 0.729      -.0095426  .0136447
------------------------------------------------------------------------------
. vargranger
  Granger causality Wald tests
 +------------------------------------------------------------------------- +
 |        Equation          Excluded       |  chi2     df Prob > chi2       |
 |---------------------------------------- +------------------------------ |
 |      D_lnrobidn       D.lnrobico        |  27.53     3    0.000          |
 |      D_lnrobidn             ALL         |  27.53     3    0.000          |
 |---------------------------------------- +------------------------------ |
 |      D_lnrobico       D.lnrobidn        |  .70728    3    0.871          |
 |      D_lnrobico             ALL         |  .70728    3    0.871          |
 +------------------------------------------------------------------------- +

. var d.lnrobidn d.lnrobico if t>tm(1994m1), lags(1/2)
Vector autoregression

Sample:  1994m2 - 2007m9                        No. of obs      =      164
Log likelihood  =  360.8019                     AIC             = -4.278072
FPE             =  .0000475                     HQIC            = -4.201338
Det(Sigma_ml)   =  .0000421                     SBIC            = -4.089055

Equation          Parms     RMSE    R-sq     chi2     P>chi2
----------------------------------------------------------------
D_lnrobidn          5    .100411   0.1589    30.9816   0.0000
D_lnrobico          5    .076806   0.0917   16.55787   0.0024
----------------------------------------------------------------

------------------------------------------------------------------------------
               |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
--------------- +--------------------------------------------------------------
D_lnrobidn     |
   lnrobidn    |
       LD.     | -.1802272   .0902906   -2.00   0.046    -.3571937   -.0032608
      L2D.     | -.2985072   .0899894   -3.32   0.001    -.4748833   -.1221312
               |
   lnrobico    |
       LD.     |  .5374503   .1167505    4.60   0.000    .3086236     .766277
      L2D.     |  .2676044   .1206652    2.22   0.027    .0311049    .5041038
               |
      _cons    | -.0008433   .0077339   -0.11   0.913    -.0160016    .0143149
```

```
--------------- +-------------------------------------------------------------
D_lnrobico      |
   lnrobidn     |
       LD.      |   .0538896   .0690648    0.78   0.435   -.0814749    .1892541
      L2D.      |  -.0089625   .0688344   -0.13   0.896   -.1438755    .1259504
                |
   lnrobico     |
       LD.      |   .2352262   .0893043    2.63   0.008    .0601929    .4102595
      L2D.      |   .0654971   .0922988    0.71   0.478   -.1154052    .2463994
                |
      _cons     |   .0021379   .0059158    0.36   0.718   -.0094569    .0137327
------------------------------------------------------------------------------

. vargranger

   Granger causality Wald tests
  +------------------------------------------------------------------- +
  |          Equation          Excluded      |  chi2        df Prob > chi2  |
  |--------------------------------------+----------------------------- |
  |        D_lnrobidn       D.lnrobico      | 27.419       2    0.000       |
  |        D_lnrobidn             ALL       | 27.419       2    0.000       |
  |--------------------------------------+----------------------------- |
  |        D_lnrobico       D.lnrobidn      | .65966       2    0.719       |
  |        D_lnrobico             ALL       | .65966       2    0.719       |
  +------------------------------------------------------------------- +


. vec lnrobidn lnrobico if t>tm(1994m1), lags(3)
Vector error-correction model

Sample:  1994m2 - 2007m9                  No. of obs      =      164
                                          AIC             = -4.345606
Log likelihood  =  369.3397               HQIC            = -4.245852
Det(Sigma_ml)   =  .0000379               SBIC            = -4.099885

Equation          Parms     RMSE    R-sq     chi2    P>chi2
----------------------------------------------------------------
D_lnrobidn           6    .100689   0.1597   30.01854   0.0000
D_lnrobico           6    .073839   0.1668   31.62712   0.0000
----------------------------------------------------------------

-------------------------------------------------------------------------------
                |     Coef.     Std. Err.     z      P>|z|     [95% Conf. Interval]
--------------- +---------------------------------------------------------------
D_lnrobidn      |
       _ce1     |
        L1.     |     .0204929  .0584224    0.35     0.726      -.0940129  .1349987
                |
   lnrobidn     |
       LD.      |    -.1955381  .1017872   -1.92     0.055      -.3950374  .0039612
      L2D.      |    -.308665   .0961128   -3.21     0.001      -.4970427  -.1202874
                |
   lnrobico     |
       LD.      |     .5514667  .1254352    4.40     0.000       .3056182   .7973152
      L2D.      |     .2813517  .1289854    2.18     0.029       .0285449   .5341585
                |
      _cons     |    -.0010984  .0079099   -0.14     0.890      -.0166014  .0144047
--------------- +---------------------------------------------------------------
D_lnrobico      |
       _ce1     |
        L1.     |     .1605071  .0428432    3.75     0.000       .076536    .2444783
                |
   lnrobidn     |
       LD.      |    -.0660298  .0746442   -0.88     0.376      -.2123296  .0802701
      L2D.      |    -.0885218  .0704829   -1.26     0.209      -.2266658  .0496222
                |
   lnrobico     |
       LD.      |     .3450075  .0919861    3.75     0.000       .1647181   .5252969
      L2D.      |     .1731707  .0945896    1.83     0.067      -.0122214  .3585629
                |
```

```
      _cons     |    .0001402   .0058006    0.02     0.981     -.0112287  .0115092
-----------------------------------------------------------------------------------

Cointegrating equations
Equation         Parms    chi2     P>chi2
--------------------------------------------
_ce1               1   418.2954   0.0000
--------------------------------------------

Identification:  beta is exactly identified

              Johansen normalization restriction imposed
--------------------------------------------------------------------------------
      beta      |     Coef.  Std. Err.     z    P>|z|     [95% Conf. Interval]
--------------- +----------------------------------------------------------------
_ce1            |
   lnrobidn     |        1         .        .      .          .          .
   lnrobico     |  -1.350584  .0660359  -20.45  0.000   -1.480012  -1.221156
      _cons     |   1.876094         .       .      .          .          .
--------------------------------------------------------------------------------

. qui reg l.lnrobidn l.lnrobico
. predict rtmin1, resid
. rename rtmin1_01 rtmin1_plus
. rename rtmin1_02 rtmin1_min
. replace  rtmin1_plus=0 if  icomin<0
. rename rtmin1_01 rtmin1_plus
. replace  rtmin1_plus=0 if   rtmin1_plus<0
. replace  rtmin1_min=0 if   rtmin1_min>0

. reg d.lnrobidn  icoplus icomin rtmin1_plus rtmin1_min ld.lnrobidn l2d.lnrobidn
l3d.lnrobidn ld.lnrobico l2d.lnrobico l3d.lnrobico

     Source     |      SS      df      MS             Number of obs  =    209
--------------- +----------------------------        F( 10,   198)   =   9.95
      Model     | .721222621   10  .072122262        Prob > F        =  0.0000
   Residual     | 1.43471298  198  .007246025        R-squared       =  0.3345
--------------- +----------------------------        Adj R-squared   =  0.3009
      Total     |  2.1559356  208  .010365075        Root MSE        =  .08512
--------------------------------------------------------------------------------
  D.lnrobidn    |     Coef.  Std. Err.     t    P>|t|     [95% Conf. Interval]
--------------- +-----------------------------------------------------------------
    icoplus     |   .5932327  .1325789    4.47  0.000      .3317849   .8546805
     icomin     |    .603442  .1707579    3.53  0.001      .2667044   .9401797
 rtmin1_plus    |  -.0085367  .0559488   -0.15  0.879     -.1188687  .1017952
  rtmin1_min    |  -.0782045  .0611547   -1.28  0.202     -.1988027  .0423936
                |
   lnrobidn     |
        LD.     |  -.1812034  .0767572   -2.36  0.019     -.33257   -.0298368
       L2D.     |  -.2767786  .0755523   -3.66  0.000     -.4257691 -.1277881
       L3D.     |  -.0445714  .0756609   -0.59  0.556     -.1937761  .1046333
                |
   lnrobico     |
        LD.     |   .3341634  .0977771    3.42  0.001      .1413451   .5269816
       L2D.     |   .2360345  .0997074    2.37  0.019      .0394097   .4326593
       L3D.     |   .1155837  .0983583    1.18  0.241     -.0783805  .309548
                |
      _cons     |  -.0066921  .0122187   -0.55  0.585     -.0307875  .0174034
--------------------------------------------------------------------------------

. test
last test not found
r(302);
. help test
. test _b[ rtmin1_min]=_b[ rtmin1_plus]
 ( 1)  - rtmin1_plus + rtmin1_min = 0
      F(  1,   198) =    0.51
          Prob > F =    0.4747
. test _b[  icoplus]=_b[ icomin]
 ( 1)  icoplus - icomin = 0
```

```
      F(  1,   198) =    0.00
           Prob > F =    0.9677

. reg d.lnrobidn  d.lnrobico rtmin1_plus rtmin1_min ld.lnrobidn l2d.lnrobidn
l3d.lnrobidn ld.lnrobico l2d.lnrobico l3d.lnrobico

     Source     |       SS      df       MS           Number of obs   =     209
--------------- +---------------------------          F(  9,   199)   =   11.11
      Model     |  .721210687    9  .080134521        Prob > F        =  0.0000
   Residual     |  1.43472491  199  .007209673        R-squared       =  0.3345
--------------- +---------------------------          Adj R-squared   =  0.3044
      Total     |   2.1559356  208  .010365075        Root MSE        =  .08491

------------------------------------------------------------------------------
  D.lnrobidn    |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
--------------- +--------------------------------------------------------------
    lnrobico    |
         D1.    |   .5974032   .0835545    7.15   0.000     .4326375   .762169
                |
 rtmin1_plus    |  -.0082264   .0552844   -0.15   0.882    -.1172449  .1007921
  rtmin1_min    |  -.0782733   .0609777   -1.28   0.201    -.1985187  .0419721
                |
    lnrobidn    |
         LD.    |   -.181387   .0764313   -2.37   0.019    -.3321063 -.0306678
        L2D.    |  -.2767557   .0753605   -3.67   0.000    -.4253633 -.1281482
        L3D.    |  -.0446564    .075442   -0.59   0.555    -.1934247  .104112
                |
    lnrobico    |
         LD.    |   .3341976   .0975279    3.43   0.001     .1418768   .5265185
        L2D.    |   .2353701   .0981073    2.40   0.017     .0419068   .4288334
        L3D.    |   .1155862   .0981112    1.18   0.240    -.0778848  .3090573
                |
       _cons    |  -.0069977   .0095979   -0.73   0.467    -.0259243  .011929
------------------------------------------------------------------------------


. varsoc  lnaraidn lnaraico

   Selection-order criteria
   Sample:  2000m5 - 2007m9                    Number of obs      =       89
  +---------------------------------------------------------------------------+
  |lag |    LL      LR      df    p      FPE        AIC        HQIC       SBIC      |
  |----+----------------------------------------------------------------------|
  |  0 |   29.317                       .001855    -.613865   -.591324   -.557941   |
  |  1 |  213.231  367.83*   4  0.000  .000033*   -4.65688*  -4.58926*  -4.48911*  |
  |  2 |  215.385  4.3079    4  0.366  .000034    -4.6154    -4.50269   -4.33578   |
  |  3 |  216.376  1.9805    4  0.739  .000036    -4.54776   -4.38997   -4.15629   |
  |  4 |  219.041  5.3308    4  0.255  .000037    -4.51777   -4.3149    -4.01445   |
  +---------------------------------------------------------------------------+
   Endogenous:  lnaraidn lnaraico
    Exogenous:  _cons

. vecrank lnaraidn lnaraico, lags (1)

                      Johansen tests for cointegration
Trend      : constant                                    Number of obs =      92
Sample     :  2000m2 - 2007m9                                     Lags  =       1
-------------------------------------------------------------------------------
maximum                                      trace            5% critical
  rank    parms      LL          eigenvalue    statistic        value
    0      2      214.60294           .        15.8471          15.41
    1      5      222.43872      0.15662       0.1756*          3.76
    2      6      222.52651      0.00191
-------------------------------------------------------------------------------

. var d.lnaraidn d.lnaraico, lags (1/3)

Vector autoregression
```

```
Sample:  2000m5 - 2007m9                      No. of obs      =        89
Log likelihood  =  213.7555                   AIC             = -4.488888
FPE             =  .0000385                   HQIC            = -4.331097
Det(Sigma_ml)   =  .0000281                   SBIC            = -4.097417

Equation           Parms      RMSE     R-sq      chi2     P>chi2
----------------------------------------------------------------
D_lnaraidn           7     .102227   0.0730   7.007551   0.3201
D_lnaraico           7     .059321   0.0784   7.574221   0.2710
----------------------------------------------------------------

--------------------------------------------------------------------------------
                |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
--------------- +----------------------------------------------------------------
D_lnaraidn      |
    lnaraidn    |
         LD.    |  -.1450843   .1187122   -1.22   0.222    -.3777558   .0875873
        L2D.    |  -.1953572   .1239273   -1.58   0.115    -.4382502   .0475359
        L3D.    |  -.0150679   .1297257   -0.12   0.908    -.2693257   .2391898
                |
    lnaraico    |
         LD.    |    .387545   .1877288    2.06  0.039     .0196033        .7554867
        L2D.    |   .1304276   .1911035    0.68  0.495    -.2441283        .5049836
        L3D.    |   .1050475   .1882194    0.56  0.577    -.2638557        .4739508
                |
       _cons    |   .0064904   .0104443    0.62  0.534    -.0139801        .0269609
--------------- +------------------------------------------------------------------
D_lnaraico      |
    lnaraidn    |
         LD.    |   .0276022   .0688869    0.40  0.689    -.1074137        .1626181
        L2D.    |   .0680503   .0719132    0.95  0.344    -.072897         .2089975
        L3D.    |  -.0320712   .0752779   -0.43  0.670    -.1796133        .1154708
                |
    lnaraico    |
         LD.    |   .1313041   .1089363    1.21  0.228    -.0822071        .3448153
        L2D.    |  -.0594725   .1108945   -0.54  0.592    -.2768218        .1578768
        L3D.    |    .206381    .109221    1.89  0.059    -.0076881        .4204502
                |
       _cons    |   .0029415   .0060607    0.49  0.627    -.0089372        .0148202
-----------------------------------------------------------------------------------

. var d.lnaraidn d.lnaraico, lags (1/4)
Vector autoregression

Sample:  2000m6 - 2007m9                     No. of obs      =        88
Log likelihood  =  212.5164                   AIC            = -4.420828
FPE             =  .0000413                   HQIC           = -4.21668
Det(Sigma_ml)   =  .0000274                   SBIC           = -3.9141

Equation           Parms      RMSE     R-sq      chi2     P>chi2
----------------------------------------------------------------
D_lnaraidn           9     .103596   0.0822   7.885677   0.4447
D_lnaraico           9     .059055   0.1199   11.98746   0.1518
----------------------------------------------------------------

---------------------------------------------------------------------------------。
                |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
--------------- +-----------------------------------------------------------------
D_lnaraidn      |
    lnaraidn    |
         LD.    |  -.1504766   .1189488   -1.27  0.206    -.383612         .0826588
        L2D.    |  -.1896407   .1249196   -1.52  0.129    -.4344786        .0551972
        L3D.    |  -.0078655   .1327754   -0.06  0.953    -.2681005        .2523695
        L4D.    |  -.0038565   .1301539   -0.03  0.976    -.2589535        .2512405
                |
    lnaraico    |
         LD.    |   .4280886   .1926324    2.22  0.026     .0505361        .8056412
        L2D.    |   .1276166   .1943725    0.66  0.511    -.2533464        .5085796
        L3D.    |   .1358862   .1927552    0.70  0.481    -.2419071        .5136794
        L4D.    |  -.1508343   .1944226   -0.78  0.438    -.5318957        .2302271
```

```
                |
      _cons     |   .0057901   .0105455    0.55  0.583     -.0148787       .0264589
--------------- +----------------------------------------------------------------------
D_lnaraico      |
   lnaraidn     |
       LD.      |   .0198732   .0678069    0.29  0.769     -.1130258       .1527723
      L2D.      |   .0791276   .0712105    1.11  0.266     -.0604424       .2186976
      L3D.      |  -.0118369   .0756887   -0.16  0.876     -.1601841       .1365103
      L4D.      |   .0257368   .0741943    0.35  0.729     -.1196814       .171155
                |
   lnaraico     |
       LD.      |   .1776921   .1098103    1.62  0.106     -.0375321       .3929162
      L2D.      |  -.0733734   .1108022   -0.66  0.508     -.2905417       .1437949
      L3D.      |   .2293837   .1098803    2.09  0.037     .0140223        .444745
      L4D.      |  -.2195328   .1108308   -1.98  0.048     -.4367572      -.0023085
                |
      _cons     |   .0023184   .0060115    0.39  0.700     -.0094639       .0141006
-----------------------------------------------------------------------------------------

. var d.lnaraidn d.lnaraico, lags (1 )
Vector autoregression

Sample:  2000m3 - 2007m9                          No. of obs     =       91
Log likelihood  =  215.3784                        AIC           = -4.601723
FPE             =  .0000344                        HQIC          = -4.534933
Det(Sigma_ml)   =  .0000301                        SBIC          = -4.436172

Equation          Parms     RMSE    R-sq     chi2    P>chi2
----------------------------------------------------------------
D_lnaraidn          3    .100265  0.0471  4.499009  0.1055
D_lnaraico          3    .059291  0.0280   2.62221  0.2695
----------------------------------------------------------------
------------------------------------------------------------------------------
                |     Coef.  Std. Err.     z    P>|z|     [95% Conf. Interval]
--------------- +--------------------------------------------------------------
D_lnaraidn      |
   lnaraidn     |
       LD.      |   -.131991   .1172621   -1.13   0.260   -.3618204    .0978385
                |
   lnaraico     |
       LD.      |   .3742564   .1822099    2.05   0.040    .0171316    .7313811
                |
      _cons     |   .0053922   .0103386    0.52   0.602   -.0148711    .0256555
--------------- +--------------------------------------------------------------
D_lnaraico      |
   lnaraidn     |
       LD.      |   .0323235   .0693427    0.47   0.641   -.1035856    .1682327
                |
   lnaraico     |
       LD.      |   .1440858   .1077494    1.34   0.181   -.0670992    .3552707
                |
      _cons     |   .0021275   .0061137    0.35   0.728   -.0098551    .0141102
------------------------------------------------------------------------------

. vargranger
  Granger causality Wald tests
 +------------------------------------------------------------------ +
 |         Equation          Excluded      |  chi2    df Prob > chi2 |
 |-----------------------------------------+-------------------------|
 |       D_lnaraidn       D.lnaraico       | 4.2189    1    0.040    |
 |       D_lnaraidn             ALL        | 4.2189    1    0.040    |
 |-----------------------------------------+-------------------------|
 |       D_lnaraico       D.lnaraidn       | .21729    1    0.641    |
 |       D_lnaraico             ALL        | .21729    1    0.641    |
 +------------------------------------------------------------------ +

. reg l. lnaraidn l. lnaraico

     Source     |      SS       df      MS           Number of obs   =      92
--------------- +-----------------------------       F(  1,    90)   =  412.56
```

```
      Model     |  10.1691102     1  10.1691102        Prob > F        =  0.0000
   Residual     |  2.21839176    90  .024648797        R-squared       =  0.8209
--------------- +----------------------------          Adj R-squared   =  0.8189
      Total     |   12.387502    91  .136126395        Root MSE        =    .157

------------------------------------------------------------------------------
  L.lnaraidn    |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
--------------- +----------------------------------------------------------------
    lnaraico    |
        L1.     |   1.196576    .058911    20.31   0.000     1.079539    1.313613
                |
      _cons     |  -.9877359   .2610615    -3.78   0.000     -1.50638   -.4690917
------------------------------------------------------------------------------

. predict raraidnico, resid
(1 missing value generated)
. rename raraidnico_01 raraidnico_plus
. rename raraidnico_02 raraidnico_min
. replace  raraidnico_plus=0 if raraidnico_plus<0
(41 real changes made)
. replace   raraidnico_min=0 if  raraidnico_min>0
(52 real changes made)
. gen deltaico=d.lnaraico
(1 missing value generated)
. rename deltaico_01 deltaico_plus
. rename deltaico_02 deltaico_min
. replace   deltaico_plus=0 if   deltaico_plus<0
(47 real changes made)
. replace   deltaico_min=0 if   deltaico_min>0
(46 real changes made)

 reg d.lnaraidn  deltaico_plus deltaico_min raraidnico_plus raraidnico_min ld.lnaraidn
ld.lnaraico

     Source     |       SS       df       MS           Number of obs   =      91
--------------- +----------------------------          F(  6,    84)   =    3.89
      Model     |  .201904135     6  .033650689        Prob > F        =  0.0018
   Residual     |  .726499318    84  .008648801        R-squared       =  0.2175
--------------- +----------------------------          Adj R-squared   =  0.1616
      Total     |  .928403453    90  .010315594        Root MSE        =    .093

------------------------------------------------------------------------------
  D.lnaraidn    |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
--------------- +----------------------------------------------------------------
deltaico_p~s    |   .9644673   .3203532     3.01   0.003     .3274099    1.601525
deltaico_min    |   .1052185   .3667921     0.29   0.775    -.6241878    .8346247
raraidnico~s    |  -.1010036   .1442237    -0.70   0.486    -.3878082    .1858009
raraidnico~n    |  -.2451728   .1186905    -2.07   0.042    -.4812019   -.0091437
                |
    lnaraidn    |
        LD.     |  -.0634474   .1188148    -0.53   0.595    -.2997238    .1728289
                |
    lnaraico    |
        LD.     |   .2016399   .1772879     1.14   0.259    -.1509166    .5541964
                |
      _cons     |  -.0243816   .0204491    -1.19   0.236     -.065047    .0162837
------------------------------------------------------------------------------

. test _b[ raraidnico_plus]=_b[ raraidnico_min]
 ( 1)  raraidnico_plus - raraidnico_min = 0
      F(  1,    84)    =    0.42
           Prob > F    =    0.5166

. test _b[ deltaico_plus]=_b[ deltaico_min]
 ( 1)  deltaico_plus - deltaico_min = 0
      F(  1,    84)    =    2.13
           Prob > F    =    0.1484
```

Appendix 5.STATA COMAND FOR CHAPTER FIVE

BELOW IS THE STATA RESULT USED IN COLUMN 1 AND 2

N=34 COUNTRIES

```
. xtabond2 lnex_quant l.lnex_quant otanew lngdp_imp lngdp_exp lndist lrca i.geo, gmm(l(0
2).(lnsize2  lndist)) ivstyle(lndist  l2.lrca) noleveleq robust two

Favoring space over speed. To switch, type or click on mata: mata set matafavor speed,
perm.
lndist dropped due to collinearity
0b.geo dropped due to collinearity
1.geo dropped due to collinearity
2.geo dropped due to collinearity
Warning: Number of instruments may be large relative to number of observations.
Warning: Two-step estimated covariance matrix of moments is singular.
  Using a generalized inverse to calculate optimal weighting matrix for two-step
estimation.
  Difference-in-Sargan/Hansen statistics may be negative.

Dynamic panel-data estimation, two-step difference GMM
------------------------------------------------------------------------------
Group variable  : ccode                         Number of obs        =     306
Time variable   : year                          Number of groups     =      34
Number of instruments = 73                      Obs per group: min   =       9
Wald chi2(5)    =    40.25                      avg                  =    9.00
Prob > chi2     =    0.000                      max                  =       9
------------------------------------------------------------------------------
                |           Corrected
  lnex_quant    |     Coef.  Std. Err.     z    P>|z|    [95% Conf. Interval]
--------------- +--------------------------------------------------------------
  lnex_quant    |
        L1.     |  .5904364  .1149233    5.14  0.000    .3651908    .815682
                |
      otanew    | -.4596975    .22673   -2.03  0.043   -.9040801  -.0153148
   lngdp_imp    |  .0449823  .2962041    0.15  0.879    -.535567   .6255317
   lngdp_exp    |  .5063494  .1683962    3.01  0.003    .1762989   .8363998
       lrca     |  .7621934  .2213691    3.44  0.001     .328318   1.196069
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.(lndist L2.lrca)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(1/11).(lnsize2 L2.lnsize2 lndist L2.lndist)
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -3.06  Pr > z =  0.002
Arellano-Bond test for AR(2) in first differences: z =  -1.33  Pr > z =  0.184
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(68)   =  82.00  Prob > chi2 =  0.118
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(68)   =  30.38  Prob > chi2 =  1.000
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  iv(lndist L2.lrca)
    Hansen test excluding group:    chi2(67)    =  30.38  Prob > chi2 =  1.000
    Difference (null H = exogenous): chi2(1)    =  -0.00  Prob > chi2 =  1.000


. xtabond2 lnex_quant l.lnex_quant otanew lngdp_imp lngdp_exp lndist lrca i.geo,
gmm(l(1).(lnsize2  lndist)) ivstyle(lndist  l2.lrca) two robust

Favoring space over speed. To switch, type or click on mata: mata set matafavor speed,
perm.
0b.geo dropped due to collinearity
Warning: Number of instruments may be large relative to number of observations.
Warning: Two-step estimated covariance matrix of moments is singular.
```

```
  Using a generalized inverse to calculate optimal weighting matrix for two-step
estimation.
  Difference-in-Sargan/Hansen statistics may be negative.

Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable  : ccode                         Number of obs      =       340
Time variable   : year                          Number of groups   =        34
Number of instruments = 76                      Obs per group: min =        10
Wald chi2(8)    =   520.77                      avg                =     10.00
Prob > chi2     =    0.000                      max                =        10
------------------------------------------------------------------------------
               |              Corrected
  lnex_quant   |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
--------------- +----------------------------------------------------------------
  lnex_quant   |
        L1.    |   .8625311   .0796401    10.83 0.000      .7064394   1.018623
               |
      otanew   |  -.3873396   .1868097    -2.07 0.038      -.75348    -.0211993
   lngdp_imp   |   .1760033   .1775022     0.99 0.321      -.1718947  .5239013
   lngdp_exp   |   .3674415   .1456368     2.52 0.012      .0819987   .6528844
      lndist   |  -1.790943   .3856593    -4.64 0.000      -2.546822  -1.035065
        lrca   |   .7592468   .2397084     3.17 0.002      .2894269   1.229067
               |
         geo   |
          1    |   2.415899   .7428398     3.25  0.001      .95996    3.871838
          2    |   6.241804   1.211701     5.15  0.000    3.866914    8.616693
               |
       _cons   |  (omitted)
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.(lndist L2.lrca)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(1/11).(L.lnsize2 L.lndist)
Instruments for levels equation
  Standard
    lndist L2.lrca
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    D.(L.lnsize2 L.lndist)
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -3.50  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =  -1.27  Pr > z =  0.204
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(67)   =  71.97  Prob > chi2 =  0.317
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(67)   =  24.15  Prob > chi2 =  1.000
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:    chi2(57)    =  24.23  Prob > chi2 =  1.000
    Difference (null H = exogenous): chi2(10)   =  -0.08  Prob > chi2 =  1.000
  iv(lndist L2.lrca)
    Hansen test excluding group:    chi2(65)    =  24.82  Prob > chi2 =  1.000
    Difference (null H = exogenous): chi2(2)    =  -0.67  Prob > chi2 =  1.000


.

BELOW IS RESULT USING DATA IN COLUMN 3 N=48

. sum

    Variable   |       Obs        Mean    Std. Dev.       Min        Max
--------------- +--------------------------------------------------------
     country   |        0
        year   |       576      2006.5    3.455053       2001       2012
         caf   |       576    .0833333    .2766256          0          1
```

```
        ceu      |       576    .4583333    .4986939          0          1
        cas      |       576        .375    .4845437          0          1
-------------- +--------------------------------------------------------
        cam      |       576    .0833333    .2766256          0          1
   ex_quant      |       576    8164.484    15020.54          0      89601
    gdp_imp      |       576    9.47e+11    2.16e+12   2.10e+09   1.60e+13
    gdp_exp      |       576    4.53e+11    2.39e+11   1.60e+11   8.80e+11
    pop_exp      |       576    2.29e+08    1.12e+07   2.10e+08   2.50e+08
-------------- +--------------------------------------------------------
       dist      |       576    9042.167    3945.059    886.141   19116.09
        rca      |       576    4.020424    .7696851    2.57727    5.27685
 ln_exquant      |       560    7.579612    2.023472          0   11.40312
  ln_gdpimp      |       576    26.30648    1.639077    21.4652   30.40361
 ln_gdp_exp      |       576    26.69646    .5440292   25.79844   27.50319
-------------- +--------------------------------------------------------
    ln_dist      |       576    8.966342    .6228541   6.786876   9.858286
     ln_rca      |       576    1.371692    .2027942   .9467307   1.663329
      ccode      |       576    31.16667    17.20425          2         62
        geo      |       576        1.25    1.051707          0          3

. xtabond2  ln_exquant  l.ln_exquant ln_gdp_exp ln_gdpimp ln_dist ln_rca i.geo, gmm(l(0
4).( ln_exquant  ln_gdpimp ln_rca )) ivstyle( ln_dist ln_rca) nodiff robust

Favoring space over speed. To switch, type or click on mata: mata set matafavor speed,
perm.
0b.geo dropped due to collinearity
Warning: Number of instruments may be large relative to number of observations.
Warning: Two-step estimated covariance matrix of moments is singular.
  Using a generalized inverse to calculate robust weighting matrix for Hansen test.

Dynamic panel-data estimation, one-step system GMM
------------------------------------------------------------------------------
Group variable  : ccode                          Number of obs        =      502
Time variable   : year                           Number of groups     =       48
Number of instruments = 183                      Obs per group: min   =        6
Wald chi2(8)    =   974.69                                  avg       =    10.46
Prob > chi2     =    0.000                                  max       =       11
------------------------------------------------------------------------------
               |              Robust
  ln_exquant   |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------- +----------------------------------------------------------------
  ln_exquant   |
        L1.    |   .7366956   .0607497    12.13   0.000     .6176283    .8557629
               |
  ln_gdp_exp   |   .0542205    .084872     0.64   0.523    -.1121256    .2205667
   ln_gdpimp   |   .1345761   .0565455     2.38   0.017     .0237491    .2454032
     ln_dist   |  -.5150934   .1825236    -2.82   0.005     -.872833   -.1573537
      ln_rca   |   .4367707   .1612145     2.71   0.007     .1207961    .7527452
               |
         geo   |
          1    |   1.310617   .3324482     3.94   0.000     .6590309    1.962204
          2    |    .575365   .2725979     2.11   0.035      .041083    1.109647
          3    |   1.247545   .4580775     2.72   0.006     .3497298    2.145361
               |
       _cons   |   .6107679   2.389109     0.26   0.798    -4.071799    5.293335
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.(ln_dist ln_rca)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(1/11).(ln_exquant L4.ln_exquant ln_gdpimp L4.ln_gdpimp ln_rca L4.ln_rca)
Instruments for levels equation
  Standard
    ln_dist ln_rca
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    D.(ln_exquant L4.ln_exquant ln_gdpimp L4.ln_gdpimp ln_rca L4.ln_rca)
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -3.86  Pr > z =  0.000
```

```
Arellano-Bond test for AR(2) in first differences: z =  -1.41  Pr > z =  0.159
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(174)  = 532.18  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(174)  =  43.83  Prob > chi2 =  1.000
  (Robust, but weakened by many instruments.)



. xtabond2  ln_exquant  l.ln_exquant otanew ln_gdp_exp ln_gdpimp ln_dist ln_rca i.geo,
gmm(l(0 4).( ln_exquant  ln_gdpim
> p ln_rca )) ivstyle( ln_dist ln_rca) nodiff robust
Favoring space over speed. To switch, type or click on mata: mata set matafavor speed,
perm.
0b.geo dropped due to collinearity
Warning: Number of instruments may be large relative to number of observations.
Warning: Two-step estimated covariance matrix of moments is singular.
  Using a generalized inverse to calculate robust weighting matrix for Hansen test.

Dynamic panel-data estimation, one-step system GMM
------------------------------------------------------------------------------
Group variable  : ccode                         Number of obs        =      502
Time variable   : year                          Number of groups     =       48
Number of instruments = 183                     Obs per group: min   =        6
Wald chi2(9)    =  1025.53                                     avg   =    10.46
Prob > chi2     =    0.000                                     max   =       11
------------------------------------------------------------------------------
             |               Robust
  ln_exquant |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  ln_exquant |
        L1.  |    .737013   .0603648    12.21   0.000       .6187    .8553259
             |
      otanew |   .0594353   .2032881     0.29   0.770    -.339002    .4578726
  ln_gdp_exp |   .0347463   .1291191     0.27   0.788   -.2183225    .2878151
   ln_gdpimp |   .1315464   .0584325     2.25   0.024    .0170208     .246072
     ln_dist |  -.5070975   .1901264    -2.67   0.008   -.8797385   -.1344566
      ln_rca |   .4309158   .1600069     2.69   0.007     .117308    .7445236
             |
         geo |
          1  |   1.300842    .342691     3.80   0.000    .6291797    1.972504
          2  |   .5425929   .3194628     1.70   0.089   -.0835427    1.168728
          3  |   1.248337   .4572413     2.73   0.006    .3521604    2.144513
             |
       _cons |   1.149982   3.444907     0.33   0.739   -5.601912    7.901876
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.(ln_dist ln_rca)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(1/11).(ln_exquant L4.ln_exquant ln_gdpimp L4.ln_gdpimp ln_rca L4.ln_rca)
Instruments for levels equation
  Standard
    ln_dist ln_rca
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    D.(ln_exquant L4.ln_exquant ln_gdpimp L4.ln_gdpimp ln_rca L4.ln_rca)
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -3.88  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =  -1.41  Pr > z =  0.158
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(173)  = 532.27  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(173)  =  41.05  Prob > chi2 =  1.000
  (Robust, but weakened by many instruments.)
```